

The Jahangirnagar Review

Part II: Social Science, Vol. XLII, 2018



Journal of
The Faculty of Social Sciences
Jahangirnagar University

**The
Jahangirnagar Review**
Part II: Social Science, Vol. XLII, 2018

Editor
Professor Dr. Rasheda Akhtar



Journal of
The Faculty of Social Sciences
Jahangirnagar University
Savar, Dhaka-1342
Bangladesh

The Jahangirnagar Review
Part II: Social Science
Vol. XLII, 2018, Printed in February 2020
ISSN 1682-7422

Editorial Board

Editor : Professor Dr. Rasheda Akhtar

Members : Professor Dr. Al Masud Hasanuzzaman
Professor Md. Nisar Ahmed Shams
Professor Dr. Mohammad Nayeem Aziz Ansari
Professor Dr. M. Shafiq-Ur Rahman
Dr. Jebunnessa
Mr. Mohammad Ibrahim Khalad

Published by

Jahangirnagar University
Savar, Dhaka-1342, Bangladesh

Notes to Contributors

The Jahangirnagar Review is published annually in three parts: Part I: Physical and Mathematical Science, Part II: Social Science, and Part III: Humanities and Arts. The Jahangirnagar Review: Part II: Social Science invites articles, notes and book reviews on any subject relevant to Social Science.

Two complete hard copies (paper copies) plus a CD copy (in MS word) of the manuscript should be submitted. Papers must not cover more than 20 pages. Manuscripts should be typed on one side of the paper, double-spaced, with ample margins. The first page of a paper should bear the title of the contribution, the names(s) and the affiliations(s) of the all the contributors and full postal addresses together with the e-mail addresses (if any) of the corresponding authors. The second page should include the title, but exclude the authors' name to assist the blind review process. All articles should include an abstract of not more than 150 words. Main text should be followed by acknowledgements, footnotes and references. Excessive endnotes to the texts should be avoided.

Authors should supply clear copies of original artwork (figures) for illustrations, in a finished format suitable for reproduction. Please note that the editor will wish to reproduce illustrations at the smallest practical size that allows for ready interpretation by readers. Tables should be numbered consecutively.

References should be cited in the text by giving the surname(s) of the authors(s) followed by the date of publication for example, Jackson (1989) or (Hossain and Khan, 1992). The page numbers of all quotations should be included with the reference, for example, (Akhter et. al., 1993:14). Multiple references should be separated by semi-colons for example, (Chowdhury, 1990; Rahman, 1994). If two or more works of the same author in the same year are cited, the works should be distinguished by using the subscripts a, b, c, along with the year for example (Islam, 1991a, 1991b, 1991c). The details of all references should be listed according to the following form:

Books

Sarantakos, S. 1994. *Social Research*, London: Macmillan Press Ltd.

Journal articles

Muhuri, P.K. and Menken, J. 1997. Adverse effects of next birth, gender, and family composition on child survival in rural Bangladesh, *Population Studies*, 51:279-294.

Books (edited volume)

Ahsan, R. M. 1998. Migration pattern and process of female construction labour in Dhaka City, Bangladesh, in N. Islam (ed) *Recent Urban Studies, Bangladesh, A collection of USP research Papers*, PP. 113-133. Dhaka: USP.

Internet Journal Article

Schilling, J. 1999. Sustainable brownfield redevelopment, *Mayor's Asia Pacific Environmental Summit Proceedings*, U.S., Enterprise for The Environmental, <http://www.csis.org/e4e/Mayor43schilling.html>.retrieved on 22.09.2005.

Webpage

ABC NEWS. 2005. <http://medialit.med.se.edu/playingwithyourmind.information> retrieved on April 4, 2005.

Titles of journals should not be abbreviated. Articles are accepted for consideration on the understanding that they are not being submitted elsewhere. The editorial board is not responsible for the opinions and statements of the authors.

Address of correspondence

Editor

The Jahangirnagar Review: Social Science
Faculty of Social Sciences
Jahangirnagar University
Savar, Dhaka-1342, Bangladesh.
email: deansoci@juniv.edu

Price: Taka 300.00 (Outside Bangladesh: US\$ 5.00)

Printed by: Momin Offset Press, Dhaka.

Contents

Mala Rani Das Prof. Mohammad Amzad Hossain	Impact of macroeconomic indicators on income inequality of Bangladesh: A cointegration approach	1
Muhammad Rabiul Islam Liton Md. Elias Hossain	Estimating Production Function and Return to Scale of Handloom Units in Tangail District of Bangladesh	15
Mohammad Jahangir Alam Shinji Kaneko	Technology Innovation and Changes of SHS Packages in Rural Bangladesh: A Description	27
Nahid Sultana Md. Saruar Hossain Millat Dipti Bhowmik Md. Nurunnabi Talukder	Revisiting the Relationship Between Fertility and Income: An Empirical Study on Bangladesh	41
Md. Mizanur Rahman Md. Nazrul Islam	Effectiveness of Co-management Approach in the Protected Areas of Sundarbans: A Double-Edged Sword Tools for Biodiversity Conservation	53
Murad Billah Bibi Hafsa Ummul Momanin Coalee	Identifying Optimal Location for Cyclone Shelters of Patuakhali District in Bangladesh: A GIS Based Approach	71
Khairunnahar Khandakar Hasan Mahmud Md. Abu Sayeid	Reproduction of the selected historical maps at present coordinate system used at the Great Voyage of Christopher Columbus	89
Ebadullah Khan	Spatial and Temporal Dynamics of the Coastal Vegetation: A Case Study of the Maheshkhali Island, Cox's Bazar, Bangladesh	111

Faria Kabir Mehedi Iqbal Md. Ashraful Habib Dr. Md. Shahedur Rashid Palash Chandra Karmaker	Extracting Thermal Data from Satellite Sensors: A Case Study between Landsat and Weather Observatory of Dhaka Metropolitan Area	125
Rezaul Roni	Extracting Building from Very High-Resolution Satellite Image through Object-Based Image Analysis for Dhaka City	137
Tasfin Aziz	The Scope of Integrating Auxiliary Conservations Areas in the Regional Planning System: Experiences from China, India and the Philippines	153
Afsana Nasreen Ummeh Saika Mohammad Nayeem Aziz Ansari	A Discourse on Incoherence between Industrialization leads Environmental Degradation and Conservation Sundarbans	169
Sahinur Rahman Mohammad Sujoun Lasker Md. Nurul Islam	River Training Program and Hydro Morphological Dynamics: A Case Study of Bangabandhu Bridge at Jamuna River	183
Dr. Muhammad Sayadur Rahman	Climate risks for girl-focused developEffectiveness of the Committee Systems at Union Parishad in Bangladeshment initiatives in Bangladesh	197
Umme Salma Sonia Md. Manjur Morshed Jebunnessa	Changes in Pre and Post Aila Livelihood Vulnerability Level in Batiaghata, Khulna	211
Md. Nazmul Haque Md. Rakibul Islam Saifullah Bin Ansar	Assessing the Water Supply, Sanitation and Waste Dumping Condition of Urban Slum: A GIS Based Approach	223
Afsana Haque Fatima Kabir Sharna Asif Khan	Is the Railway plus Property model of Hong Kong replicable in Dhaka's TODs?	237
Abu Zubair Sania Sifat Miti	Household Coping Strategies to Reduce the Effects of Flood on Livelihood Pattern: A Case Study on Sariakandi	251
Dr. Halima Begum	Housing Preferences of the Urban Poor: Case Study of Selected Low Income Settlements in Dhaka	263

Abu Zubair Farhana Akter	Kitchen Market Waste Management System and Opportunities: A Case Study on New Market Bonolata and Mirpur-1 Kitchen Market	277
Muhammad Rashidul Hasan Md. Kausar Uddin Mohammad Mizanur Rahman Md. Rakibul Hasan Kauser	Analysis of Access to Water: A Case Study on Some Selected Slum Areas of Chittagong City	295
Dr. Adil Mohammed Khan Farsia Naznin	People's Participation in Physical Planning Process: A Case Study of Detailed Area Plan Preparation for Dhaka City	311
Dr. Rasheda Akhtar Md Sazzadul Alam Noor Kutubul Alam Siddiquee	Education for Visually Impaired: Congeniality Study of Digital Talking Book	327
Ranjan Saha Partha	The Bipolar of Politics: The Role of Political Parties in the Post Peace Accord Context of Chittagong Hill Tracts	337
Md Mossabber Hossain	A Review of the Development of Online Environmental Impact Assessment Process in Bangladesh	347
Kamrul Hasan	Regional Conflicts and Conventional security in South Asia: Is Human Security Overlooked?	359
Muhammad Kamruzzaman	Understanding the New Dimensions of Bangladesh-India Relations: A Critical Analysis	391
Md. Sayeed Al-Zaman Manir Uddin Sikder	Impact of Digital Media on Electoral Campaign: A Study on 2018 Parliamentary Election in Bangladesh	407

Impact of macroeconomic indicators on income inequality of Bangladesh: A cointegration approach

Mala Rani Das*

Prof. Mohammad Amzad Hossain**

Abstract: Unemployment and inflation are key economic indicators of any country. The main objective of this study is to investigate the impact of unemployment and inflation on the income inequality of Bangladesh using data from the period 1991 to 2017. The study has used econometric techniques on time series data. Stationarity of data has been checked by using Augmented Dickey-Fuller (ADF) test. All data are found to be stationary at first difference. The result of Johansen co-integration test has confirmed that there is a long-run relationship between the variables. In the long run a 1% increase in inflation and unemployment leads to almost 1.76% decrease and 10.87% increase in income inequality respectively. The result of vector error correction (VECM) model indicates that inequality requires approximately 0.29%, inflation requires 4.92% and unemployment requires 0.37% of error correction per year to reach equilibrium. The result of Granger Causality shows that there is a unidirectional causality running from inequality to unemployment. The result of impulse response function indicates that any external shock on particular variables has positive and negative effects on itself and on other variables respectively over time.

Key words: Unemployment, inflation, income inequality, co-integration, Granger Causality, impulse response function.

Introduction

Equality is a primary principle of democratic society and inequality, particularly income inequality, presents a brief picture of society that exhibit who receives what. According to a report of IMF-if the top 20% of earners raise their income share by 1 %, GDP actually shrinks in the following five years. Where income rises for the poorest 20 percent, however, the GDP rises by about one-third of a percent (Picchi, A. 2015). One of the great challenges of the present time is nothing but increase in inequality. Too much inequality may give incentives to the individual to divert their endeavor toward having favored treatment that leads to a misallocation of resources, corruption, and nepotism which cause huge social costs, in terms of undermining the opportunities for the poor and middle income class. The GINI coefficient is a widely used tool for measuring income inequality that ranges from 0(perfect equality) to 1 (perfect inequality).

* Lecturer, Department of Economics, Jahangirnagar University, Savar, Dhaka-1343,
Email: mrdas@juniv.edu

** Professor, Department of Economics, Jahangirnagar University, Savar, Dhaka-1343,
Email: amzad104@gmail.com

Table 1: Trend in income inequality in Bangladesh during 1991 to 2016

Year	National	Rural	Urban
1991-92	0.39	0.36	0.40
1995-96	0.43	0.38	0.44
2000	0.451	0.393	0.497
2005	0.467	0.428	0.497
2010	0.458	0.430	0.452
2016	0.483	0.454	0.498

(Source: Bangladesh Bureau of Statistics (BBS) of various years, Different HIES)

According to BBS, HIES (Household Income and Expenditure Surveys) 2016, the percentage share of income of the lowest 5 percent households has decreased from 0.78 to 0.23 percent respectively in HIES 2010 to HIES 2016. On the other hand, the income share of top 5 percent households has increased from 24.61 percent in 2010 to 27.89 percent in 2016 (BER 2017). Recently inequality has recaptured a key role in the macroeconomic debate. Inequality dynamics has connection to unemployment and inflation. Unemployment and inflation as key macroeconomic indicators have immense impact on income inequality as well as on welfare. Arthur Okun, distinguished the adverse effects of unemployment and inflation through the misery index - the sum of the unemployment and inflation rates that revealed how rising values of unemployment and inflation lowered national well-being (Blanchflower et al. 2013). There is a cause and effect relationship between unemployment and inequality. Unemployment is the cause and inequality is the effect. . Unemployment, whether it is cyclical, structural or frictional, adds to the hardship of the jobless workers. To meet the daily necessities they start borrowing that leads to debt burden leading towards a debt trap. This widens the income gap between employed and unemployed person, aggravating the inequality problem. Income inequality adversely affects the standards of living. Hyper-inflation also causes similar trouble by reducing the purchasing power. Hyper-inflation hurts the poor much more than the rich. However, there is a downward trend in inflation rate in recent years. Mild inflation is beneficial to economic activities as it creates favorable investment opportunities which provides greater number of people with employment and so on. So the effect of inflation on income inequality is debatable. Although income inequality is affected by many factors, among those unemployment and inflation are two macroeconomic indicator that have severe influence on income inequality. The central aim of this study is therefore to show the impact of unemployment and inflation on the income inequality of Bangladesh. This study has the following specific objectives:

- i. To investigate whether there exists any long run relationship between income inequality and Inflation as well as between unemployment and income inequality and their impact on the income inequality.
- ii. To explore whether there exists any causal relationship between the variables.
- iii. To examine the external shocks on the variables

Literature Review

Siarni-Namino and Hudson (2017) setting gini index as a function of inflation, GDP per capita, unemployment rate, international trade openness, & urbanization index and utilizing panel data of 26 developed and 66 developing countries over the period 1990 to 2014, the results of Kao residual cointegration test confirmed a long-run co-integration between variables, and also confirmed a non-linear relationship between inflation and income distribution. Moreover from Granger-causality the study showed that in short run there were no bidirectional causality between inflation and income inequality but in long run it was for developed and developing countries. Bratoeva-Manoleva (2017) applying OLS and using data from 1990 to 2015, the result indicated that GDP growth and structural changes were the key determinants that intensified the income inequality of Bulgaria. Govt. spending on social payment were statistically significant but had inverse impact on income inequality, while inflation, FDI & education were statistically insignificant.

Focusing on Kenya, Uganda and Tanzania and using data from 1975 to 2015 Ndungi (2017) examined the effect of inflation, unemployment, interest rates, and international trade openness on income inequality of East Africa. Result revealed that in Kenya inflation had a negative significant effect, interest rate had a positive significant effect and Unemployment and international trade openness had long term insignificant effect on income inequality. But in Uganda inflation, unemployment and international trade openness had negative significant impact and interest rate had positive significant impact on income inequality. Where in Tanzania inflation and international trade openness had positive significant impact and unemployment and interest rate had negative significant impact on income inequality. Deyshappriya (2017) using dynamic panel data analysis over 1990–2013 across 33 Asian countries the study found an inverted U-shaped relationship between GDP and inequality. It was also found that in Asian countries inequality reduced by education, official development assistance (ODA), and labor force participation where inequality increased by the political risk, terms of trade, higher inflation and unemployment. Mihaylova and Bratoeva-Manoleva (2017) investigated the impact of various kinds of social transfers in Bulgaria from 2000–2014 and concluded that social transfers (pension, unemployment benefit, family allowance and other social benefits) lessen the income inequality. Among the social transfers pension dispensed great impact on reducing inequality, pension and unemployment were mostly equally distributed among different deciles, family allowances had weaker impact and other social benefits were concentrated on the richest decile.

Ali (2016) using ARDL and VECM model to examine the relationship between macroeconomic instability and income inequality over the time 1980 to 2015 Ali (2016) disclosed that macroeconomic instability had great impact on income inequality of Pakistan. Odeh (2015) wanted to examine the effect of trade openness on income inequality involving five Latin American countries - Brazil, Argentina, Colombia, Paraguay, and Uruguay from the time 2000 to 2012. Result revealed that trade openness and unemployment had negative significant impact on income inequality where ideology of govt. had positive significant impact and inflation had no significant impact on income inequality. Matin (2015) from Bangladesh indicated that rising growth was associated by

rising inequality over the period under consideration. Monnin (2014) linking variables like unemployment, inflation, business cycles, unionization, economic development level, skill-biased technological change and international trade openness of ten OECD countries over the period 1971 to 2010, the study found a U-shaped link between long-run inflation and income inequality. Inequality decreases with the increase in inflation reached a minimum with an inflation rate of about 13%, and then starts rising again. Using a large panel analysis (200 economies) Skare and Stjepanovic (2014) mentioned the crucial determinants of income distribution such as Inflation, unemployment, export, labour force, and population. Hassine (2014) wanted to investigate the economic inequality in 12 Arab countries and identified moderate inequality with gross expenditure-based gini coefficient ranging from less than 32 in Libya and Egypt while more than 40 in Mauritania, Tunisia and Yemen. Also added that variation in demographic composition, human capital and community characteristics seemed to be the main sources of the urban–rural inequality. Where variation in returns to human capital were the main variation of metropolitan and non-metropolitan regional inequality.

Thalassinos et al. (2012) taking inequality index named gini as dependent variable and the inflation rate, the growth rate, the employment level and the openness of the economies as independent variables for the period 2000 to 2009 in 13 European countries, the study revealed that inflation had a positive significant effect on income inequality. Maestri and Roventini (2012) analyzed inequality series for some OECD countries, such as the U.S., the U.K., Germany, Sweden, the Netherlands, and Canada and found that most of inequality series were not stationary and in most of the cases inequality series were counter-cyclical except Germany. However granger causality test suggested that in some cases inequality series help to predict output fluctuations. Using data 1983 to 2009 Faik (2012) from Germany expressed that demographic ageing leads to a increase in inflation, unemployment and growth rate where inflation increases income inequality and growth rate and unemployment rate reduces income inequality. That is demographic ageing reduces income inequality by lowering inflation rate, increasing growth rate as well as unemployment rate. Habibov (2012) indicated that inequality was very high in low-income transitional Countries of the Caucasus. Study suggested that the rise in inequality in low-income transitional countries in 2006 was mainly led by a combination of human capital factors (e.g. access to higher education) and institutional factors (e.g. social security or lack of gender mainstreaming).

Hoover et al. (2009) conducted asymmetric cointegration tests method to exhibit the influence of unemployment and immigration shocks on income inequality and exposed that positive and negative shocks to the economy neither had equal effects nor did the effect of these shocks affect income quintiles identically. DiPietro et al. (2005) using Phillips-Hansen fully modified OLS method to find out the relationship between four key macroeconomic variables (such as trade, inflation rate, real interest rate, and unemployment rate) and the seven topmost income shares for the United States from 1961 to 1998. The study concluded that the extent of trade, unemployment, inflation rate and real interest rate were highly significant in demonstrating the shares of the highest income groups are complicated and seems to have no easy answer on whether inflation or unemployment is detrimental to the standard of living of UK.

Galli (2001) explored the impact of Akinbobola and Saibu (2004) from Nigeria using vector autoregressive model referred that decrease in unemployment had progressive impact on human development which leads to a reduction in poverty. Jenkins and Jäntti (2001) noted that the effect of macroeconomic conditions on inequality monetary policy and inflation on the income inequality. Then referred that countries with high inflation there restrictive monetary policy might be helpful for inequality but countries with a low inflation there reduction of inflation may rise inequality which is supported by US and 15 OECD countries. Decomposing unemployment in to structural and cyclical unemployment Mocan (1999) wanted to find the impact of unemployment and inflation on income inequality of US. Then revealed that rising structural unemployment had prolonged effect on income inequality and because of unforeseen factors inflation also had augmented effect on income inequality. Cardoso et al. (1995) dividing the population of Brazil of six largest metropolitan into five groups the researchers measured inequality within and between the groups. Researchers expressed that in all metropolitan areas, except *Sgo* Paulo change in unemployment and inflation could illustrate about one-third of all in the level of inequality. Inflation stretched a reduction impact on real income of all educational groups especially had strong impact on the middle-income group.

Reviewing the existing literature it has been identified that very few studies have been conducted in Bangladesh in this area of role of macroeconomic indicators on income inequality. That’s why this study has been conducted.

Data and methodology

In this study income inequality has been represented by Gini coefficient which is taken in percentage form used as a dependent variable. Inflation has been represented by consumer price index (CPI) is taken in annul percentage growth. Unemployment rate is taken as percentage of total labor force (modeled ILO estimated) used as independent variables. The data of income inequality has been taken from UNDP data and data of CPI & unemployment rate have been taken from World Development Indicators (WDI) over the period 1991 to 2017.

If a time series in non-stationary it may give spurious regression, hence the time series need to stationary. Augmented Dickey Fuller (ADF) test has been applied to check the stationarity and to check the existence of unit root in the time series. The ADF test run the following regression equation with a constant and trend form:

$$\Delta Y_t = \beta_1 + \beta_2 t + \alpha Y_{t-1} + \lambda_j, \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t \dots\dots\dots (1)$$

Where Y_t is the time series variables under consideration, t is linear deterministic trend, ε_t is error term and m refers to the number of lag in the dependent variable which is selected by the Schwarz criteria. The ADF test evaluates the null hypothesis of $\alpha = 0$, representing the time series has a unit root. If $H_0: \alpha \neq 0$, then it represents the time series is stationary. Therefore if null hypothesis is rejected at first difference, then the series is regarded as integrated of order I i.e. $I(1)$ and so on. Johansen Co-integration test (Johansen, 1988;

Johansen and Juselius, 1990) has later been performed to determine the co integrating vectors.

Two test statistics that are used to identify the number of cointegrating vectors as follows.

The trace test is computed as:

$$\lambda_{trace(r)} = -T \sum_{i=r+1}^h \ln(1 - \hat{\lambda}_i) \dots\dots\dots(2)$$

and the maximum Eigen value test is computed as:

$$\lambda_{\max(r,r+1)} = -T \ln(1 - \hat{\lambda}_{r+1}) \dots\dots\dots(3)$$

Where T = number of observation and $\hat{\lambda}_i$ is the estimated values of the matrix and r is the number of cointegrating vectors under the null hypothesis. The $\lambda_{trace(r)}$ is a joint test that test the null hypothesis of r cointegrating vectors against the alternative hypothesis of more than 1 cointegrating vectors. Where the $\lambda_{\max(r,r+1)}$ test the null hypothesis that the number of cointegration vectors r against the alternative $r+1$ cointegrating vectors (Brooks 2008).

After then restricted VAR model i.e. VECM is constructed when the series are cointegrated to see the short-run and long-run dynamics of the relationship estimating the following equations:

$$\Delta Gini = \alpha_{11} + \alpha_x V_{t-i} + \sum_{i=1}^k \gamma_{11,i} \Delta Gini_{t-i} + \sum_{i=1}^k \gamma_{12,i} \Delta CPI_{t-i} + \sum_{i=1}^k \gamma_{13,i} \Delta Unem_{t-i} + \epsilon_1$$

$$\Delta CPI = \alpha_{21} + \alpha_y V_{t-i} + \sum_{i=1}^k \gamma_{21,i} \Delta CPI_{t-i} + \sum_{i=1}^k \gamma_{22,i} \Delta Gini_{t-i} + \sum_{i=1}^k \gamma_{23,i} \Delta Unem_{t-i} + \epsilon_2$$

$$\Delta Unem = \alpha_{31} + \alpha_z V_{t-i} + \sum_{i=1}^k \gamma_{31,i} \Delta Unem_{t-i} + \sum_{i=1}^k \gamma_{32,i} \Delta Gini_{t-i} + \sum_{i=1}^k \gamma_{33,i} \Delta CPI_{t-i} + \epsilon_3$$

The Granger causality test for two time series, like y_t and x_t involves running the following modes:

$$y_t = \delta_0 + \sum_i^{I+r} \alpha_{1t} y_{t-i} + \sum_i^{I+r} \beta_{1t} x_{t-i} + u_{1t}$$

$$x_t = \delta_0 + \sum_i^{I+r} \alpha_{2t} x_{t-i} + \sum_i^{I+r} \beta_{2t} y_{t-i} + u_{2t}$$

Here, r = order of integration, I = optimum lag order, α and β are the coefficients of y_t and x_t and

u_{1t} and u_{2t} = error term

Finally, impulse response function (IRF) function and variance decomposition can be designed. IRF shows how changes in one variable resulting from external shocks may affect the other variable over time. It can be stated as following bivariate framework:

$$\Omega_i = \phi_i B^{-1} \Lambda^{1/2} \dots\dots\dots(4)$$

Where B^{-1} is the coefficients matrix of all the variables at time t , $\Lambda^{1/2}$ denotes lower Cholesky decomposition of the variance –covariance matrix of μ_t , and ϕ_i represents another matrix that shows the effects of a one unit increase in error term at date t (μ_t) on the value of the other variable at time $t+s$. Forecast error variance decompositions shows the contribution of each type of shock to the forecast error variance. Both are helpful in evaluating how shocks to economic variables reverberate through a system.

Results and Discussion

This section covers the results of different time series models that the study intended to estimate. It begins with the descriptive statistics of the variables then present the other results step by step. Here gini represents income inequality, Cpi represents inflation and unem stands for unemployment.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Gini	27	49.88148	6.491535	39.40	60.80
Cpi	27	6.165444	2.394898	2.007174	11.33292
Unem	27	3.562333	.815840	2.20	5.00

From the summary statistics significant variability can be seen in each variables.

Result of unit root test:

Table 3: Augmented-Dickey-Fuller (ADF) test

Variables	(Intercept) Level	(Trend and intercept) Level	(Intercept) First difference	(Trend and intercept) First difference
Gini	0.715634	-1.674540	-4.628895***	-4.628259***
Cpi	3.681897***	-4.031663**	-6.803378***	-6.761440***
Unem	-1.778845	-1.778845	-5.766193***	-5.860588***

Note: ***is 1% level of significance and ** is 5% level of significance. Table 2 shows that all the variables are stationary at 1% level of significance in case both with trend and without trend.

Table-4: Unrestricted Cointegration Rank Test (Trace)

Maximum rank	Eigen value	Trace statistic	Critical value 0.05
None *	0.565677	32.39334	29.79707
At most 1	0.365348	11.54415	15.49471
At most 2	0.007062	0.177184	3.841466

Trace test indicates 1 cointegratingeqn (s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

In case of the trace statistic test, the null of no co-integrating vectors is rejected since the trace statistic of 32.39334 is greater than the 5% critical value of 29.79707. Moving on to test the null of at most 1 and 2 co-integrating vectors, the trace statistic is less than the 5% critical value, so the null hypothesis is accepted at 5%. Finally, results indicate the existence of one integrating relationship among the variables in the series.

Long-run impact of inflation and unemployment on income inequality of Bangladesh (1991 – 2017) are shown in Table-5.

Table 5: Normalized Cointegrating Coefficients

Cointegrating equation(s)	Coint Eq ¹	SE	T Stat
Gini	1.000000		
Cpi	1.763386	(0.55501)	3.177214***
Unem	-10.87866	(1.41724)	7.675947***

The values of the normalized co integrating coefficient indicate that in the long run the explanatory variables inflation is negatively and unemployment is positively related to the income inequality. In the long run 1% increase in inflation leads to almost 1.76% decrease in income inequality and 1% increase in unemployment leads to a 10.87% increase in income inequality respectively.

Vector Error Correction Model (VECM):

VECM can be used when there is cointegrated series, if not then VAR model would be utilized. As there is one cointegrating equation according to trace test, so VECM can be run.

Table 6: Vector Error Correction Estimates (Speed of Adjustment)

Cointegrating Equation(s)	Coint Eq1	SE	T-Stat
D(Gini)	0.002933	(0.00220)	[1.33454]
D(Cpi)	-0.049216	(0.02434)	[-2.02203]
D(Unem)	-0.003732	(0.00284)	(0.00284)
C	-91.66735		

VECM indicates that inequality requires approximately 0.29% of error correction per year, so inequality becomes in equilibrium after 345 years, inflation requires 4.92% of error correction per year to reach equilibrium, so inflation becomes in equilibrium after 21 years and unemployment requires approximately 0.37% error correction per year to reach equilibrium, so unemployment becomes in equilibrium after 270 years.

Granger Causality:

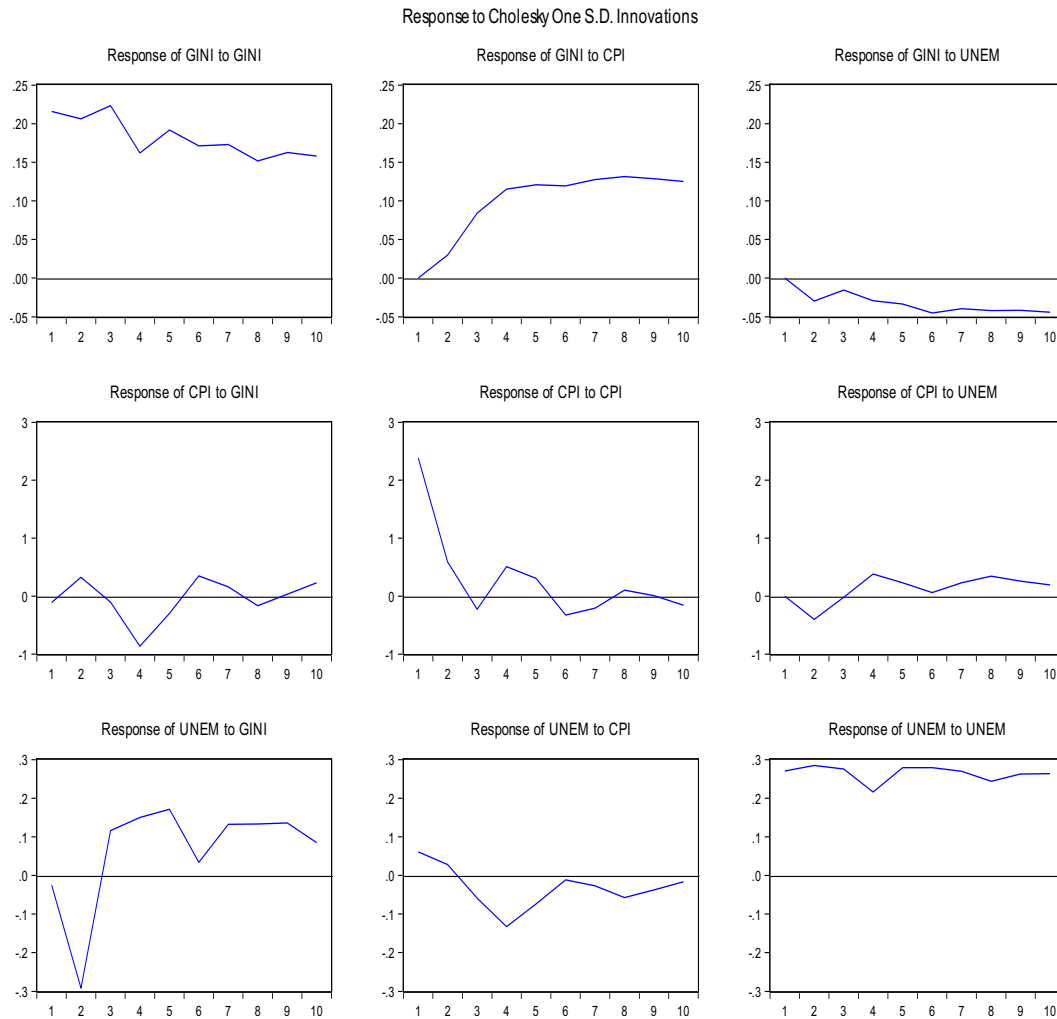
Granger Causality suggests that if p-value is greater than 0.05 critical value then we cannot reject null hypothesis rather we accept null hypothesis.

Table 7: Granger Causality (Lags 2)

Null hypothesis	Obs	F-statistic	Prob.	Granger Causality
CPI does not Granger Cause GINI	25	0.47952	0.6260	No
GINI does not Granger Cause CPI	25	1.18468	0.3264	No
UNEM does not Granger Cause GINI	25	0.68384	0.5161	No
GINI does not Granger Cause UNEM	25	11.1378	0.0006	Yes
UNEM does not Granger Cause CPI	25	2.34034	0.1221	No
CPI does not Granger Cause UNEM	25	0.20687	0.8148	No

From the table we see that there is uni-directional causality running from inequality to unemployment.

Impulse Response Function



We consider ten years forward following a shock in VAR model is shown by horizontal axis of the figure. The vertical axis shows estimated values of a response variable following an external shock. The upper part of the figure shows how income inequality is responding from one standard deviation shock from inequality, inflation and unemployment. We find that own shock and other shock causes a rise in inequality. Middle part presents how inflation is reacting to its own shock as well as shock from inequality and unemployment. Shock causes a positive and negative effect on inflation. Lower part shows how unemployment is reacting to a shock on inequality, inflation as well as to its own shock.

Variance Decomposition:

Table 8: Variance Decomposition of Gini (inequality):

period	S.E	Gini	CPI	Unem
1	0.215654	100.0000	0.000000	0.000000
2	0.301413	98.05043	0.975231	0.974339
3	0.384822	93.85290	5.387926	0.759178
4	0.434119	87.66935	11.27555	1.055105
5	0.490799	83.82292	14.88111	1.295975
6	0.535220	80.69681	17.49986	1.803330
7	0.578068	78.11736	19.87023	2.012416
8	0.613373	75.49559	22.24748	2.256928
9	0.648852	73.75997	23.81394	2.426095
10	0.680882	72.37955	24.99665	2.623799

In short run i.e. at year 3, own shock of inequality account for 93.85290 percent variation of the fluctuation in inequality. Then shock to CPI can cause 5.387926 percent fluctuation in inequality, but shock on unemployment cause 0.759178 percent fluctuation in inequality. In long run i.e. at year ten, own shock of inequality contributes 72.37955 percent, shock to CPI contributes 24.99665 percent fluctuation in the variance of inequality. Finally an impulse or shock on unemployment can cause 2.623799 percent fluctuation in inequality. Comparing short and long run we see that in short run inequality contributes 93.85290 percent variation of inequality but in long run contribution has gone down to 72.37955 percent. While CPI causes more fluctuation 24.99665 percent of the inequality in long run and contribution of unemployment is 2.623799 percent in the long run.

Table 9: Variance Decomposition of CPI

period	S.E	Inequality	CPI	Unem
1	2.387955	0.219360	99.78064	0.000000
2	2.512934	1.851881	95.60814	2.539976
3	2.525597	1.999239	95.47878	2.521978
4	2.744000	11.59975	84.31578	4.084466
5	2.786673	12.39799	82.95363	4.648382
6	2.827709	13.54111	81.89728	4.561615
7	2.849031	13.64697	81.21374	5.139288
8	2.876201	13.72287	79.81587	6.461264
9	2.888099	13.62308	79.16019	7.216728
10	2.908004	14.06717	78.36800	7.564831

Comparing short and long run, we see that a shock on inequality contributes slightly in long run. A shock on unemployment contributes much in the fluctuation of CPI in long run. But a shock on CPI i.e. own shock highly contributes to itself in the short run but slightly less in the long run.

Table 10: Variance Decomposition of Unem (unemployment)

period	S.E	Inequality	CPI	Unem
1	0.278186	0.786180	4.788456	94.42536
2	0.494740	35.13031	1.840407	63.02928
3	0.581039	29.44807	2.348695	68.20324
4	0.651511	28.75460	5.980392	65.26501
5	0.732737	28.19059	5.737887	66.07152
6	0.784907	24.75628	5.022220	70.22150
7	0.840984	24.04718	4.474656	71.47816
8	0.887553	23.83230	4.436167	71.73153
9	0.936349	23.51817	4.144409	72.33742
10	0.976465	22.38088	3.839353	73.77977

Finally a shock to unemployment can cause 68.20324 percent in the forecast error variance of unemployment and in long run it contributes much to 73.77977 percent. Meaning that a shock to inequality and a shock to CPI cannot influence unemployment both in short run and in long run

Conclusion and Recommendation

The study investigated the impact of unemployment and inflation on income inequality of Bangladesh. ADF test and Johansen co-integration test were used. Long run relationships between variables were found. The results show that inflation has significant negative relationship and unemployment has significant positive relationship with income

inequality. The results show that in the long run 1% increase in inflation and unemployment leads to almost 1.76% decrease and 10.87% increase in income inequality respectively. Applying VECM, the study indicates that inequality requires approximately 0.29%, inflation requires 4.92% and unemployment requires 0.37% of error correction per year to reach equilibrium. Furthermore the result of Granger causality shows that there is a uni-directional causality running from inequality to unemployment. The results of impulse response function indicate that any external shock on particular variables have positive and negative effects on itself and on other variables over time. Unemployment has positive impact on aggravating the income inequality situation while inflation lessen income inequality situation. This support the findings of Ndungi (2017), Monnin (2014), Akinbobola and Saiba (2004), Mocan (1999) and contradict with the findings of Odeh (2015), Faik (2012), Thalassions et al. (2012). Although unemployment and inflation as key macroeconomic indicators have significant impact on income inequality, income inequality is also affected by other factors like urbanization, globalization, political risk, education, trade, FDI, growth, productivity, and so on. Therefore further study can be performed with this variation and variation with time frames as well as techniques. Some policies towards better income distribution should be adopted to lessen the degree of income inequality such as redistributing land, improving human capital of the poor, providing better opportunity of education and healthcare, spending on rural infrastructure, providing sufficient rural credit, increasing spending on social protection, and providing better governance and monitoring. This therefore put much importance on the fiscal policy measures.

References

- Akinbobola*, T. O., & Saibu, M. O. O. (2004). Income inequality, unemployment, and Poverty in Nigeria: a vector autoregressive approach. *The Journal of Policy Reform*, 7(3), 175-183.
- Ali, A. (2016). Issue of Income Inequality under the perceptive of Macroeconomic Instability: An Empirical Analysis of Pakistan.
- Bratoeva-Manoleva, S. (2017). *Macroeconomic Determinants of Income Inequality in Bulgaria* (No. bep-2017-07). St Kliment Ohridski University of Sofia, Faculty of Economics and Business Administration/Center for Economic Theories and Policies.
- Blanchflower, D. G., Bell, D. N., Montagnoli, A., & Moro, M. (2013). The effects of Macroeconomic shocks on well-being. *Manuscript, University of Stirling*.
- BER (2017). Bangladesh Economic Review Brooks, C. (2008) Introductory Econometrics for Finance.
- Cardoso, E., Barros, R. P., & Urani, A. (1995). Inflation and unemployment as determinants of Inequality in Brazil: the 1980s. In *Reform, Recovery, and Growth: Latin America and the Middle East* (pp. 151-176). University of Chicago Press.
- Deyshappriya, N. R. (2017). Impact of Macroeconomic Factors on Income Inequality and Income Distribution in Asian Contries.
- DiPietro, W. R., Anoruo, E., & Sawhney, B. (2005). Macroeconomic Determinants of the Income Shares of the Very Highest Income Groups. *Review of applied Economics*, 1(1), 85-98.
- Dickey DA and Fuller WA (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, *Econometrica* 49:1057-1072.

- Faik, J. (2012). Impacts of an ageing society on macroeconomics and income inequality—the case of Germany since the 1980s.
- Galli, R. (2001). Is inflation bad for income inequality: The importance of the initial rate of Inflation.
- Hoover, G. A., Giedeman, D. C., & Dibooglu, S. (2009). Income inequality and the business cycle: A threshold cointegration approach. *Economic Systems*, 33(3), 278-292.
- Hassine, N. B. (2014). *Economic inequality in the Arab region*. The World Bank.
- Habibov, N. (2012). Income inequality and its driving forces in transitional countries: Evidence from Armenia, Azerbaijan and Georgia. *Journal of Comparative Social Welfare*, 28(3), 209-221.
- Jenkins, S. P., & Jäntti, M. (2001). *Examining the Impact of Macro-Economic Conditions on Income Inequality*. Institute for Social and Economic Research, University of Essex
- Johansen, S. (1988) Statistical Analysis of Cointegrating Vectors, *Journal of Economic Dynamics and Control* 12:231-54.
- Johansen, S. and Juselius, K. (1990) Maximum Likelihood Estimation and Inference on Cointegrating with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics* 52: 169-211
- Mocan, H. N. (1999). Structural unemployment, cyclical unemployment, and income inequality. *Review of Economics and Statistics*, 81(1), 122-134.
- Matin, K. A. (2015). Economic Growth and Inequality in Bangladesh
- Monnin, P. (2014). Inflation and income inequality in developed economies. CEP working paper
- Maestri, V., & Roventini, A. (2012). Inequality and macroeconomic factors: A time-series analysis for a set of OECD countries. LEM working paper series.
- Mihaylova, S., & Bratoeva-Manoleva, S. (2017). Social transfers and income inequality in Bulgaria. *South East European Journal of Economics and Business*, 12(1), 38-49.
- Ndungu, G. M. (2017). *Effects Of Macroeconomic Factors On Income Inequality In East Africa* (Doctoral dissertation, KCA University).
- Odeh, O. (2015). *The Effect of Trade Openness on Income Inequality Selected Latin American Countries* (Master's thesis, Eastern Mediterranean University (EMU)-Doğu Akdeniz Üniversitesi (DAÜ)).
- Picchi, A. (2015). Is trickle-down economics to blame for inequality? Retrived from <https://www.cbsnews.com/news/the-failure-of-trickle-down-economics/>
- Škare, M., & Stjepanovic, S. (2014). Income distribution determinants and inequality—International comparison. *Amfiteatru Economic Journal*, 16(37), 980-993.
- Siami-Namini, S., & Hudson, D. (2017). Inflation and Income Inequality in Developed and Developing Countries.
- Thalassinos, I. E., Ugurlu, E., & Muratoglu, Y. (2012). Income Inequality and Inflation in the EU. *European Research Studies Journal*, 15(1), 127-140.

Estimating Production Function and Return to Scale of Handloom Units in Tangail District of Bangladesh

Muhammad Rabiul Islam Liton*
Md. Elias Hossain**

Abstract: Production function specifies the technical relationship between output and combination of factor inputs assuming certain state of technology during a time period. It is an externally given relationship that influences decision making of the firms as well the whole industry. Estimation of production function also provides information about returns to scale which has significant impact on firm survival, farm productivity and farm concentration. However, scant attention has been given on production function and returns to scale with regard to the handloom sector of Bangladesh. Therefore, the aim of this study is to estimate the production function to obtain relationship of handloom outputs with different inputs used in the production process. It also aims at estimation the returns to scale of the handloom units. To the end, the study collected required data from 90 handloom units located in Sadar and Delduar upazilas of Tangail district, the traditional handloom concentrated areas in Bangladesh, and employed the Cobb-Douglas production function model to explore the technical relationship between handloom production and factors that contribute to production. The analysis found that handloom industry is a labor intensive weaving industry because share of labor is higher in all cases than that of capital. The estimated production function for the sample handloom units exhibited increasing return to scale. The disaggregated analysis showed that small scale units exhibited same return to scale. While, due to use more unskilled family members and small scale of production, single units exhibited decreasing return to scale. On contrast, due to diminishing marginal productivity of labor and capital as well as low managerial control over labor decreasing return to scale has been found in large scale handloom units.

Keywords: Production function, Return to scale, Cobb-Douglas, Handloom industry, Bangladesh.

Introduction

In Economics, production function specifies the technical relationship between output and combination of factor inputs assuming certain state of technology during a time period. It is an externally given relationship to the entrepreneurs that influence decision making of the firms as well the whole industry (Banaeian 2011). The estimation of production function provides deeper understanding about the production process of firms, and a good number research studies have been devoted to empirically estimate the technical relationship between output and factor inputs with regard to various firms or industries. Estimation of production function also enables to measure the contribution of various factors or factor shares in production of commodities or services (Cobb and

* PhD Fellow, Department of Economics, University of Rajshahi, Bangladesh and Assistant Professor, Department of Economics, Mawlana Bhashani Science and Technology University, Bangladesh.
Email: rabiul388@gmail.com (Corresponding author).

** Professor, Department of Economics, University of Rajshahi, Bangladesh. Email: eliaseco@ru.ac.

Douglas, 1928). In addition, production function addresses efficiency in the use of factor inputs in production and the resulting distribution of income to those factors. Therefore, under certain assumptions, the production function can be used to derive the marginal product for each factor, which implies an ideal division of the income generated from output into income to each input factor of production. Production function also indicates the manner in which a firm can substitute one input for another without altering the total output and when price is taken into consideration, the production function helps to select the least cost combination of inputs for desired level of output of a commodity. In short, the relationship between output and inputs as expressed by the production function, governs the decision of firms regarding the scale of production, input use and substitution of factors aiming at achieving least cost combination or maximizing production with certain amount of inputs.

In the studies involving the production function, attentions were also given on costs, revenue and output behavior in response to changes in inputs used. That is, estimation of production function provides information about the extent of returns attainable by the entrepreneurs from their productive activities at different scale of production and the laws governing the changes in output due to changes in inputs. This is generally known as returns to scale which reveals the relative economic efficiency of an industry. Increasing returns to scale indicates producing more output with the same amount of input while decreasing returns lead to inefficiency or misuse of factors of production (Khreisat, 2011). It is believed that in case of the handloom industry, observed heterogeneity among the firms crucially depends on firm level returns to scale. Moreover, returns to scale matters for the shape of the cost curve and thus supply curve of handloom products (Gao and Kehrig 2017). Differences in returns to scale then translate into differences in relative factor prices in the industry. Thus, returns to scale has significant impact on firm survival, farm productivity and farm concentration with regard to hand loom industry.

Handloom is considered as a promising sector for rural development in Bangladesh. A large segment of population in rural areas in the country is engaged with this sector. According to the Handloom Census 2003, around 0.89 million people in Bangladesh is directly employed in the industry and an additional 0.5 million in related tasks (BBS 2005). Again the sector, employed 0.48 million family weavers in the industry who can do handloom activity as a supplementary occupation. Therefore, handloom industry is considered as an important source of additional income to the rural households, and thus it contributes significantly to rural poverty alleviation (Islam and Elahi 1991). Handloom units use various input factors specifically- labor, capital and yarn in large quantities in the production process, and estimation of production function of handloom industry in the study area would explain the marginal productivity of employed labor, capital and yarn that would help the price determination of inputs in competitive markets.

Handloom industry uses heterogeneous labor with respect to gender, age, education, and experience. It also employs capital and yarns of heterogeneous types and values. In order to maximize return or profit, handloom owners need to substitutes cheaper inputs for costly ones. Estimating the production function provides required information in this regard. Handloom industry in Bangladesh has developed in the rural areas where labor is abundant compared to capital. However, it is important to know the appropriate

technology, labor intensive or capital intensive, that would ensure efficiency and gives profit maximizing level of output. By estimating factor contributions, production function identifies the factor intensity of the industry and helps in choosing right technique of production. With the help of cost function, production function identifies the optimal combination of labor, capital and yarn to produce certain amount of handloom products during a period of time that ensures maximum profits for the weavers. Therefore, production function model can be used as a practical tool for solving a number of planning and analytical tasks associated with handloom industry (Rezepin et al. 2017).

According to Banerjee et al. (2014), although handloom units play important role in the rural economy of Bangladesh, there are several issues and reasons existing that require proper investigation. Due to low profitability in handloom activity, number of handlooms decreased drastically in recent decades (Liton et al. 2016). In addition, a huge number of looms remain non-operational. Therefore, handloom faces a critical moment in the recent years. For reviving the handloom sector it required to identify the appropriate input-output relationship in the sector and identify the appropriate combination of inputs which ensures more profit in the activity. Thus, the aim of the study is to estimate production function and to identify the returns to scale of production for handloom units in the study area.

The paper is structured with six sections. After introducing the issue in current section, section 2 discusses the previous related literature. In the next section the study presents features of handloom units and the methodological structure is explained in section 4. Section V discusses the results of the estimated model and finally last section presents the summary of findings of the study.

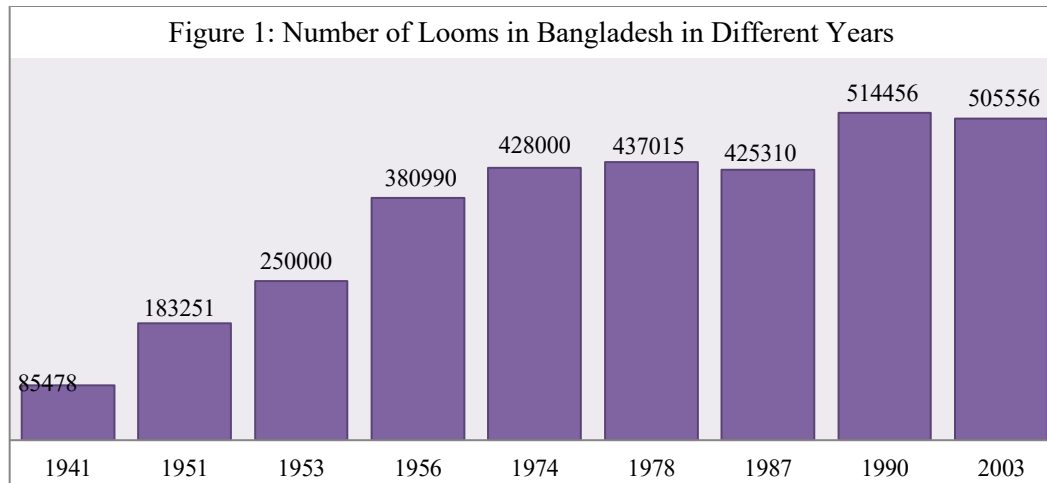
Literature Review

Although almost no study has been found to have estimated the production function and returns to scale in the context of handloom industry, a significant number of previous studies have been devoted to estimate the production function and return to scale for textile manufacturing industry. Using Cobb-Douglas production model, Nurunnajib et al. (2018) estimated the production function for textile manufacturing firms in Indonesia where the share of labor and capital were 0.0715 and 0.9303, respectively, with increasing return to scale (1.0018) indicating that capital's share greater than labor's share and the sample textile manufacturing firms were found to be operating at the stage of increasing returns to scale. The authors held that increasing the scale of production through adding more capital would increase the profit of the textile firms. Hossain et al. (2013) found a decreasing return to scale (0.708) in the same industry in Bangladesh. The study found that a one percent increase in labor would result in 0.194 percent increase in output and a one percent increase in capital would result in 0.515 percent increase in output. In contrast, Husain and Islam (2016) found increasing return to scale in textile manufacturing industry in Bangladesh. Therefore, output elasticity of labor and capital, the study found, are 0.712 and 0.409, respectively. In addition, Banerji (2007) also found increasing return to scale (1.065) in Indian textile manufacturing industry.

Khalil (2005) estimated a translog production function for Jordanian textile manufacturing industry. The study found cost share of labor, capital and material as 0.0810, 0.1778 and 0.7413, respectively. The study also found constant capital share elasticity with respect to capital, labor and material as 0.0182, 0.0056 and 0.0237, respectively, and constant material share elasticity with respect to labor and materials, and constant labor share elasticity of labor with respect to labor are -0.0253, 0.0490 and 0.0198, respectively. Finally the study used Cobb-Douglas production function and found elasticity of output for labor, capital and material as 0.1377, 0.20561 and 0.6567, respectively. It is found that most of the previous studies estimating production function for textile manufacturing industry have used Cobb-Douglas production model. In addition, analyzing data of handloom census 1990, Jaforullah (1999) employed both translog and Cobb-Douglas production functions in for handloom data from collected by handloom board in the year 1990. The author found that production technology of handloom, a traditional technique textile, can be well represented by Cobb-Douglas functional form. The author concluded that production technology of the Bangladesh handloom industry is homogeneous of degree one and it is well represented by Cobb-Douglas functional form. Therefore, the study attempts to estimate production function and return to scale by using Cobb-Douglas production function. Islam and Hossain (2015) investigated the technical efficiency of the handlooms firms in Kushtia district of Bangladesh and using the Cobb-Douglas production function framework the authors found significant inefficiency existing in the production.

Handloom Industry in Bangladesh

Handloom is a traditional weaving industry in Bangladesh. Weavers of ancient Bengal started to produce cloth through handloom during the early thirteenth century. Within few years the industry spread out in Capital Dhaka and adjacent areas like Sonargao, Dhamrai, Gazipur etc. Finally weavers of Dhaka improved their production technique and introduced world famous Dhaka Muslin. From the early stage handloom industry in Bangladesh goes through ups and downs. It is evident from Figure 1 that handloom increased tremendously from very early periods. Until the rise of the British Rule, production of Muslin and other handloom products increased continuously and exported to Europe and other parts of the world. During the British Rule handloom faced many adverse situations and after that period the industry has revived again, although through a long way of ups and downs. Figure 1 presents that handloom industry of Bangladesh has gradually developed since the 1940s.



Source: Ministry of Textile (MOT) and Bangladesh Bureau of Statistics and cited in BBS (2005).

Due to trade liberalization during the 1970s and 1980s handloom faced high competition with powerloom and mill sectors. Therefore, number of looms decreased drastically after the 1990s. Currently 0.51 million handlooms are operating in Bangladesh in 0.18 million units. Presently handloom industry in Bangladesh concentrates in some regions viz. Sirajgonj, Tangail, Pabna, Narshingdi, Kustia district and produces mainly Sharee, Lungi, Gumcha etc.

With the passing of time, handloom industry of Bangladesh experienced huge structural changes. Initially weavers of Bangladesh used only Pit looms for handloom production. During 1950s the weavers started to use another types of looms called Chittaranjan loom. Then use of Chittaranjan looms increased tremendously during following decades and during 1980s it holds equal share to Pit looms. Up to this time period handloom weavers used only Pit and Chittaranjan looms. After 1990, weavers started to use other types of handlooms like Frame loom, Waist loom (Komor loom) etc. Finally, according to the latest estimation in 2003 share of pit loom, Chittaranjan loom and others loom becomes 34%, 30% and 36% respectively.

Due to various locational advantages, handloom firms of Bangladesh have concentrated in some regions viz. Sirajgonj, Tangail, Pabna, Narshingdi, Kustia, etc. and they are producing several products like Sharee, Lungi, Gumcha, bedcover, towel, etc. Handloom is considered as rural industry in Bangladesh. More than 90% handloom units, containing near about 92% of looms, are located in rural areas of Bangladesh and thus, contributed rural economy by providing employment and income. In addition, handloom is considered as a family based private economic activity. Almost 99% units containing more than 95% handlooms are family based while the rest 1% units which contain 4.4% looms units are operating under partnership or cooperative arrangements. Handloom activity is often characterized as small business and more than 90% handloom units in Bangladesh are of small size that operates maximum 5 looms among which 51.43% are single units. Although small in number (8.40%) medium-size units operates a significant

number of looms (28.92%). The reason is, in most of the cases handloom owners are poor and therefore are not able to increase their unit size.

Handloom is an important source of employment for rural people in Bangladesh. It employed 0.89 million people directly, of which a large number (0.42 million) are female. It provides work opportunity for the family members in a family environment, who generally cannot work outside the family environment. In the handloom units hired labor work side by side the family labors and according to the 2003 census, the number of family labors and hired labors working in this industry are 0.41 million and 0.48 million, respectively. The percentage of weavers employed in different categories of units are: 54% in small scale (less than 5 looms) units, 19.7% in single-loom units, 35% in medium scale (6-19 loom) units and 11% in large scale (20 and more looms) units.

The industry in Bangladesh has been facing various problems that caused a set back of the industry in recent years in terms of number of loom and units. The main set back happened after 1987 when the operational rate of looms in handloom industry has decreased drastically and in 2003, it is observed that more than 38% looms are non-operational while the rate was only around 27% in 1987. The reason for such non-operation of units is lack of capital. With prevalence of poverty among the weaver households and lack of access to capital, many of the handloom owners ceased to operate their units. Other problems include lack of timely supply of raw materials, low price of handloom products, marketing problem, lack of skilled labor, lack of government support, less profitability and competition from alternative non-farm occupations in the rural areas.

Methodology

Data Collection

The present study mainly based on primary data. Following multi stage sampling technique, the study selects Tangail district, traditional handloom concentrate area in Bangladesh, for estimating production function and returns to scale of handloom industry. In second stage it selects two upazila- Tangail Sadar upazila and Delduar upazila for data collection. Finally, 90 respondents from the study area selected randomly and interviewed with a questionnaire that covers all required information. Secondary data, however, is collected from reports of Bangladesh Handloom Board (BHB), various reports of Bangladesh Bureau of Statistics (BBS), Publish articles and published magazines etc.

Empirical Model

The study employed The Cobb-Douglas Type Production Function for its analysis which is also used by Husain and Islam (2016). The relation between handloom output and its inputs may be expressed as:

$$Q = f(L, K, Y) = \beta_0 L^{\beta_1} K^{\beta_2} Y^{\beta_3} e^u \dots (1)$$

Where, Q stands for total output in terms of their monetary value, while L, K and Y stands for explanatory variables- labor, capital and yarn in terms of monetary values. Finally, u is stochastic disturbance term, and β_i is coefficients. From this equation it is

clear that the relationship between output and inputs is nonlinear. However, a log transformation of this model is as follows:

$$\ln Q = \beta_0 + \beta_1 \ln L + \beta_2 \ln K + \beta_3 \ln Y + u_i \dots (2)$$

Thus written, the model is linear in the parameters β_0 , β_1 , β_2 and β_3 , therefore, is a linear regression model. It may be mentioned here that though it is nonlinear in the variables Q, L, K and Y but linear in the logs of these variables. In short, equation (2) is a log-log, double log, or log linear model. The empirical analysis has been carried out to study β_1 , the (partial) elasticity of output with respect to the labor, β_2 the partial elasticity with respect to capital and β_3 , the partial elasticity with respect to yarn for handloom industry. However, return to scale is measured by summing up coefficients of labor, capital and yarn.

If $\beta_1 + \beta_2 + \beta_3 > 1$ then production function said to exhibit increasing return to scale

If $\beta_1 + \beta_2 + \beta_3 = 1$ then production function said to exhibit constant return to scale

If $\beta_1 + \beta_2 + \beta_3 < 1$ then production function said to exhibit decreasing return to scale.

Discussion of Results

Descriptive Statistics of Collected Data

It is found that sales volume, labor, yarn and capital in terms of their monetary value are not same for various handloom units operating in Tangail district. It is observed from Table 1 that sales volume in monetary terms of produced handloom products of sample units varies from minimum Tk.76.80 thousand to maximum Tk.9000.00 per year and average sales volume is Tk.1390 thousand which indicates a large gap in earning revenue by handloom products.

Table 1: Descriptive Statistics of Collected Data (Tk. '000)

Items	Total Output	Labor	Capital	Yarn
Mean	1397.78	461.42	12.67	648.40
Std. Deviation	1976.48	614.49	12.06	1011.09
Minimum	76.80	32.40	0.98	33.60
Maximum	9000.00	2970.00	52.40	5550.00

Source Authors own calculation from collected data.

The mean also indicates that maximum handloom owners earn less than average sales volume. There found fluctuation in production costs also. The study found average labor cost, capital cost and yarn cost 461.42 thousand, 12.67 thousand and 648.40 thousand with huge fluctuation between maximum and minimum.

Discussion of Results

This section of the study discusses the regression result estimated based on equation (2). The study found significant difference among results of various size groups. The study organized this section with five parts. First part analyzes all handloom units. Second part discusses those units that operate single loom in their units. Third and fourth parts

analyze small and large handloom units that operate 2-5 looms, and 6 or more looms in their units respectively. Finally the study compares results of different groups in the last part of the section.

Regression Results for All Handloom Units

It is observed from Table 2 that output mainly depends on labor and yarn. Both the amount and contribution in output of capital is very small in handloom industry in the study area.

Table 2: Regression Results for All Handloom Units.

Items	Coefficient	Std. error	t-value	p-value
Labor	0.296***	0.041	7.20	0.000
Capital	0.080***	0.028	2.85	0.005
Yarn	0.644***	0.035	18.52	0.000
Constant	0.930***	0.151	6.15	0.000

N: 90, R-squared: 0.988, Adj. R-squared: 0.987, VIF: 8.18

Source: Authors calculation. N.B: ***, ** and * indicate significance at 1%, 5% and 10%, respectively

The table states that 1 percent increase in labor will increase output by 0.30 percent while 1 percent increase in yarn will increase output by 0.64 percent. Contrast, for increasing output by 8.3 percent it required double the capital, if other conditions remain unchanged. Therefore, production function for handloom industry in the study area becomes-

$$Q = 0.930L^{0.296} K^{0.080} Y^{0.644} \dots (3)$$

Where, Q represents outputs in terms of their monetary value. L, K and Y stand for yearly labor, capital and yarn respectively. It is observed from production function that handloom industry exhibits increasing return to scale and return to scale is 1.020.

Regression Results for Single Handloom Units

It is observed from Table 3 that in case of single handloom units, production of handloom products mainly depends on yarn used.

Table 3: Regression Results for Single Handloom Units

Items	Coefficient	Std. error	t-value	p-value
Labor	0.204	0.136	1.50	0.157
Capital	0.027	0.080	0.33	0.744
Yarn	0.649***	0.106	6.11	0.000
Constant	2.304**	0.874	2.64	0.020

N: 18, R-squared: 0.933, Adj. R-squared: 0.919, VIF: 2.70

Source: Authors own calculation. N.B: ***, ** and * indicate significance at 1%, 5% and 10%, respectively

It indicated that 1 percent increase in yarn cost will increase output 0.649 percent. Contribution of other production factors is not statistically significant. Therefore, the production function becomes-

$$Q = 2.304L^{0.204} K^{0.027} Y^{0.649} \dots (4)$$

Where, Q stands for total output while L, K and Y are labor, capital and yarn respectively. Therefore, the production function exhibits decreasing return to scale and the value of return to scale is 0.880.

Regression Results for Small Handloom Units

It is observed from Table 4 that labor and yarn are the main determinants of handloom production.

Table 4: Regression Results for Small Handloom Units

Items	Coefficient	Std. error	t-value	p-value
Labor	0.428***	0.053	8.04	0.000
Capital	0.007	0.035	0.15	0.903
Yarn	0.587***	0.047	12.36	0.000
Constant	0.677**	0.323	2.10	0.042
N: 46, R-squared: 0.975, Adj. R-squared: 0.973, VIF: 3.38				

Source: Authors own calculation. N.B: ***, ** and * indicate significance at 1%, 5% and 10%, respectively

It is observed from Table 4 that due to increase labor cost 1 percent output increases by 0.43 percent while 1 percent increases in yarn cost will increase output same amount. Impact of capital is not statistically significant. Therefore, production function for handloom production becomes-

$$Q = 0.949L^{0.428} K^{0.007} Y^{0.587} \dots (5)$$

Where, Q, L, K and Y stand for total output, labor, capital and yarn in their monetary value. Values of coefficients show that production function exhibits increasing return to scale having value 1.022.

Regression Results for Large Handloom Units

It is observed from Table 5 that in case of large handloom unit labor and yarn is the main determinants of handloom production. In such type of units 1 percent increase in 1 labor and yarn in terms of monetary value will increase output by 0.19 and 0.71 percent respectively. Capital does not affect handloom production significantly.

Table 5: Regression Results for Large Handloom Units

Items	Coefficient	Std. error	t-value	p-value
Labor	0.187**	0.075	2.48	0.021
Capital	0.083	0.082	1.01	0.325
Yarn	0.709***	0.059	12.06	0.000
Constant	1.522**	0.711	2.14	0.044
N: 26, R-squared: 0.976, Adj. R-squared: 0.973, VIF: 3.50				

Source: Authors own calculation. N.B: ***, ** and * indicate significance at 1%, 5% and 10%, respectively

Therefore, production function for large handloom units becomes-

$$Q = 1.522 L^{0.187} K^{0.083} Y^{0.709} \dots (6)$$

Where, Q, L, K and Y stand for total output, labor, capital and yarn per year in terms of monetary value. Therefore, the production function exhibits decreasing return to scale having value 0.979.

Comparison among Production Function for Various Size Groups of Handloom Units

It is observed from Table 6 that in all cases handloom industry is a labor intensive industry in the study area and labor intensity is higher in smaller units where capital intensity is higher in larger units.

Table 6: Production Function for Different Size Groups

Size group	β_1	β_2	β_3	Sum of β_s	Return to scale
All units	0.296	0.080	0.644	1.020	Increasing
Single units	0.204	0.027	0.649	0.880	Decreasing
Small units	0.428	0.007	0.587	1.022	Increasing
Large units	0.187	0.083	0.709	0.979	Decreasing

At the same time yarn has significant contribution in handloom production in the study area. Although production function shows increasing return to scale for all handloom units, it is decreasing return to scale for single and large units while increasing for small units. It is decreasing in single units because these units use mainly family labors in production, in most of the cases, which are unskilled. In addition due to numerous reasons most of the cases they produce a small amount in their units. While due to diminishing marginal productivity of labor and capital large scale units are exhibiting decreasing return to scale.

Conclusion

Handloom weaving activity is very crucial economic activity in rural areas of Bangladesh and also in Tangail district. Handloom units in the study area use conventional inputs viz. labor, capital and yarn which are heterogeneous in nature. Labors used in various units are different by sex, family/hired ratio, age, experience etc. Similarly, main capital (wooden loom) is different in types, design, products etc. and yarn is differentiated by type, count, value etc. In addition, the average volume of using inputs and outputs in terms of value also differs with firm size. Therefore, effects of economy of scale vary with firm size. Thus, handloom units in various size groups experienced different production function exhibits different return to scale. Indicating more opportunities for extension in case of all handloom units production function exhibits increasing return to scale. In disaggregated analysis small scale units also exhibits same type results. Due to employing unskilled family members small scale units exhibits decreasing return to scale and for lower marginal productivity of labor and capital large scale units also exhibits same type return to scale. Since handloom units use conventional inputs and are highly labor incentives, government should provide institutional and policy related support to handloom industry for employing more people in economic activity.

Reference

- Banaeian, N. and Zangenem, M. (2011), Estimating Production Function of Walnut Production in Iran Using Cobb-Douglas Method, *Agricultural Tropica et Subtropica*, VOL. 44 (4) 2011.
- Banarjee, S.; Muzib, M. M. and Sharmin, S. (2014), Status of Handloom Workers and Causes of Their Migration: A Study in Handloom Industry of Tangail District, Bangladesh, *Research on Humanities and Social Sciences*, Vol.4, No.22, 2014.
- Banerji, A. (2015), Production functions for selected Indian industries, *The Journal of Development Studies Publication details*, including instructions for authors and subscription information: <http://www.tandfonline.com/loi/fjds20>
- BBS (2018), Labor Force Survey 2016-17, *Bangladesh Bureau of Statistics*, Statistics and Information Division, Ministry of Planning, Bangladesh.
- Cobb C.W.P., Douglas H. (1928), A theory of production, *American Economic Review*, 18(1):139-165. Supplement, Papers and Proceedings of the Fortieth Annual Meeting of the American Economic Association.
- Gao, W. and Kehrig. M. (2017). Returns to Scale, Productivity and Competition: Empirical Evidence from U.S. Manufacturing and Construction Establishments, *Department of economics*, University of Texas, Austin. Available at: <http://papers.ssrn.com/abstract=2731596>
- Hossain, M.M.; Basak, T. and Majumder, A.K. (2013), Application of Non-Linear Cobb-Douglas Production Function with Autocorrelation Problem to Selected Manufacturing Industries in Bangladesh, *Open Journal of Statistics*, 2013, 3, 173-178 <http://dx.doi.org/10.4236/ojs.2013.33019>
- Husain, S. and Islam, M.S. (2016), A Test for the Cobb Douglas Production Function in Manufacturing Sector: The Case of Bangladesh, *International Journal of Business and Economics Research*, 2016, vol. 5(5), pp 149-154, doi: 10.11648/j.ijber.20160505.13
- Islam, M. S. and Elahi K. Q. (1991), Impact of handloom Weaving on Employment and Income of Small Farmers in Some Areas of Tangail District, *The Bangladesh Journal of Agricultural Economics*, Vol. XIV, No. 1, pp:73-86.
- Islam, M.K., Hossain, M. E. and Ghosh, B.C. (2013). Cost-Benefit Analysis of Handloom Weaving Industry in Kumarkhali Upazila of Kustia District of Bangladesh, *Development Compilation*, Vol. 09, No. 01, pp 63-72.
- Jaforulla, M. (1999), Production Technology, Elasticity of Substitution and Technical Efficiency of the Handloom Textile Industry of Bangladesh. *Applied Economics*, 31(4), 437-442.
- Khalil, A.M. (2005), A cross Section Estimate of Translog Production Function: Jordanian Manufacturing Industry. *Topics in Middle Eastern and African Economies*, Vol. 7, September 2005.
- Liton, M R I; Islam, T; and Saha, S. (2016), Present Scenario and Future Challenges in Handloom Industry in Bangladesh, *Social Sciences*, Science Publishing Group, 5(5).
- Nurunnajib et al. (2018), Application of Cobb-Douglas Production Function to Manufacturing Industries in West Sumatra Indonesia, *World Scientific News* 101 (2018, pp145-156. Available online at www.worldscientificnews.com
- Rezepin, Alexandr; Amirova, T. and Mishina V. (2017), The research of the production function of an industrial enterprise, *SHS Web of Conferences*, 35, 01038 (2017)

Technology Innovation and Changes of SHS Packages in Rural Bangladesh: A Description

Mohammad Jahangir Alam*
Shinji Kaneko**

Abstract: This study examines the innovation and changes of the solar home system (SHS) in rural Bangladesh based on qualitative and descriptive statistics information. The solar home system is till now becoming more popular in rural areas in Bangladesh. SHS program is one of the most successful off-grid programs with highest install rates. Grameen Shakti (GS) is the pioneer organization that implements and maintain the solar home system in the early 90s. Today, we see the dramatic change in technological innovation and package of SHS. Consumer preferred to low watt peak solar PV at a convenient price. The import source of solar PV also changed.

Keywords: Solar Home System, Grameen Shakti, IDCOL, SREDA, Watt peak

Introduction

Solar power is significant and a potential source of energy due to improving the air pollution, save the environment, shortage of power supply, and other benefits. Environmental pollution is being considered a big problem because of using huge fossil fuels. Due to the growing population, it is difficult to provide a secure energy supply to maintain their standard of living smoothly. About 40% of the population has no access to electricity, but there are also high penetration rates of solar homes in their off-grid areas. The situation in Bangladesh is very strong reference applicability for everyone to enjoy sustainable energy targets. Despite this, although the Solar Home System Program and 3.6 million systems have been globally recognized, there are considerable limitations in their use, especially in providing higher levels of energy services for productivity. Currently, according to the National Solar Housing Program implemented by Infrastructure Development Ltd. (IDCOL), Bangladesh deploys more than 70,000 SHS per month. This is one of the most successful off-grid SHS programs with the highest installed rates in the world today. Allowing the development of off-grid populations in Bangladesh in the economic, social and technological aspects, it is necessary to explore different levels of progress.

About one-third of rural households in Bangladesh are not connected to the grid. To compensate for this gap, solar energy has been a viable option for people in rural areas. In the past few years, the market has grown steadily and has reached a level that requires a stronger regulatory and quality assurance framework to protect the sustainability of end-user investments and programs. Therefore, updates to existing policies, norms and guidelines must be based on an assessment of the field performance of SHS. We need to see the ongoing technological innovation of SHS in the rural areas and packages pattern of SHS. Recognizing the importance of the technical quality of SHS design, installation,

* Associate Professor, Department of Economics, Jahangirnagar University, Dhaka, Bangladesh.

** Professor, Graduate School for International Development and Cooperation, Hiroshima University, Japan

operation and maintenance, we need to review the existing market demand as well consumer preference of the package offer by the partner organization (PO).

Providing affordable electricity to remote families is an important aspect of human and economic development in rural areas around the world and an obligation of the government to its citizens. For many developing countries, this obligation is a huge challenge because of their economic weakness, which is a key obstacle to rural electrification. In recent time, most of the research try to find out the technically feasible and economically viable solar home systems around the world. There are many factors that affect electricity demand, such as weather, economic growth, social and demographic factors, end-user prices and subsidies, policy factors, technology development and energy conservation, industrial structure, energy intensity, energy efficiency and demand side management, peak load and seasonal changes, Population growth, industrialization and urbanization. We investigate the current trend of the development of a solar home system in Bangladesh and consumer demand of existing solar home system and their trend.

There are several sources of lighting in Bangladesh such as grid electricity, kerosene, solar, and biogas, etc. Access to electricity is increasing due to the expansion of grid area, and 68% of total population have access to the grid electricity (including renewable energy), and per capita electricity generation is still now low compare to the world average.

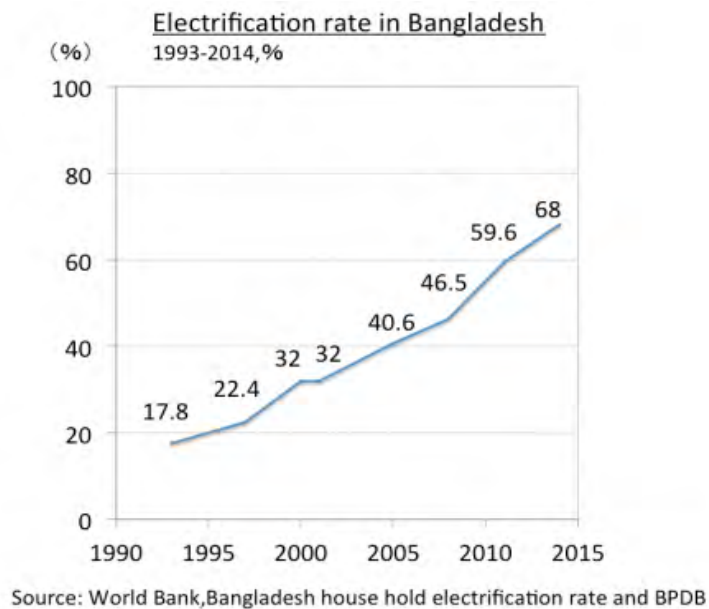


Figure 1: Trend of Electrification rate in Bangladesh

The standard of living of the people depends on easy access to electricity for lighting and cooking which also enhance the income generation activities. In Bangladesh, the SHS is getting more popularity in the off-grid areas because of the low price of SHS and financing mechanism. Now the government has given more emphasis to produce electricity from renewable sources due to ensure sustainable development.

This study outlines the technical innovation and packages of operating a solar home system in a remote off-grid location in Bangladesh. Therefore, in addition to policy makers, this groundbreaking experience has become a learning platform for other investors, financing and development institutions. Some national clean energy policy decisions for off-grid rural electrification business models are taking advantage of the experience gained.

Brief energy scenario in Bangladesh

Only two-thirds of Bangladesh's population is currently connected to the grid. This shows that as Bangladesh continues its growth trajectory, as many as 60 million people will connect to the untapped market of the national grid in the next few years. Oil, natural gas and coal are the main sources of fuel for power generation. To ensure power generation, it is necessary to ensure the safety of primary energy. In 2021, Bangladesh's total electricity demand will be about 20,000 megawatts. To achieve this goal, relevant departments must be assessed and motivated through the implementation of short-, medium-, and long-term plans. Due to the increase in power generation, the demand for natural gas is increasing. If there is no alternative fuel source, the demand for natural gas may increase several times. In other words, if coal is used as an alternative fuel for natural gas, millions of tons of coal are needed each year to meet demand. Bangladesh has enormous potential for renewable energy, and the natural availability of alternative energy creates opportunities for growth in the power sector. Not only should technology be developed to produce energy in an environmentally friendly manner, but full attention should be paid to conserving energy in the most efficient form. The government issued a "Vision and Policy Statement 2020" to provide electricity services to the entire country throughout the year.

Energy mix

Solar power is important for ensuring green energy mix in Bangladesh. Among various renewable energy sources, hydropower, geothermal, solar, tidal, wind, biomass, and biofuels can be effectively utilized in Bangladesh. Solar energy is the most accessible and free energy source. Traditionally, solar thermal energy has been used in different household and industrial activities in Bangladesh.

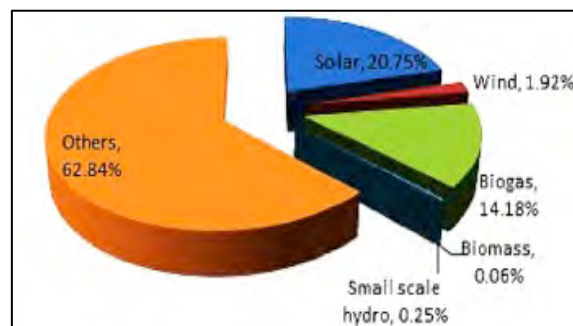


Figure 2: Renewable energy share in Bangladesh

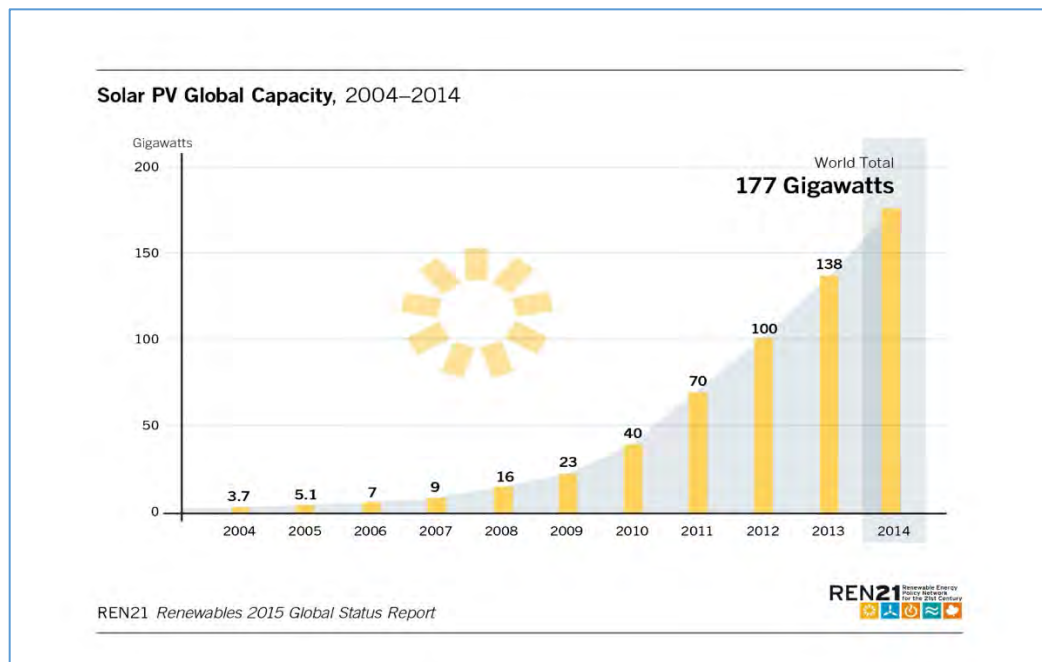
Source: Bangladesh Bureau of Statistics

SHS present status and potential

The year 2014 marked another record year of growth of Solar PV cell due to 40 GW of capacity added to global total about of 177 GW (“RENEWABLES 2015 GLOBAL STATUS REPORT,” n.d.). The top three markets were China, Japan, and the United States followed by the United Kingdom and Germany. SHS achieved remarkable success as off-grid power generation in rural and remote areas for domestic and small business in Bangladesh (Hossain Mondal, 2010).

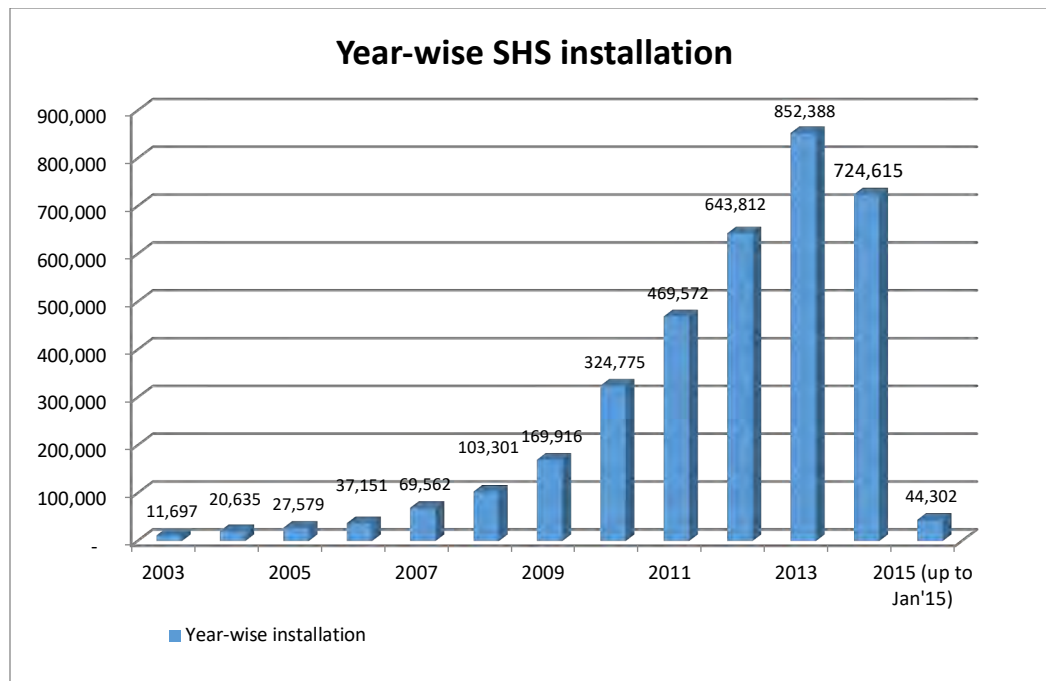
The cost of solar panel growing down over time and demand increases for small watt peak in rural areas. Installation of SHS is financially viable and reliable in rural Bangladesh. Pico-PV system (1-10wp) is getting more popularity and available in the market of Bangladesh. However, poor quality of products and lack of strong monitoring spoiling the image and prospects of such systems.

Bangladesh is a recipient of sufficient sunshine round the year. Solar energy can be produced in all parts of the country. By this time, solar technology is convenient, proven and well accepted in Bangladesh. It is environment-friendly, and price of a solar panel is decreasing day by day.



(“RENEWABLES 2015 GLOBAL STATUS REPORT,”)

Figure 3: Solar PV Global Capacity, 2004-2014



(Source IDCOL) ("Solar Home System Program," 2017)

Figure 4: Year-wise SHS installation in Bangladesh

Discussion

The journey of Grameen Shakti (GS) as a solar energy leader

Grameen Shakti (GS) started its journey in 1996 as a non-profit company to provide renewable energy services such as solar, biogas, improved cook stove and wind energy in remote rural areas of Bangladesh. GS has designed the most successful market-based model for rural electrification through solar PV technology. GS has achieved an international appreciation for being the first company in the world to promote solar technology successfully to rural communities and develop a sustainable and cost-effective renewable technology program, targeting rural people.

GS initiated its first demonstration point with a 17W solar panel with two lamps at a Grameen Bank branch with no grid connection and a second one at the customer home near to the office. Both demonstration points were located in Kalihati, Tangail, where the Grameen Bank had been working since 1980 and was well known and respected in the community (Wimmer, 2012). During 1996 to 1997 SHS installation was very low because of high initial cost. This increased significantly from 2004 to 2010 because of the soft credit through installment, reduction of price and the favorable policy of Bangladesh government (Hoque, Das, & Beg, 2014). The experiences of GS are important because the organization operated in a country where economic, political, and social environments are not conducive to renewable energy (K. Sovacool Benjamin, 2011).

A landmark of one million SHS reached by GS

GS reached the first landmark of one million SHS installation rural areas in Bangladesh on November 30, 2012. It was the largest non-grid program in the world. During this historical journey, GS reached quarter million in April 2009 and half a million by the end of 2010.

GS aims to involve the local community in the planning, implementation, and maintenance of SHS and it also has a network of the technology center. The technology center mainly managed by the women engineers who provide training to women as solar technicians. The solar energy systems installed by GS each year save more than 153 million liters of kerosene whose current market price is about BDT 10.72 billion.

The inception of IDCOL and SHS

Infrastructure Development Company Limited (IDCOL) started its journey in 2003 with Solar Home System (SHS) for the poor people who have not accessed to grid electricity with support from GoB, World Bank, ADB, JICA, IDB, KfW, GIZ, etc. IDCOL is implementing its SHS program through the 47 Partner Organizations (POs). The POs are local NGOs, Microfinance Institution (MFI) and private entities whose role under the program includes selecting the project area and potential customers, extending loans, installing SHS and maintenance support. It provides low-cost financing and technical capacity building support to the POs which support to the customers.

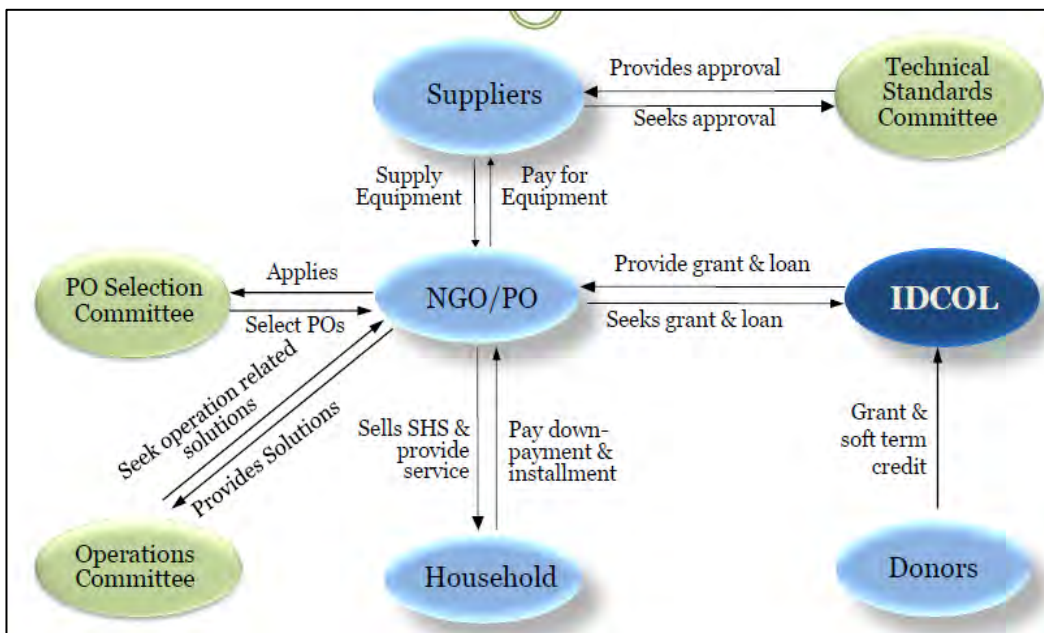


Figure 5: Program Structure (Haque, 2013)

Table1: IDCOL SHS Program- at a glance

● Program Target	: 6 million SHS by 2016
● Program Achievement	: 2.6 million SHS till October'13
● Number of Beneficiaries	: About 12 million people
● Power Generation	: About 110 MW
● Fossil Fuel Saving	: 250,000 ton/year
● Subsidy Saving by Govt.	: USD 37 million/year
● Direct Job Creation	: 30,000 people
● IDCOL Investment	: About USD 550 million

Source: IDCOL (Haque, 2013)

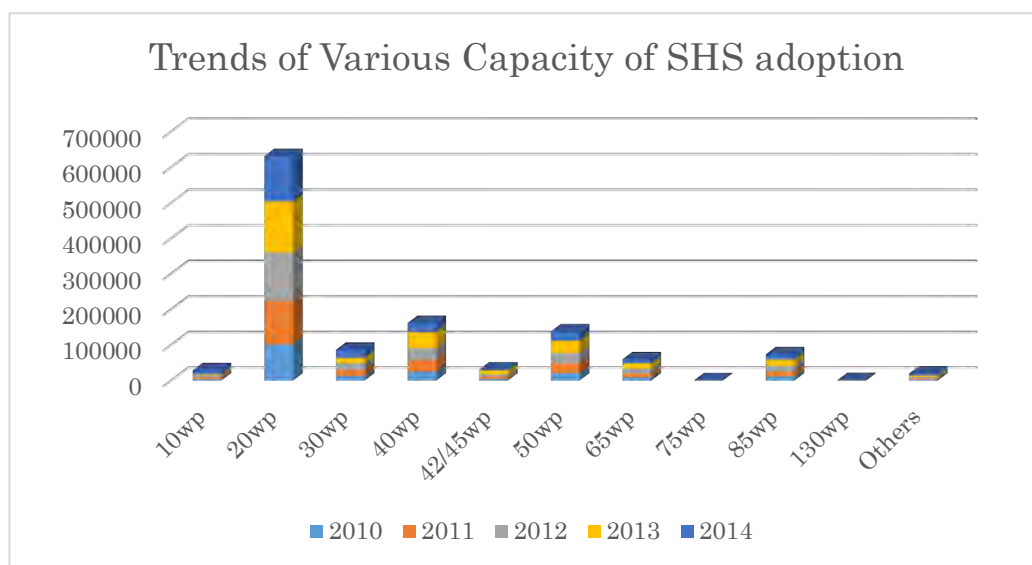
Establishment of SREDA and SHS

Sustainable and Renewable Energy Development Authority (SREDA) started its official journey from 22nd May 2014. The vision of SREDA is to promote sustainable energy and builds an energy conscious nation to ensure energy security, reduce carbon emission, and to set standard energy policy. The core values of SREDA are given as follows:

- Implement the policies, laws, rules, and regulations relating to sustainable energy.
- 10% (2000 MW) contribution of renewable energy generation to the total power generation by 2021.
- Keep all the stakeholders on the board to meet its objectives.
- Identify and analyze the opportunity of accessing different funds for investment in sustainable energy development.

Technological Innovation of SHS in Bangladesh

The important technological improvement of SHS is an introduction to Light Emitting Diode (LED) lamps instead of the Compact Fluorescent Lamps (CFLs) that are currently being used in most solar PV projects. LED brings many advantages such as low maintain cost, ability to turn down, cold start capacity and operability at low voltages thereby reducing the size of the battery and PV module (Palit Debajit, 2013). 20wp are gaining more popularity due to smaller capacity and affordable price.



Source: Grameen Shakti. "Solar Home System" 2017

Figure 6: Trends of the various capacity of SHS packages in Bangladesh.

LED lamp made a significant shift in the SHS system as it formed a large capacity for other electric home appliances. The LED lamp is being considered the economy, and it consumes only 3 to 5 watts; even LED television can be used with the 50W system.

SHS technology: The technological innovation in SHS has observed for the past few years (from 2012) and the trend is accelerating. Substantial improvements in the quality of system components such as solar panel, battery and light bulbs which increase the lifetime of each component and also permitting more energy efficient LED to run on SHS, and it also requires lesser capacity panels and batteries that lowering the cost of SHS.

Solar PV modules: These are imported items sold in the local market at the rate of USD 3-USD 4 per Wp. Japanese and Indian modules were the most widely used modules in the country. Now China is the main source for importing modules at a low price.

Batteries: These are locally manufactured items with imported raw materials. Finished batteries are sold at approximately USD 1-USD 2 per Ah. The battery is a basic part of SHS. All the battery manufacturers must meet warranty conditions and technical specifications fixed by Technical Standards Committee (TSC) of IDCOL before being suitable for the program. TSC has determined the warranty period to be five years and set the technical specifications considering the life of a battery to be five years.

Batteries approved for IDCOL solar program as follows:

Rahimafrooz, MICRO, RIMSO, Navana, SAARC Power.

Charge controllers: Now, charge controllers are locally manufactured. Price varies from local charge controllers to imported charge controllers. Local charge controllers are cheap as well good quality.

SHS price: The price of unit SHS continuously declined due to technological development. Many organizations (47 POs and others) are involved in this business, and they try to provide SHS to the customers at a minimum profit. That's why customers have continued to enjoy a significant drop in SHS price and SHS price reduction now a major force for market expansion.

Quality Control Mechanisms by IDCOL

IDCOL always devoted for customer satisfaction regarding SHS installation in rural areas. The SHS is packaged to provide convenient installation at a remote customer home site by a qualified technician. A user can perform routine maintenance such as adding battery water, replacing light bulbs and fuses and a technician can easily perform system diagnostics or replace components. IDCOL provide quality service to the customers through 12 quality control offices, 180 quality inspectors, and 11 field auditors. IDCOL inspectors are always checking the systems for compliance with approved technical standards. Those company that could not comply with the standards facing the penalty.

Technical Standard Committee (TSC) of IDCOL requires the suppliers to provide minimum 20-year warranty for solar PV, five years for batteries and three years for charge controllers/lamp circuits

Table 2: Training and Capacity Building

Types of Training	Participants	Trained so far
Training of Trainers	PO Officials	389
Staff Training	PO Field Staffs	13,157
Customer Training	Households	395,117
Technician Training	Local people	1,529
Management Training	PO Officials	129

Source: IDCOL (Haque, 2013)

SHS faced many problems such as technical, financial, political and institutional, etc. Many program implementers claim that customers often failed to properly maintain their systems though the POs provide training for users.

There are several weakness and risks affecting the SHS market in Bangladesh. The most important weakness and risk as follows:(Urmee Tania, 2011)

Table 3: Weakness and risks of SHS

Weakness	Risks
● SHS design and low-quality components ● Lack of coordination among the market actors ● Lack of policy and government support ● Difficulty in obtaining loans ● Lack of managerial training ● Lack of sense of ownership on the part of customers	● Increasing equipment costs ● Increasing transportation cost ● Natural disasters ● A lack of reliable suppliers of charge controllers and lamp ● Lack of advocacy for renewable energy policy by the implementers

Economic Incentives of SHS package in Bangladesh

Table 1: SHS-Specification of Grameen Shakti, 2014(“Solar Home System,” n.d.)

System Capacity (Watt)	Battery capacity (Ah)	Factor (Ah/watt)	Price in USD	Specific Investment Cost (USD/W)
10	15	1.5	97	9.7
20	30	1.5	178/140	8.9/7
30	40	1.3	229	7.6
40	44	1.1	332	8.3
50	80	1.6	422	8.4
65	100	1.5	474	7.3
85	130	1.5	579	6.8

Atypical SHS consists of five things: a solar panel, an inverter, a charge controller, a battery and fluorescent/ LED lamps. System is ranging from a capacity of 10 Watts-peak (Wp) to 130 Wp. The cost of a single 50 Wp, typically imported from Japan, along with a battery and associated equipment runs about \$380(K. Sovacool Benjamin, 2011).

30 Wp system can be given priority for dissemination and installation of SHS in rural areas of Bangladesh. Some benefits for using 30 Wp SHS are: It is the very cheapest options to customers because of less affordability, it meets basic lighting demand, it is financially feasible to NGOs, and it is available in the local markets and contribute to less carbon emission (Ahammed & Azeem, 2013).

Table 5: Purchasing price of SHS packages in Bangladesh

Capacity	Content	Operating hours	Cost (in USD)
20wp	Lamp: 2 (5 watt each) Mobile charger: 1	4-5 hours	140
40wp	Lamp: 3 (6 watt each) Mobile charger: 1, B & W TV: 1	4-5 hours	280
50wp	Lamp: 4 (7 watt each) Mobile charger: 1, B & W TV: 1	4-5 hours	380
85wp	Lamp: 9 (7 watt each) Mobile charger: 1, B & W TV: 1	4-5 hours	580
130wp	Lamp: 11 (9 watt each) Mobile charger: 1, B & W TV: 1	4-5 hours	940

Source: IDCOL. “Solar Home System Program,” 2017

Bangladesh is still now highly dependent on imported solar pv, and the familiar vendors are:

- British Petroleum,
- Kyocera,
- Siemens,
- Shell Solar,
- Tata BP

The background of rapid expansion of SHS in Bangladesh is substantial price decline of solar panel and related parts. The cost reduction of SHS changed the situation dramatically. During the late 1990s, there was a prevalence of solar power system in the developed countries. The cost of solar panel imported from Germany is very high, but China is very less. For example, China is now the main source for solar PV due to the low price.

The world production of solar panel increased from 277MW in 2000 to 24,000 MW in 2010-a rise about 90 folds. As a result, the cost of each solar panel reduced to USD 0.74 per watt in 2013 from USD 77 in 1997. That's why the solar power system no longer remained an expensive power facility.

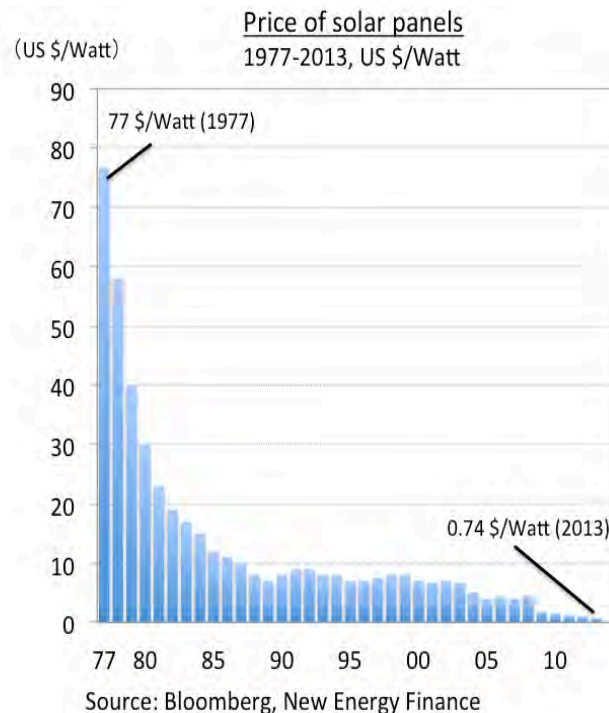


Figure 7: Price of solar panels

Table 6: Cost structure of SHS

1997-2002	2008-2014
Solar Panel-60%	Solar Panel-40%
Battery-30%	Battery-50%
Charge controller-5%	Charge controller-5%
Others-5%	Others-5%

Source: Author's own calculation

Some panels are assembled locally, but most are imported from China, India, and Japan. The IDCOL Technical Committee has approved the total of 550 different types of panels. The price of batteries increased recently, largely due to an increase in lead price. Batteries are made locally. There is 20 company involved to produce a battery.

IDCOL provides a small portion of the SHS cost as a subsidy to the POs for the sale of each unit. At the beginning of SHS, the program allowed for \$70 per system. The consumer and PO got 70% and 30% respectively. Now, this subsidy is fixed for SHSs of less than 30 wp. The subsidy amount now per system is \$20, and PO did not receive any amount of subsidy.

Table 7: Trends of Subsidy

Types	2003	2004-05	2006-07	2008-09	2010-2011	2012-13	2014-2015
Consumer	\$70	\$55	\$40	\$40	\$25	\$25	\$20*
PO	\$20	\$15	\$10	\$5	\$3	-	-

Source:IDCOL

*For small SHS (up to 30wp) only

Most of rural Bangladesh's people are unaffordable to buy the solar home system because of low income. The amount of subsidy is crucial for overcoming the affordability barrier. The cost of solar panels has come down over time and also existing subsidy for a small Wp SHS (10 to 30 Wp) allowing poorer households gain access to electricity.

Existing Sales Practices

- Door-to-Door Sales
 - Very effective to-date
 - Build relationships
 - Labour intensive
- Free monthly checkups during payments of installment.
- Post-warranty service through annual maintenance contact with the company for solar home systems.
- Inclusive warranty system plus a buy back system under which a buyer may return his system to the company when his area gets connected to the grid.
- Training of users and technicians so that they can take care of their systems.

Multi-party Financial Contribution: The main feature of the IDCOL's program is ensuring that the customer as well POs contribute the installation cost of SHS. A customer makes a minimum 10% down payment to the PO who want to get by loan for getting SHS. The remaining cost (90%) is a loan from the PO to the customer. IDCOL refinances 70-80% of this loan amount to the PO at the rate of 6-9% per annum. On the other hand, the PO charged to the customer at the rate of 16% per annum. These multi-party contributions ensure the good sale of SHS and all three parties benefited through prompt and consistent repayment of the loan and also leading to ownership.

Table 8: The success of the financing model

(a) Market price of 20 wp SHS	USD 193
(b) Buy-down grant	USD 20
(c) System price for Household [(a)-(b)]	USD 173
(d) Down payment from the customer to PO [10% of (c)]	USD 17
(e) PO loan to the customer [(c)-(d)]	USD 156
Loan Tenor	3 years
Interest rate	16% p.a.
Monthly installment amount	USD 5.40
(f) IDCOL Refinance [70%-80% of (e)]	USD 109-125
Loan Tenor	5-7 years
Interest rate	6-9% p.a.

Source: IDCOL. "Solar Home System Program," 2017

Sustainable Development Strategy through the SHS program: Solar power is helping to green Bangladesh's energy mix. Renewable energy only contributes 1% of total energy generation. The government of Bangladesh will have a plan to ensure 10% of its national grid powered by renewable energy by 2020 ("Lighting rural Bangladesh with rooftop solar & carbon credits | Development in a Changing Climate," n.d.). SHS play an important role to achieve sustainable development. SHSs are also helpful for reducing greenhouse gas emission and earning carbon credits by reducing the use of kerosene for lighting and diesel generators that had been used to charge batteries. The program is projected to deliver 1.1 million Certified Emission Reductions or Carbon Credits under Clean Development Mechanism (CDM) by 2016. The carbon credits are sold to the World Bank (WB) Community Development Carbon Fund that generates a revenue stream. That revenue is enhancing the solar companies financing, installing and servicing the solar panels to expand the program.

Conclusion

Access to energy through the solar home system can create new opportunities for poor people in rural areas. Therefore, in the context of the ethical framework for sustainable development, policy makers should pay more attention and provide more support using the innovation and people-oriented business model. This is important not only for socio-economic reasons, but also to address concerns about global warming and climate change, and to minimize the environmental impact of traditional energy production methods. If we want to maximize the choice of energy use in the energy supply sector, while we consider the needs of future generations, appropriate packages of SHS need to be pushed to the forefront of energy policy, changing the way we address current and future energy needs.

Further empirical research is needed to enrich the ideas and systems of the innovation system. Innovators are accelerating the promotion of solar home technologies in developing countries. More importantly, further research on how to identify appropriate solar home systems and business model practices for successful communication and further development of innovation.

References

- Ahammed, F., & Azeem, A. (2013). Selection of the most appropriate package of Solar Home System using Analytic Hierarchy Process model in rural areas of Bangladesh. *Renewable Energy*, 55, 6–11. <https://doi.org/10.1016/j.renene.2012.12.020>
- Haque, N. (2013). *IDCOL Solar Home System Program in Bangladesh. "Rural Energy Access : A Nexus approach to Sustainable Development and Poverty Eradication". Addis Ababa, Ethiopia*. Retrieved from http://www.ioec.org/ioec1/pdf/1_Session3.pdf
- Hoque, S. M. N., Das, B. K., & Beg, M. R. A. (2014). Evaluation of Energy Payback and CO₂ Emission of Solar Home Systems in Bangladesh. *Procedia Engineering*, 90, 675–679. <https://doi.org/10.1016/j.proeng.2014.11.792>
- Hossain Mondal, M. A. (2010). Economic viability of solar home systems: Case study of Bangladesh. *Renewable Energy*, 35(6), 1125–1129. <https://doi.org/10.1016/j.renene.2009.10.038>
- K. Sovacool Benjamin, D. I. M. (2011). Summoning earth and fire: The energy development implications of Grameen Shakti (GS) in Bangladesh. *Energy*, 36(7), 4445–4459. <https://doi.org/10.1016/j.energy.2011.03.077>
- Lighting rural Bangladesh with rooftop solar & carbon credits | Development in a Changing Climate. (n.d.). Retrieved August 6, 2015, from <http://blogs.worldbank.org/climatechange/lighting-rural-bangladesh-rooftop-solar-carbon-credits>
- Palit Debajit. (2013). A comparative analysis of the Solar Energy Programme for Rural Electrification and lessons from South Asia. *Energy for Sustainable Development*, 17, 270–279. <https://doi.org/10.1016/j.esd.2013.01.002>
- Renewables Global Status Report. (2015). Retrieved August 1, 2015, from http://www.ren21.net/wp-content/uploads/2015/07/REN12-GSR2015_Onlinebook_low_nolinks.pdf
- Solar Home System. Retrieved from Grameen Shakti website: <https://www.enfsolar.com/directory/installer/2793/grameen-shakti>
- Solar Home System Program. (2017). Retrieved from IDCOL website: <http://idcol.org/home/rd>
- Urme Tania, H. D. (2011). Determinants of the success and sustainability of Bangladesh's SHS program. *Renewable Energy*, 36(11), 2822–2830. <https://doi.org/10.1016/j.renene.2011.04.021>
- Wimmer, N. (2012). *Green Energy for a Billion Poor: How Grameen Shakti Created a Winning Model for Social Business*. Retrieved from <http://www.amazon.com/Green-Energy-Billion-Poor-Business/dp/3943310000>

Revisiting the Relationship Between Fertility and Income: An Empirical Study on Bangladesh

Nahid Sultana*
Md. Saruar Hossain Millat**
Dipti Bhowmik***
Md. Nurunnabi Talukder****

Abstract: The relationship between income and fertility is an issue of much interest in demography since Malthus published the Principles of Population. But the economic analysis of fertility was pioneered by Gary Becker who argued for a positive relation of income with the demand for children. He also raised argument that fertility has negative relationship with contraceptive and cost of child that are tried to capture in this study by considering household consumption expenditure. This study attempts to revisit this relationship by using time series data for the period 1987-2016 in the context of Bangladesh which is one of the most densely populated countries of the world. The result obtained from the empirical analysis supports the proposition of Gary Becker. Outcome of this study has revealed positive relation with income but negative relation with consumption expenditure but both the variables cause fertility rate of Bangladesh. Therefore standing at the phase of economic graduation it can be suggested that Bangladesh can maintain desired fertility rate by setting the level of two macroeconomic variables income and consumption accordingly.

Key words: Demography, Fertility, Income, Consumption Expenditure, Bangladesh

Introduction

Fertility is one of the most abundant and comprehensive theoretical foundations of demography (De Bruijn, 2006). The demographic transition theory considers fertility transition in any society, both developed and developing, as a rapid pace of fertility decline with expected social and economic changes. In one side there are rising costs and declining economic values of children influencing couples to keep the family size smaller, on the other side in the economic argument it emphasizes a conflict between quality and quantity with rising income. Rising opportunities for women with 'time' also plays an important role in household decision regarding the number of children. But in the case of developing countries, the modernization approach or economic argument cannot explain the full course of fertility transition. Because, firstly, fertility decline has occurred in many places where the economic condition is very poor. Secondly, there are limited opportunities that can ensure the quality of children and lastly, irrelevance to the

* Associate Professor, Department of Economics, Jahangirnagar University,
e-mail: nahideconju@gmail.com

** B.Sc. and M.Sc. in Economics, Jahangirnagar University, e-mail: mail:maillatsaru@gmail.com

*** Lecturer, Department of Economics, Mawlana Bhashani Science and Technology University,
e-mail: bhowmikdipti39@gmail.com

**** Lecturer, Department of Economics, National University, Bangladesh,
e-mail: nurunnabiecoju@gmail.com

value of ‘time’ when the majority of women are illiterate and underemployed (Dev et al., 2002).

In Bangladesh GDP increased by four times during the period of 1980s and 2000s. The annual GDP growth rate has been doubled to over 6 per cent between 2006-2007 and 2012-2013 compared to that in 1980s. Over the same period, per capita GDP increased by 2.6 times (UNFPA, 2015). By the same period, fertility rate of Bangladesh has declined to 2.1 per cent which was approximately 6.9 at the period of independence in 1971 (WB, 2019). But the average population density remains high in Bangladesh compared to the other countries with similar socio-economic condition. At present Bangladesh is standing on the phase of graduation from the category of least developed countries of the world to the middle-income countries. It is expected that Bangladesh will move from LDC to the rank of middle-income countries by the year 2024 on the basis of exceeding threshold in three criteria, income, human development and resilience (Gimenez et.al. 2013). To achieve this target Bangladesh has to maintain and monitor strictly both the income growth and population growth rate. Historically, population growth has a positive relationship with income in the case of low-income countries (Becker, 1960, Lee, 1987). But in recent years they have projected a declining trend in fertility with an increase in income which is mostly the character of middle-income countries (Docquier, 2004). Using a time series analysis our study tries to focus on whether the declining trend in the fertility rate of Bangladesh complies with its income growth scenario that will affirm its position to the rank of a middle-income country.

After Introduction, the rest of the sections of this article are organized as follows: Section II presents a brief literature review of the existing (available) studies in this field. Section III tries to establish the theoretical base of the relationship between income and fertility. Section IV specifies the model and data used. This section presents the econometric model that is estimated here using time series data. Section V chronologically describes the total estimation procedure and presents the results obtained. Section VI concludes the study based on the findings from empirical analysis.

Literature Review

There are considerable amount of literatures focusing on the relationship between fertility rate and income. According to Gilbert (1993), Robert Thomas Malthus (1798) is a pioneer in this field and his masterpiece “An Essay on the Principles of Population” has argued that the demand for food driven by the rate of fertility plus the prevailing population will surpass the food production. His most famous theory reveals that population grows faster than the food production during abundance and thus leave the poorer section of the society in distress. Malthus argued that there exist two types of check to push back the situation in equilibrium. The first one is the **positive** check, in which famine or natural disaster would increase the mortality rate and thus restore equilibrium in a cyclic order. The second one is called the **preventive** check, in which people can control the population through birth control, celibacy and delayed marriage. But the pioneering view of Malthus is not free from criticism.

Becker (1960) in this early work has suggested that fertility is positively related to income. But later his argument for the downward trend of fertility rate with income reveals that though fertility is positively related to income, the wide spread use of contraceptive and increase in the cost of a child offset the positive impact of income. As per Willis (1973), the Chicago school has supported the lack of positive income fertility relationship by stressing for a trade-off between the demands for quantity against the quality of children. Freedman and Thornton's (1982) paper has examined the effects of income experience on the fertility of the individual couple. This paper has investigated the relationship of husband's income experience to family size decisions over 15 years for four groups of women (first, second, fourth or had just got married). But husband's income is not found as positively related to fertility in three of the four parity groups (second parity has a positive relationship with income). For the merged group husband's income has showed a small positive relationship with completed fertility. Schultz (1994) in his study has also found no significant relationship among fertility, family planning and urbanization. Rather, schooling, fuel export share of GDP and employment creation outside agriculture are found as statistically significantly related with fertility rate. Orbeta (2005) has proposed that wealth, education, and inhabitation region (urban or rural) of women have a significant effect on the fertility rate. Moreover, he has observed a significant impact of wealth and education on contraceptive use with no significant impact of inhabitation on modern contraception use. Docquier (2002) paper has presented a model of inequality, income determination and fertility and which showed that indivisibilities in human capital investment limit the possibility of a trade-off between the quantity and quality of children. This generates a non-monotonic relationship between income and fertility at the micro-level. On the aggregate, he concludes that depending on the income distribution of population and the cost of education, the total fertility rate might increase or decrease with income. Co'rdoba and Riples (2014) paper has argued that the constraints to intergenerational transfers are crucial for understanding the negative relationship between family income and fertility. Using cross-section data he finds this relationship as negative when the intergenerational elasticity of substitution is greater than one, a case in which parental consumption is a good substitute for children's consumption.

Cleland et al. (1994) claim that fertility has been declining due to enhanced adaptation of family planning in Bangladesh in the 1990s, though they could not deny the impact of other socioeconomic variables such as urbanization, literacy, growing prosperity etc. World Bank report (1994) has projected that the fertility rate of Bangladesh is plummeting though Bangladesh has not gone through any significant socioeconomic changes. In response to that report, Caldwell et al. (1999) and Khuda & Hossain (1996) have argued that Bangladesh did experience major socioeconomic improvements which function as the key catalyst of declining fertility rate. However, Bongaarts (2006) has not found a significant causal relationship between declining fertility rate and socioeconomic development in Bangladesh as well as other analogous six developing countries. Rabbi has (2012) argued for exposition of mass media that played a significant role in declining fertility rate even after halting the effect of other important variables such as access to contraceptive, education of mother etc. Therefore, this study finds that there is an opportunity to explore a relationship between fertility, income and expenditure in the

context of Bangladesh while most other literatures observe fertility rate on the basis of socioeconomic and noneconomic variables.

Economic Theory of fertility and identification of the variables

The study of fertility and its relationship to income has a historical base that refers to the seminal work of Malthus. The Malthusian cycle of boom and bust demonstrated that increase in income generated increase in fertility and Europe's distant past was characterized by this fact. But the course of demographic transition over the years of 19th and 20th centuries projected a breach of this relationship and revealed that higher level of per capita income was no longer translated into higher fertility rate. However, economists in the first half of the 20th century observed confusion in this negative relationship that identified children as an inferior good. Becker (1960) provided a solution to this problem under the modern neoclassical framework of durable consumer demand by considering the capability of parents to the trade-off between investment in quality and quantity of children (Fox, 2015). In this setting Becker (1960) involved the traditional variables income and price along with the quality of children and budget constraint in terms of allocation of time and opportunity cost. Parents seek to maximize their utility subject to the budget constraint where children are included in the bundle of consumer commodities that household produces. Budget constraint is a function of the price of having children along with other consumer goods which include the opportunity cost of parenting time plus the cost of rearing children. When the cost of rearing children increases with income, two opposite effects (substitution effect and income effect) impose on fertility. Therefore fertility decision is linked here to other household decisions including consumption. The desired number of children depends on this optimization process (De Bruijn, 2006, Davalos & Morales, 2017, Becker, 1960, Becker & Lewis, 1973).

But Okun rejected the idea of comparing the cost of children with the cost of other consumer good used in the explanation of family size based on consumer theory, though Mincer acknowledged the analysis of opportunity cost that considered the value of the time spent by mother to rear her child instead of other activities (Llovel, 1989). Under this theoretical standing income along with consumption, expenditure is considered in this study as variables of interest to find their causal relationship on fertility rate. A brief description of the variables is presented below.

FERTILITY RATE: Total fertility rate represents birth per woman up to her child bearing age. Data on fertility rate that is collected for this study from the year 1987 to 2016 has projected a persistent declining trend. In 1987, fertility rate was 5.09 which was declined to around 3.00 in the year 2001. In first decade of twentieth century fertility rate trend to merge with replacement rate and in 2017 it was climbed down to 2.104 (WB, 2019).

INCOME: Adjusted net national income represents the value of GNI that is calculated after the deduction of the consumption of fixed capital and natural resources depletion. Adjusted net national income has increased throughout the entire period of interest. It has gradually rises from 22.888 billion (\$) in 1987 and reached to 213.49 billion (\$) in 2016. Data projects an upward trend throughout the whole period of time (WB, 2019).

EXPENDITURE: The Household Final Consumption Expenditure sums up the market value of all goods and services, including durable products that are purchased by households in a given year. It excludes purchases of dwellings but includes imputed rent for owner-occupied dwellings. It also includes payments and fees to governments and expenditures of nonprofit institutions serving the households. Household final consumption expenditure has monotonically increased throughout the entire range of time. Data projects that it was 19.86568 billion (\$) in 1987 and was reached to 153.0638 billion (\$) in 2016 (WB, 2019).

Method and Data

The Econometric Model

Relationship between income and fertility can be expressed by using the following econometric model.

$$\text{FERTILITY RATE}_t = \beta_0 + \beta_1 \text{INCOME}_t + \beta_2 \text{EXPENDITURE}_t + u_t \dots \dots (1)$$

Where, t and u_t denotes time and stochastic error term respectively.

Here income (INCOME_t) and EXPENDITURE_t can be replaced by Adjusted Net

National Income (ANNI_t) and Household Final Consumption Expenditure (HFCE_t) respectively. Since logarithmic series have greater estimation benefit, we will use logarithmic form of the variables as follows.

$$\text{LFR}_t = \beta_0 + \beta_1 \text{LANNI}_t + \beta_2 \text{LHFCE}_t + u_t \dots \dots \dots (2)$$

Here, LFR= Logarithmic series of FR

LANNI = Logarithmic series of ANNI

LHFCE = Logarithmic series of HFCE

Now, this model is used for empirical analysis using data.

Data

This study is based on secondary data and the data has been collected from World Development Indicators, 2018 by World Bank. Time series data is used here and the study period is 30 years from 1987 to 2016.

Empirical Estimation, Analysis and Result

Conversion of Data

For time series data, it is usual practice to convert the data into logarithmic form. One advantage of this transformation is that it gives us normally distributed data. This is a routine work in EViews statistical software. Thus, using EViews software we converted FR, ANNI and HFCE data into logarithmic form which is denoted as LFR, LANNI and LHFCE respectively.

Time Series Property of the Data

For regression analysis using time series data, data needs to be stationary. Unit root test is conducted to test for stationary data. Frequently used unit root tests are Dicky Fuller (DF) Test, Augmented Dicky Fuller (ADF) Test, and Phillips Perron (PP) Test. Phillips Perron Test is used here to identify the unit root. In cointegration literature it is a common consensus that ADF test is preferred to DF test while PP test is superior to ADF test (Gujrati et. al, 5th edition). Table 1 show the summary of Phillips Perron test statistic for LFR, LANNI and LHFCE, which is obtained by Eviews.

Table 1: Unit Root Test Statistic Summary for Logarithmic Data

	LFR	LANNI	LHFCE
Adj. t-Stat (Prob. *)	1.313488 (0.9999)	2.224350 (0.9999)	1.810764 (0.9996)

*MacKinnon (1996) one-sided p-values.

Unit Root Test was conducted under the null hypothesis that series has a unit root. From the table, it is evident that all the series has unit root since the probability of getting such adjusted t statistic is better than .9 in each case hence accepting the null hypothesis.

Since each series has unit root, ordinary regression will show spurious relationship. Hence, we need to convert the non stationary series into stationary series. This is usually done by taking 1st difference of the data. Table 2 shows the Phillips Perron Test statistic to check whether the 1st difference has unit root.

Table 2: Unit Root Test Statistic Summary for First Difference of Logarithmic Data

	D(LFR)	D(LANNI)	D(LHFCE)
Adj. t-Stat (Prob. *)	-2.166928 (0.0314)	-3.280752 (0.0256)	-3.629335 (0.0115)

*MacKinnon (1996) one-sided p-values.

Table 2 indicates that 1st difference of all the series is stationary at 5 percent significance level. Thus, it can be concluded that all the series are integrated to the degree of one i.e. **I(1)**.

Cointegration Test

Cointegration test is necessary to see the long run association among variables i.e. to find whether all the variables are cointegrated or not. If all the variables are cointegrated, Vector Error Correction (VCE) model is applicable to the model. On the other hand if the variables are not cointegrated, Unrestricted VAR model is used. Johansen Cointegration Test is usually used for checking cointegration. There are two method of Johansen test of cointegration. They are Trace test and the Maximum Eigenvalue test. Table 3 shows Trace test and table 4 shows Maximum Eigenvalue test.

Table 3: Unrestricted Cointegration Rank Test (Trace)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.732703	51.03114	29.79707	0.0001
At most 1	0.418732	15.40750	15.49471	0.0515
At most 2	0.027714	0.758854	3.841466	0.3837

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 4: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.732703	35.62364	21.13162	0.0003
At most 1 *	0.418732	14.64865	14.26460	0.0435
At most 2	0.027714	0.758854	3.841466	0.3837

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Both of the tables indicate that all the variables are cointegrated and there is only one cointegrating equation at 5 percent significance level with 2 lag length. This also states that even if shocks may affect the movement of series in the short run, it may tend to equilibrium in the long run. Table 5 shows the cointegrating equation.

Table 5: Long Run Relationship

1 Cointegrating Equation(s):		Log likelihood	319.4477
Normalized cointegrating coefficients (standard error in parentheses)			
LFR	LANNI	LHFCE	
1.000000	-1.357688 (1.40844)	3.185730 (1.75717)	
Adjustment coefficients (standard error in parentheses)			
D(LFR)	0.002662 (0.00089)		
D(LANNI)	0.029167 (0.10054)		
D(LHFCE)	0.112629 (0.09765)		

Since all the variables are cointegrated, vector error correction model is selected to estimate the model. Table 5 shows the result of long run model. Here 1.357688 is the long run coefficient of LANNI and 3.185730 is the long run coefficient of LHFCE. This model shows that LANNI is positively related to LFR. On the other hand, LHFCE is negatively related to LFR.

Optimal Lag Length Selection

Lag length selection is important to estimate vector error correction model. Table 6 shows optimal lag length depending on various information criteria.

Table 6: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	85.12030	NA	5.69e-07	-5.865736	-5.722999	-5.822100
1	272.2832	320.8507	1.70e-12	-18.59166	-18.02071	-18.41711
2	308.9957	55.06875*	2.41e-13*	-20.57112*	-19.57197*	-20.26567*

* indicates lag order selected by the criterion

From the table we see that almost all the information criteria selects 2 lag length as the optimal lag length. Hence, lag length 2 will be used as the optimal lag length.

Vector Error Correction Model

Error correction model can be used to analyze the short run behavior if all the variables are cointegrated i.e. all variables have long run stochastic trend. The VECM can be defined as follows.

$$\Delta LFR_t = \sum_{k=1}^n \alpha_{1k} \Delta LFR_{t-k} + \sum_{m=1}^q \beta_{1m} \Delta LANNI_{t-m} + \sum_{k=1}^n \gamma_{1k} \Delta LHFCE_{t-k} + \delta_1 \text{ERROR}_{t-1} + u_t$$

Here the coefficient of the first difference of LANNI and LHFCE shows the short run dynamics. On the other hand, coefficient of ERROR term shows the adjustment speed of the variables if there prevails any deviation from equilibrium. Hence, the coefficient of this term is expected to be negatively signed and its magnitude is expected to be less than one in absolute value.

Table 7: Vector Error Correction Model

Error Correction:	D(LFR)	D(LANNI)	D(LHFCE)
CointEq1	-0.009101 (0.00115) [-7.89350]	-0.142874 (0.09215) [-1.55047]	-0.139143 (0.09559) [-1.45568]
D(LFR(-1))	0.710663 (0.04264) [16.6661]	-3.165829 (3.40786) [-0.92898]	-3.219384 (3.53496) [-0.91073]
D(LANNI(-1))	0.029040 (0.00999) [2.90598]	0.365013 (0.79864) [0.45704]	0.495051 (0.88110) [0.59758]
D(LHFCE(-1))	-0.032798 (0.01063) [-3.08586]	-0.230806 (0.84942) [-0.27172]	-0.418761 (0.88110) [-0.47527]
C	-0.007905 (0.00130) [-6.09777]	-0.033126 (0.10361) [-0.31972]	-0.038459 (0.10747) [-0.35785]

From the table, VECM can be rewritten as follows.

$$\Delta LFR_t = 0.710663\Delta LFR_{t-1} + 0.029040\Delta LANNI_{t-1} - 0.032798\Delta LHFCE_{t-1} - 0.009101\text{ERROR}_{t-1} - 0.007905$$

From the equation it is evident that growth in ANNI causes a growth in FR. On the other hand, growth in HFCE decreases growth in FR. Besides, the coefficient of ERROR term is, as expected, negatively signed and its magnitude is less than one in absolute value. This coefficient states that .9 percent deviation is corrected every year which is very low that is it will take long time to attain equilibrium. Hypothesis testing tells that all coefficients are statistically significant at 5 percent significance level.

Granger Causality Test

Prior regression results only tell that there is positive association between LFR and LANNI as well as negative association between LFR and LHFCE. But this does not tell that LANNI and LHFCE cause change in LFR. There is the probability that the reverse might be true. So, following possibilities should be tested.

$$\Delta LFR_t = \sum_{k=1}^n \alpha_{1k} \Delta LFR_{t-k} + \sum_{m=1}^q \beta_{1m} \Delta LANNI_{t-m} + \sum_{k=1}^n \gamma_{1k} \Delta LHFCE_{t-k} + \delta_1 \text{ERROR}_{t-1} + u_t$$

$$\Delta LANNI_t = \sum_{k=1}^n \alpha_{1k} \Delta LFR_{t-k} + \sum_{m=1}^q \beta_{1m} \Delta LANNI_{t-m} + \sum_{k=1}^n \gamma_{1k} \Delta LHFCE_{t-k} + \delta_1 \text{ERROR}_{t-1} + u_t$$

$$\Delta LHFCE_t = \sum_{k=1}^n \alpha_{1k} \Delta LFR_{t-1} + \sum_{m=1}^q \beta_{1m} \Delta LANNI_{t-1} + \sum_{k=1}^n \gamma_{1k} \Delta LHFCE_{t-1} + \delta_1 \text{ERROR}_{t-1} + u_t$$

To find out causality, VEC Granger Causality Approach can be used since all the variables are cointegrated. VEC Granger Causality Test results are depicted in table 8.

Table 8: VEC Granger Causality Test

Dependent variable: D(LFR)			
Excluded	Chi-sq	df	Prob.
D(LANNI)	8.444695	1	0.0037
D(LHFCE)	9.522540	1	0.0020
All	9.604820	2	0.0082
Dependent variable: D(LANNI)			
Excluded	Chi-sq	df	Prob.
D(LFR)	0.863001	1	0.3529
D(LHFCE)	0.073832	1	0.7858
All	0.920434	2	0.6311
Dependent variable: D(LHFCE)			
Excluded	Chi-sq	df	Prob.
D(LFR)	0.829425	1	0.3624
D(LANNI)	0.357101	1	0.5501
All	0.875583	2	0.6455

From the table, it is evident that DLANNI and DLHFCE granger causes DLFR and this result is significant at 5 percent significance level. All other possibilities are rejected at 5 percent significance level.

Result

VEC Granger Causality Test shows that log of adjusted net national income and log of household final consumption expenditure granger causes log of fertility rate. The expected result of some important residual tests i.e. normality test, heteroskedasticity test and serial correlation test show the robustness of the model.

Conclusion

The objective of this paper is to reinvestigate the causal relationship between income and fertility. For better understanding household consumption expenditure is also added to this model as another explanatory variable. The study has found that both income and consumption expenditure cause fertility rate of Bangladesh. From the empirical analysis we have reached to a conclusion that in case of Bangladesh, increasing income leads to an increase in fertility rate which supports the argument of Becker (1960) that considered

children as normal consumption good. Result also finds fertility rate (FR) is negatively related to Household Final Consumption Expenditure (HFCE). Since the cost of children is included in the consumption expenditure of a household, this negative relation implies that the demand for children declines with the increase in household final consumption expenditure. Increase in income can increase both the quantity and quality of children but the quantity elasticity is small relative to quality elasticity (Becker, 1960). Therefore the negative relationship between fertility rate and household expenditure is supposed to lead to the trend of higher expenditure on qualitative improvement of children.

This result also reveals that the impact of income effect of fertility rate is counterbalanced by the expenditure effect. Moreover, since the expenditure coefficient is slightly higher than income coefficient fertility rate approaches downward. This result is consistent with the findings of Garry S. Becker (1960) and Freedman & Thornton (1982).

From the empirical finding of this study, it can be concluded that if Bangladesh wants to attain its desired fertility rate, that is needed to achieve targeted per capita income and human development threshold for confirming the middle-income country status in world economic ranking, adjustment of income and household consumption expenditure (that include cost of children as a durable consumer good) can be considered as a great tool. A careful selection of socio economic policies and priorities that reflects social choice can play a crucial role in this end.

References

- Becker, G.S., (1960), An economic analysis of fertility. Demographic and Economic Change in Developed Countries. Conference of the Universities-NBER Committee for Economic Research. Princeton, NJ: Princeton University Press.
- Becker S. G. and Lewis H G., (1973), On the Interaction between the Quantity and Quality of Children, *Journal of Political Economy* 81(2), S279-S288.
- Bongaarts, J. 2006. "The Causes of Stalled Fertility Transitions", *Studies in Family Planning* 37(1):1- 16.
- Caldwell, J.C., Khuda, B., Caldwell, B., Pieris, I. and Caldwell P. (1999). "The Bangladesh Fertility Decline: An Interpretation", *Population and Development Review*. 25(1): 67- 84.
- Cleland, J., Phillips, J.F., Amin, S. and Kamal, G.M. (1994). *The Determinants of Reproductive Change in Bangladesh: Success in a Challenging Environment*, The World Bank, Washington DC.
- Co'rdoba C. J. & Riples M., (2014). Intergenerational Transfers and the Fertility-Income Relationship, *The Economic Journal*, 126,949-977.
- Davalos,E.& Morales, L.F.,(2017). Economic crisis promotes fertility decline in poor areas: Evidence fromColombia, *Demographic Research*, 37,867-888
- Docquier,F.,(2004). Income distribution, Non Convexities and the Fertility-Income Relationship, *Economica*, 71,261-273.
- De Bruijn, B. (2006). *Fertility: Theories, Framework, Model, Concepts*, DEMOGRAPHY: ANALYSIS AND SYNTHESIS, Elsevier Academic Press, Chap 19, 549-569.

- Dev, S.M., James, S.K., Sen, B., (2002). Causes of Fertility Decline in India and Bangladesh: Role of community, *Economic and Political weekly*, 37(43), 4447-4454.
- Freedman S.D., Thornton, A., (1982). *Income and Fertility: The Elusive Relationship*, Demography, 19(1).
- Fox, J., (2015). Is a Positive Relationship between Fertility and Economic Development Emerging at the Sub-National Regional Level? Theoretical Considerations and Evidence from Europe. MPIDR Working Paper WP 2015-006.
- Gilbert, G., (1993). Malthus T.R., *An Essay on the Principle of Population*. (1798) Oxford World's Classics reprint. xii-xxv.
- Gujrati et. al. *Basic Econometrics*, 5th edition, published by McGraw Hill chapter 15, p 584- 590.
- Gimenez, L., Jolliffe, D., Sharif, I. (2014). Bangladesh, a Middle Income Country by 2021: What Will it Take in Terms of Poverty Reduction? World Bank, Washington, DC. <http://openknowledge.worldbank.org/handle/10986/18668>.
- Khuda, B., & Hossain, M. B. (1996). Fertility decline in Bangladesh: toward an understanding of major causes. *Health Transition Review*, Supplement 6 1996, 155-167.
- Lee, R., (1987). Population dynamics of human and other animals, *Demography*, 24, 443-465
- Llovet, J.J., (1989), *Estud Demogr Urbanos Col Mex*, 4(1) 139-59.
- Malthus, T. R., (1798). *An Essay on the Principle of Population*. Oxford World Classic reprint. Chapter II, p. 18.
- Orbeta, Aniceto C., (2005). Poverty, Fertility Preferences and Family Planning: Practice in the Philippines. Paper presented at the 25th IUSSP International Population Conference, July 18-23, Tours, France.
- Rabbi, A. M. F. (2012). Mass Media Exposure and its Impact on Fertility: Current Scenario of Bangladesh. *Journal of Scientific Research*, 4 (2), 383-395.
- Schultz, T., (1994). Human Capital, Family Planning, and Their Effects on Population Growth. *The American Economic Review*, 84(2), 255-260. Retrieved from <http://www.jstor.org/stable/2117839>
- United Nations Population Fund (UNFPA), (2015). *The Impact of the Demographic Transition on Socioeconomic Development in Bangladesh: Future prospects and Implications for public Policy*.
- Willis, R., (1973). A New Approach to the Economic Theory of Fertility Behaviour, *Journal of Political Economy*, 80(2), 14-64.
- World Development Report 1994: *Infrastructure for Development*, World Bank, Oxford University Press.
- World Bank (2019). The World Bank. <https://databank.worldbank.org/data/source/world-development-indicators#> (Accessed on 10 February, 2019).

Effectiveness of Co-management Approach in the Protected Areas of Sundarbans: A Double-Edged Sword Tools for Biodiversity Conservation

Md. Mizanur Rahman*
Md. Nazrul Islam**

Abstract: The main purpose of this study is to explore the current status of co-management approaches and how these approaches are important to contribute the capacity building, reduced dependency on natural resources in the Sundarban Mangrove Forest areas in Bangladesh. Sundarban is the largest tidal mangrove forest in the world is being degraded day by day due to the geophysical position, anthropogenic interferences and socio-economic contexts. It is highly disaster prone to frequent natural hazards like cyclone, storm surge and salinity intrusion etc. The Sundarban forest offers a solid wall against cyclones and that is why when tropical cyclones Sidr, Aila and Bulbul hit the coast, loss of life was relatively lighter. The forest took the force of the storms saving human lives. Once it is disappeared or depleted, the coastal people will become vulnerable to cyclones which would be a frequent phenomenon because of current global warming and climate change. Unfortunately, nor s single management systems will not enough to protect this forest biome. Therefore, protecting this mangrove forest it is important to apply the co-management approach for adapting climate change and anthropogenic impacts. Lately, the co-management approach is considered as a new practical model of decentralization in natural resource management in Bangladesh which tools are widely used in this study. It encompasses a set of activities that are specially designed to empower local people through participation in the management and extraction of natural resources at Sundarban areas. The results of this study also examined where this co-management was played a vital role in reducing inequalities. The applied co-management approaches in this study also could be the pathway to conserve the protected or non-protected forest in Bangladesh with supporting the tools of double-edged sword for Biodiversity Conservation.

Keywords: Biodiversity, Conservation, Double Edged Sword, Participatory, Challenges

Introduction

The structure and composition of Sundarbans, the largest single halophytic mangroves unit in the world are undergoing major changes due to anthropogenic climate change effects (Hossain et al., 2013; Sarwar and Woodroffe, 2013; Hossain et al., 2015; Pao et al., 2016; Mamun, 2017; Islam et al., 2018). The destruction of the mangrove forests is occurring at a faster pace than never before (Mohammed et al., 2010; Kibria et al., 2011). After independence Bangladesh followed the traditional forest management approach of British and Pakistani Regimes (Iftekhar, 2006). Two parallel systems of production

* Director (Research and Development), Bangladesh Public Administration Training Centre (BPATC), Savar, Dhaka 1343, E-mail: mizan_peroj@yahoo.com

** Professor, Department of Geography and Environment, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh; E-mail: nazrul_geo@juniv.edu

forestry exist in Bangladesh as government forests managed by the Forest Department under ministry of Forest and Environment and privately owned home gardens or village forest. The top-down forest management approach adopted by colonial and post-colonial regimes proved to be also inefficient (Rashid et al., 2016). The forest management history in Bangladesh is considered a typical example of an increasing trend of habitat losses and fragmentations (Nath et al., 2015; Huda, 2018). The traditional forest management system in Bangladesh has been proved non-functional for the natural resource management sustainably and for addressing socio-economic challenges due incapability of protecting widespread overexploitation of forest resources, huge population pressure, corruption and increasing demands for forest resources (Biswas and Choudhury, 2007). Due to centralized, bureaucratized, formalistic and authoritarian systems of management and policy practices (Giessen et al., 2016; Rahman and Giessen, 2016), the Forest Department could not secure the participation of the community at large scale leading to massive encroachment and deforestation (IRG, 2003; Millat-e-Mustafa, 2002). In order to prevent huge degradation, the emphasis has been given over the last three decades on adopting decentralized forest policy (Nath et al., 2015).

Bangladesh ratified the first national forest policy in 1979, which clearly described the participatory approach to be followed in state-owned forest land (Muhammed et al., 2005). In the recent time, forest policy discussions have focused sustainable management of forest resources. Consequently, complex multiple international and national policies, emphasizing sustainable forest management have been adopted in different jurisdictions relying on foreign donors' projects (Giessen et al., 2016). Despite the implementation of conservation policies since the 1980s, the Forest Department could not manage the protected areas of Sundarbans due to passive participation of the stakeholders in the planning, group formation, and implementation processes. Ineffective conservation programs and failure to increase awareness among local community are also main causes (Murshed, 2007; Rashid et al., 2016). Community's participation becomes effective when the right, incentives, responsibilities and the participants are clearly defined (Sawhney et al., 2007). Bangladesh introduced co-management in targeted forests and wetlands of Sundarbans in 2008 with support from different international organizations including USAID (Cunningham et al., 201; Huda, 2005; Fox et al., 2013). The objective of this co-management was a sustainable use of natural resources through maintaining ecological balance, promoting green growth and engaging the community in the governance (Fox and Mustafa, 2013). Sometimes the donor dependency projects and their prescriptions worsen the scenario in terms of conservation and social equality (Rashid et al., 2016). There is compelling evidence that co-management played a crucial role in achieving the objectives (Hoof, 2010; Carlsson and Berkes, 2005; Gurung et al., 2011). The main objective of this study is to explore the current status of co-management approaches and how these approaches are important to contribute the capacity building, reduced dependency on natural resources in the Sundarban Mangrove Forest areas in Bangladesh.

Background of Co-management Approach for Forest Resources Management

The Forest Department with the support of the USAID launched the Nishorgo Support Project (2003-2008) in 2003. The objective of this research was to enhance biodiversity

conservation in Protected Areas (PAs). It actively and formally involved the local people in the forest management. The community accessed benefits from PAs for playing roles against loggers, poachers and land grabbers. In 2008, USAID assisted to launch the Integrated Protected Area Co-Management (IPAC) project (2008-2012) (Huda, 2005). IPAC clustered the Sundarbans are divided into four sections as: 1) Sundarbans East Wildlife Sanctuaries (SEWS), 2) Sundarbans West Wildlife Sanctuaries (SWWS), 3) Sundarbans South Wildlife Sanctuaries (SSWS) and 4) Ecologically Critical Areas of Sundarbans (ECA). The communities are involved in planning, capacity building, and field-level conservation (IRg, 2003.a; Huda, 2018). An empirical tool double-edged sword acts in two ways, often with one negative and one positive effect. As a very different discourse and method for regulating forest conservation to collective opinions, the law provided a double-edged challenge to control the forest with co-management manner. The imperial approach, which imposed protected areas and policed them with military style forces, seems outmoded. Conservation gains will become more secure if we can reduce the burden on local people and ensure that conservation efforts gain the legitimacy of local democratic accountability. There are many options for conservation and management of forest but how to do that. The important point is, it isn't hard to do and almost always brings worthwhile benefits, insights and opportunities. There are also ethical arguments about why local people's views matter. It is not our role to make all the choices. There are many voices that need to be heard and trying to be included as co-management approaches. The co-management followed a matrix-based approach for biodiversity conservation and enhancing environmental governance (Table-1).

Table 1: Co-management Matrix in the Sundarbans adopted from USAID, 2013

Co-Management	Participation	Conservation	Benefit
Strategy	Legal and institutional framework development for co-management	Capacity building in conservation through training	Increased income generation from conservation and equitable sharing of benefits arising from sustainable use of natural resources
Capacity Building	Establishing conservation networks	Short courses; training programmes; mentoring	Emphasize on public-private partnerships and creation of new alliances
Implementation	Formation of hierarchical committees and guidelines	Accelerating participatory management and habitat restoration work at the landscape level	Increasing alternative income generation activities through eco-friendly value chains

Source: Kibria et al., 2011; United States Agency for International Development (USAID), 2013; DeCosse et al., 2012; Fox and Mustafa, 2013; Huda, 2018

In this multi-stakeholder participatory approach, the local communities play a vital role in nature conservation and management (Rashid et al., 2016). As a part of community-based governance different committees were formed hieratically (Figure-1). According to Rahman and Laskar (2016), the charters of duties are shared through the formation of different committees and groups in the co-management system.



Figure 1: The hierarchy of participatory organizations for each protected area (Helal, 2005; Huda, 2005; DeCosse et al., 2012)

According to the guidelines formed by the Forest Department, Co-management Committee is responsible for the management of Protected Areas with the stakeholders' consultations. Each Village Conservation Forum (VCF) comprised of 30-100 villagers having one-third female members. The members of each VCF elected one male and one female as Peoples Forum (PF). Community Patrol Groups (CPG) and Eco-Tour guides are selected by the VCF (Islam, 2013). The Co-management Committee performs activities in PAs under the guidance of the Council. All activities are supported by a group of local motivators called Nishorgo Shahayaks (NSs). The Co-management Council/ Committee and the Village Conservation Forum are registered by the Social Welfare Department of the government in Bangladesh. The international standard organizational structure of Co-management group and interviewed organizational structure of Co-management group in this study is shown below (Table-2).

Table 2: Organizational Structure of Co-management in each Protected Areas (PA)

Members	Standard Rules of Co-management Council (N=65)	No. of Member of council (for this study)	Standards Rules of Co-management Committee (N=29)	No. of Member of the Committee council (for this study)
Member of Parliament/Civil Society/Media	05	4	02	1
Government Departments	07	6	03	2
Forest Beneficiary	08	7	05	3
Local Government Representatives	06	5	02	1
Local peoples	35	27	14	10
NGO Person	01	1	01	1
Entrepreneurs	03	2	02	2
Total	65	52	29	20

Source: Huda, 2005; Helal, 2005; DeCosse et al., 2012; Adopted from Ionita et al., 2013

For measuring the effectiveness of co-management approaches, it is quite important to analysis the existing recent application of co-management approach for biodiversity conservation project in Bangladesh. In this context, the Integrated Protected Area Co-Management (IPAC) project (2008-2012) provided financial support for imparting training on eco-tourism, aquaculture, nursery management, homestead forestation, vegetable cultivation, and waste management. As a part of the initiatives of creating alternative income generation activities the project supported the VCF members by providing grants for fish fingerling, pond re-excavation, and for buying rickshaw and sewing machine. Different occasions were observed to motivate the local people towards conservation. After completion, the Integrated Protected Area Co-Management (IPAC) project (2008-2012) was replaced by Climate-Resilient Ecosystems and Livelihoods (CREL) project (2012-2017) with the help of the USAID Bangladesh. The CREL worked to scale-up and adapt co-management models of IPAC to conserve the Sundarbans and to increase resilience to climate change through more participatory planning and livelihoods diversification (Winrock, 2015).

Background to the Study Area (Case Point of Chandpai Forest Ranges in Sundarban)

Chandpai is one out of four ranges of the Sundarbans having more luxuriant biodiversity and covering 100,021 ha of forest lands. The forests and wetlands are very rich plant and wildlife diversity. Chandpai is surrounded by the Sarankhola Range to the east and south, mainland to the north, and Khulna Range to the west. The landscape area of the site is about 50 km in length and 5 km wide covering 2 districts named as Khulna and Bagerhat.

One sub-district (Dacope) from Khulna district and two sub-districts (Mongla and Morrelgonj) from Bagerhat districts are under this area.

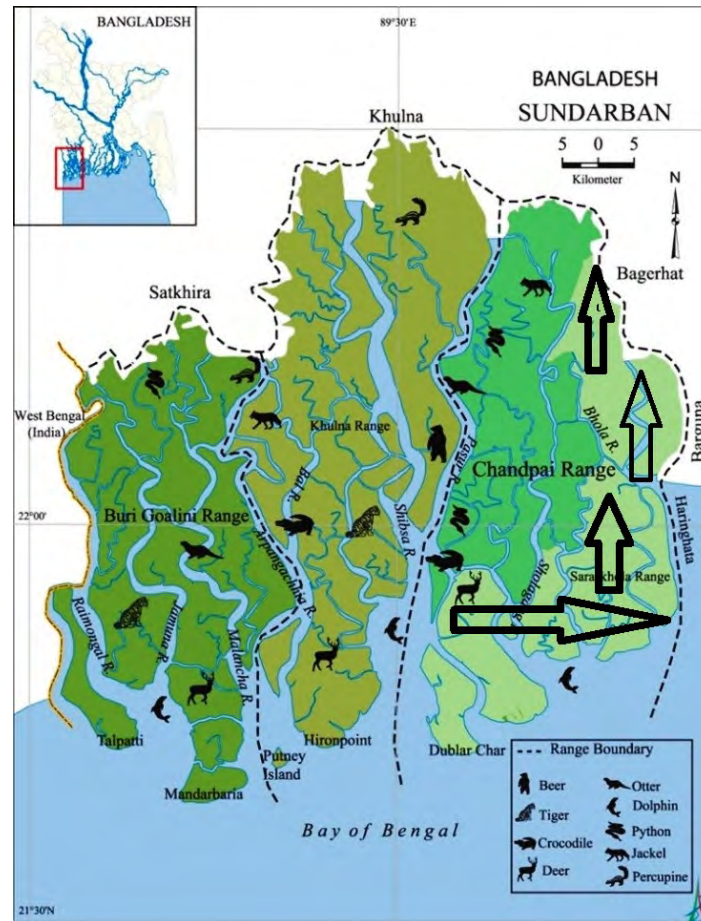


Figure 2: Map showing four ranges of the Sundarbans-landscape areas of the Chandpai Range is marked by arrows (Modified from Hela, 2005 and Huda, 2018)

Five unions from these 03 sub-districts are included in co-management. These unions cover 29 villages with about 24,440 households and 134,420 people in the landscape (Helal, 2005). The Forest Department has 4 station offices, 22 patrol camps and about 200 staffs for the management of the forest under this Range. A total of 01 co-management Council (CMC), 01 co-management Committee (CMC) and 05 Union Committees are functioning that included 29 Village Conservation Committees (VCF). In addition, other important co-management platforms included Peoples Forums (PF), Federation of Resources User Groups (FRUG), Nishorgo (to cherish the sanctity of nature) Clubs, Community Patrol Group members (CPG), Nishorgo Sahayaks (local motivators), and Eco-Guides (DeCosse et al., 2012). Figure 2 shows the map of four ranges of the Sundarbans (landscape area of the Chandpai Ranges which are marked by arrows signed (Helal, 2005). The main characteristics of the Chandpai Range are mentioned below (Table-3).

Table 3: Characteristics of the study area “the Chandpai Ranges of Sundarban”

Attributes	Chandpai Range
Status	a wildlife sanctuary, an ecologically critical area, a crocodile breeding center, a dolphin sanctuary, and two tourist spots
Ownership	Government
Management	Mostly top-down management and partly co-management
Coordination with academia and researchers	No
Year established	Wildlife Sanctuary in 1977; Ecologically Critical Area (ECA) in 1999; Dolphin Sanctuary in 2012
Forest area (ha)	760
Main plant species (Ahmed et al. 2018)	Sundri (<i>Heritiera fomes</i>), Keora (<i>Sonneratia apetala</i>), Kankra (<i>Bruguiera gymnorrhiza</i>), Khalshi (<i>Aegiceras corniculata</i>), Passur (<i>Xylocarpus moluccensis</i>), Dhundul (<i>Xylocarpus granatum</i>), Hantal (<i>Phoenix paludosa</i>) and Golpata (<i>Nypa fruticans</i>)
Main Wildlife Species (Rahman and Asaduzzaman 2010)	The river terrapin (<i>Betagur baska</i>), Indian flap-shelled turtle (<i>Lissemys punctata</i>), Peacock soft-shelled turtle (<i>Trionyx hurum</i>), Yellow monitor (<i>Varanus flavescens</i>), Water monitor (<i>Varanus salvator</i>), Indian python (<i>Python molurus</i>), the Bengal tiger (<i>Panthera tigris</i>), Spotted deer (<i>Axis axis</i>), Rhesus monkey (<i>Macaca mulatta</i>)
Projects	Integrated Resource Development of the Sundarbans Reserve Forest (1992 -1995), Sundarbans Biodiversity Conservation Project (1999-2005), Forest Resources Management Project (1992-2001), Nishorgo Support Project (2003-2008), Integrated Protected Areas Co-management (2008-2012), Sundarban Environmental and Livelihoods Security (SEALS) Project (2012-2014), Climate-Resilient Ecosystems and Livelihoods (2012-2017)
Community involvement in decision making	Partially
Tourism facilities	Yes
Community benefits from forests	Yes
Human-wildlife conflict	Loss of livestock and human lives
Compensation for losses from wildlife	No compensation

Sources: Helal, 2005; Huda, 2018)

Data Sources and Methodology

For the purposes of this study a large number of spatial and attribute information were collected from primary and secondary sources. The primary information was collected from field observations, interview and questionnaire survey. A semi-structured questionnaire was delivered to all the sampled stakeholder and respondents in order to gather information concerning organization, the role and tasks of these organizations and the integration in and interaction with local and national-regional level. There are some coordination meetings were organized at the beginning, mid and end of the study provided a framework for interactive discussions and provision of feedback that play an important role in checking the results and developing realistic conclusions in a participatory way. The respondents were classified as 'people involved in co-management' (PICM) and 'people not involved in co-management' (PNCM). Twenty VCFs out of 29 were considered for data collection. Ten respondents from each VCF were selected with a combination of purposive and simple random sampling for face to face interviews.

A total number of 200 PICM were examined in this study. Female respondents were selected purposively, where the male by drawing a lottery from the name list to reduce potential biases associated with convenience sampling. The nearest neighbour of each PICM who are not involved in co-management was selected as PNCM so that the social attributes remain same. In the case of PNCM, the total number of respondents and gender ratio was similar to PICM. The qualitative study examined the impact of co-management on awareness building, dependency on natural resources and annual income. A comparison analysis was conducted of the results from the surveys incorporating data from the feedback of the interviews. Some suspected respondents involving in illegal professions were cross-interviewed by their neighbours and relatives very carefully. Their market chains, supply chains, and financial transactions were closely observed and monitored intelligently to confirm real annual income and profession. The interviews were structured consisting of 30 closed-ended questions. Most of the questions had a rating scale of 1 to 5 that corresponded to performance levels, with 1 being 'strongly disagree' and 5 being 'strongly agree'.

The questionnaire was prepared in Bengali and translated into English. The field research was conducted between March and May of 2017-2018. These responses were quantified from the rating scale by the author for further analysis. For identifying to determine the income inequality of the forest depended inhabitants Lorenz Curve and Gini Coefficient were applied in this study. It is used as estimate of economic inequality, measuring income distribution among a population of the study areas. In generally, it is known that the coefficient ranges from 0 (or 0%) to 1 (or 100%), with 0 representing perfect equality and 1 representing perfect inequality. Values over 1 are not practically possible as we don't take into account the negative incomes. (Income can be 0 at it's owest but not negative). Thus, a country in which every resident has the same income would have an income Gini coefficient of 0. A country, in which one resident earned all the income, while everyone else earned nothing, would have an income Gini coefficient of 1.

Results and Discussion

Demographic Profiles in the Study Area

The table-4 shows that both PICM and PNCM are identical in social status in terms of household size, educational level, age, and family size. The average family size in the study was higher than in the study area was higher than the national average of 4.09 in 2017 (BBS 2017). Quasem MA (2011) found a similar average family size (5.1) in rural areas of Bangladesh. The average household size shows that the people residing in the Sundarbans areas are functionally landless (< 0.5 acres). The household size was very small, where one-third of the population did not own land. They depend on forest lands instead of their own lands (Getzner and Islam 2013). The education level was very poor as half of the populations had no formal education. According to Getzner and Islam (2013), only 14–23% population in the Sundarbans areas achieved secondary education. Sarkar and Bhattacharya (2003) focused on the necessity of increasing education levels in the mangrove forest areas.

Table 4: Demographic profiles of the respondents in the study area

Description	Mean $\pm$ SD	
	People Involved in Co-Management' (PICM)	People Not Involved in Co-Management' (PNCM)
Household Size (Decimal)	16.74 $\pm$ 6.85	15.48 $\pm$ 6.63
Education Level (Class)	2.65 $\pm$ 2.77	2.58 $\pm$ 2.68
Family Size (N)	5.29 $\pm$ 0.95	5.25 $\pm$ 0.97

Source: Field Survey, 2018

Dependency on Mangrove Resources

According to the guideline of the Forest Department, a resident can extract resources like fish, crabs, honey, and nypa palm with prior permission and providing a prescribed fee. But logging and hunting are strictly prohibited. The duration, area and the quantity to be harvested are assigned by the Forest Department. Fishing and crab catching except in the Ramsar Sites is allowed all the year-round, while honey and nypa palm can be collected seasonally (Getzner and Islam 2013). In PICM group 62.5% respondents depended on the natural resources of the Sundarbans, while 74% in PNCM.

The dependency on the Sundarbans was reduced through different co-management projects. But it is irony of fate that co-management facilitated the criminals to be involved in illegal activities like clear felling (6.5% of the respondents), poaching (3%) and spraying poison (2%) for sweeping fishes from the forbidden Ramsar Canals. Only 3% respondents of PNCM were involved in illegal logging (Table-5). So they start to use the forestland for agricultural land, shrimp farm, settlement etc. they use wood of Sundarban as fuel wood, furniture, house construction etc. This underlying cause played a vital role in deforestation of Sundarban. Due to illiteracy, peoples of Sundarban are not aware about Sundarban forest. They do not know the significance of forest and ecological balance of forest ecosystem. They have a very little knowledge about the disadvantage of

deforestation. So they are falling into competition to cut down tree. They have no enough idea about the protection of forest. So that lack of awareness is also an underlying cause of deforestation of Sundarban.

Table 5: The Occupational Percentage (%) of Distributions of People Involved in Co-Management' (PICM) and People Not Involved in Co-Management' (PNCM)

Type of occupation	People Involved in Co-Management' (PICM) (%)	People Not Involved in Co-Management' (PNCM) (%)
Boatman	3	4
Crab Catcher	4	6
Day Labourer	2	3
Fisherman	12	20
Fisherman (Poison)	2	0
Fuel Wood Harvester	7	9
Honey Collector	5	6
Logger (illegal)	6.5	3
Mangrove Palm Collector	4	5
Nypa Palm Collector	6	10
Poacher	3	0
Others	5	3.5
Small Business	3	4.5
Total	62.5	74

Source: Field Survey, 2018

Annual Income and Inequality

The mean annual income of PICM (76243 takas) was better than PNCM (64445 takas). Without consideration, the incomes of the respondents who were involved in illegal activities, the mean annual income of both PICM and PNCM were almost the same (Table-6).

Table 6: Annual Income of People Involved in Co-Management' (PICM) and People Not Involved in Co-Management' (PNCM)

Activities	Number (N)		Annual Income in Bangladesh Taka (Mean)	
	PICM	PNCM	PICM	PNCM
Who extracts resources legally	177	194	63751	62957
Who extracts resources illegally	23	6	172375	112564
Total	200	200	76243	64445

Source: Field Survey, 2018

The respondents (11.5%) who were involved in logging, poaching and spraying poison contributed 26% of total income of PICM, where 3% of PNCM contributed 5.24% of the total income of PNCM (Figure-2).

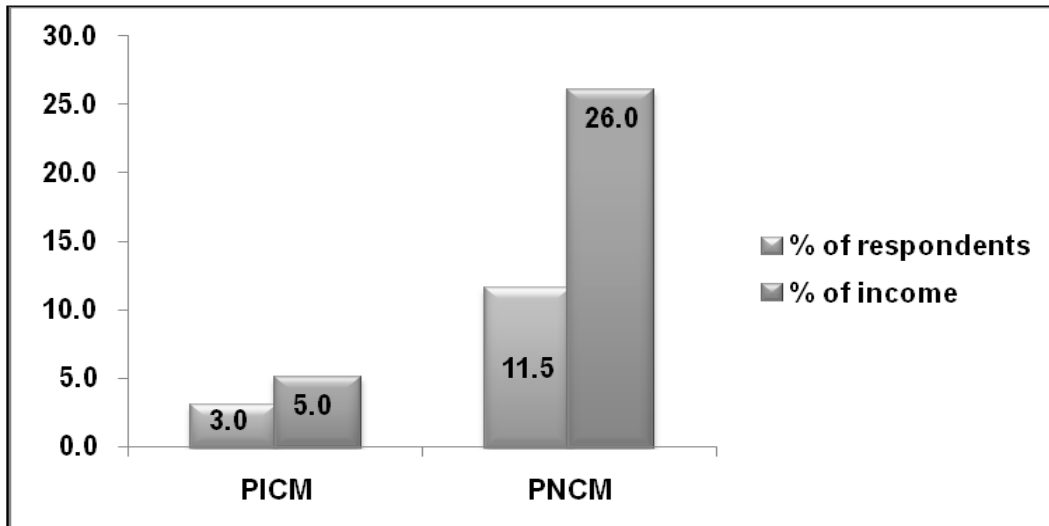


Figure 2: Proportion of the respondents (%) involved in illegal professions and their contributions (%) to the total income

The Gini-coefficient was greater of PICM (0.31) than that of PNCM (0.24). The co-management had a positive role in increasing income inequality (Figure-3 & 4).



Figure 3: Lorenz Curve for PICM

Income inequality is based on how the income is distributed among individuals of a society. It has a propensity to analyze the economic conditions in individual or collective level.

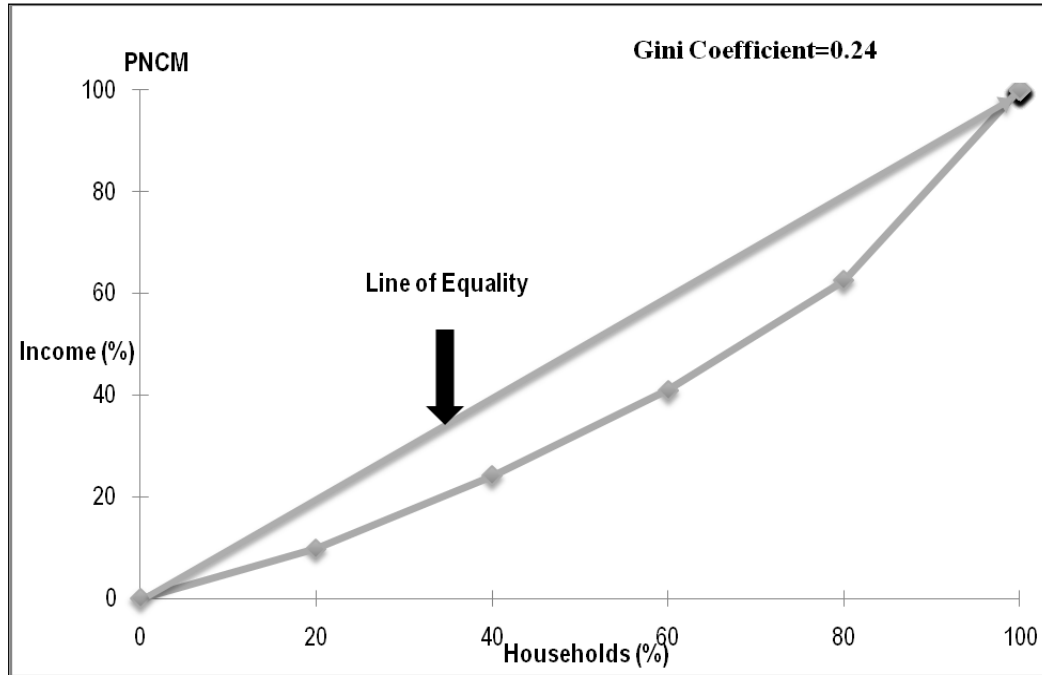


Figure 4: Lorenz Curve for PNCM

Awareness about Conservation

The PNCM scored better than PNCM in terms of awareness about nature conservation (Table-7). All respondents of both PICM and PNCM showed the highest score for punishing the criminals and tiger conservation though some of them were involved in all those illegal activities. The lowest numbers of respondents of both groups were interested to donate fund for the conservation purpose.

Table 7: People Involved in Co-Management' (PICM) and People Not Involved in Co-Management' (PNCM) Scores for awareness about conservation

SL	Scale Items for Rating Community Perceptions about Conservation	Mean Score	
		PNCM	PINCM
1	The Sundarbans is like our mother	4.8	4.2
2	I am happy that I have been living in the border of Sundarbans	4.4	3.7
3	Bangladesh cannot survive without the Sundarbans	4.9	4.5
4	I would be happy if my children benefitted from the Sundarbans	4.9	4.5
5	It is important to protect plants and trees of Sundarbans	4.7	4.2
6	It is important to protect deer, wild boars, birds, Bengal Tigers, and other animals	4.8	4.4
7	People who log the Sundari and other tree species should be punished	4.6	4.4
8	People who hunt Spotted Deer, birds and Bengal Tiger poach should be punished	4.6	4.3
9	People who hunt dolphins should be punished	4.9	4.9
10	People who spray poison on the water to sweep fishes should be declared as the national enemy	4.9	5.0
11	People who grab the forest land should be punished	4.5	4.1
12	Saboteurs (land grabbers) who are setting fire to the Sundarbans should be punished	4.3	4.2
13	People who catch baby Hilsa fishes should be punished	2.4	2.3
14	People who use gill nets (netting with a very small mesh) for catching larvae of fishes and shrimps should be punished	2.5	2.4
15	The water robbers (Sundarbans destroyer) should be brought under criminal justice	4.8	4.9
16	The Bengal Tigers can save the Sundarbans	5.0	5.0
17	I would be happy to see more tourists here	5.0	5.0
18	I like eco-tourism	4.6	3.9
19	I motivate other people to protect Sundarbans	3.9	2.6
20	Aforestation is necessary for the deforested areas	3.3	3.3
21	I am engaged in forest protection as a volunteer without pay	2.9	1.0
22	In the future, I shall be involved in forest protection	2.6	1.0
23	I am willing to donate some fund for the conservation purpose	1.0	1.0
24	I am willing to share my knowledge and skill of mangrove rehabilitation	3.6	1.0
25	I have skills in mangrove conservation	3.1	1.4
26	Overall	4.0	3.5

Source: Field Survey, 2018

Discussions

Based on the findings and bearing associated caveats in mind, the co-management practices in the Sundarbans represent a painted picture that is often puzzled, complex, and full of confusions. Usually, biodiversity conservation relies on a vague dichotomy between community and nature (Brecht et al., 2002). Since biodiversity conservation is a human effort, it depends on the commitment of social actors. The Forest Department took both saints and devils in the formation of different hierarchical co-management committees. The Devils remain behind the scenes but force to fulfill their desires through illegal activities. The key positions of different committees were occupied by the elite, politically involved and influenced persons who rarely respect the laws (Chowdhury, 2013; Belal, 2013). In true sense, the co-management committee functions as per the framework and guidelines set by the Forest Department (Fox and Mustafa, 2013). The management practices in the Sundarbans are hierarchical and primarily focused on earning revenue.

There are some laws and protective measures (such as temporal and spatial restrictions, prohibition of clear felling, restrictions on fishing in the Ramsar Canals, etc.) to enhance conservation in the Sundarbans. But violations of the laws are rampant (Islam et al., 2018). Some people involved in co-management were engaged in clear felling, poaching, spraying poison for sweeping dead fishes and using fine-meshed nets. Such heinous crimes in the Sundarbans have occurred with the collaboration of the greedy staffs of Forest Department (Islam et al., 2018). The poison not only kills the fishes of the canals but also flows into the rivers, damaging the aquatic ecosystem (Hoq, 2007). The corruption not only affects the quality of public infrastructure but also the services very badly. The performance decreases due to corruption (Mauro, 1998). The origins income inequalities are caused by poor governance and corruption (Kar and Saha, 2012). Sustainable development goal 10 urges for reducing inequalities in income, where, co-management enhances inequalities.

Conclusions

The co-management has created few steps toward public awareness and participatory governance but has not adequately provided the mechanisms for playing a significant role for communities in biodiversity conservation. It poses the Sundarbans to a greater risk for heinous crimes are committed by some people who are sheltered under the umbrella of co-management. Due to the illegal activities of such people, income inequality is being increased, which are contrary to sustainable development goals. In order to make co-management effective few recommendations are given: (1) excluding politically influenced muscle man; 2) enforcing existing laws against the culprits; and 3) bringing the poachers, loggers and poison sprayers in a verdict.

References

- Ahmed A., Ataulah M., Rashid P., Paul A. R., Dutta S., Ali M. S (2018) Species diversity, change in forest cover an area of the Sundarbans, Bangladesh. *Bangladesh J Bot* 47(3): 351-360.

- Bela M. A. H (2013) Effectiveness of Co-management committees in Teknaf Wildlife Sanctuary. In: Fox J, Mustafa MG, Bryan RB, Stephen MB, Laurie D (eds.) Connecting communities and conservation: Co-management initiatives implemented by IPAC in Wetlands and Forests of Bangladesh.
- BFD (2015) Success in Co-management: Bangladesh Forest Department. Available from <http://www.bforest.gov.bd/site/page/7860ce97-a221-401e-9ca7-6870649c937c/Co-management>.
- Biswas S., R., Choudhury J. K (2007) Forests and forest management practices in Bangladesh: The question of sustainability. *Int For Rev*, 9(2), 627–640.
- Carlsson L., Berkes F (2005) Co-management: Concepts and methodological implications. *Journal of Env M* 75:65-76.
- Chowdhury R. I (2013) Attitudes towards co-management: Is Satchari National Park a suitable model for Bhawal National Park? In: Fox J, Mustafa MG, Bryan RB, Stephen MB, Laurie D (eds.) Connecting communities and conservation: Co-management initiatives implemented by IPAC in Wetlands and Forests of Bangladesh.
- Cunningham E. J, Chassels M., Fox J., Mustafa M. G (2011) Introduction: Tailoring collaborative conservation in Bangladesh. In: Jefferson Fox et al. (eds.) Rural Livelihoods and protected landscapes: Co-management in the wetlands and forests of Bangladesh. Dhaka, Nishorgo Network, pp.204.
- DeCosse P. J., Thompson P. M., Ahmad I. U., Sharma R. A and Mazumder A. H (2012) Protected area co-management where people and poverty intersect., United States Agency for International Development (USAID), Bangladesh Forest Department (BFD), Department of Environment (DoE), Department of Fisheries (DoF), Dhaka, Bangladesh
- Fox J., Mustafa M. G (2013) Co-management initiatives implemented by IPAC in wetlands and forests of Bangladesh. Proceedings of the connecting communities and conservation: co-management initiatives implemented by IPAC in wetlands and forests of Bangladesh. Bangladesh: USAID, IPAC
- Fox J.; Mustafa M. G., Bushley B. R., Brennan S. M., Durand L (2013) Connecting Communities and Conservation: Co-Management Initiatives Implemented by IPAC in Wetlands and Forests of Bangladesh; The United States Agency for International Development (USAID): Dhaka, Bangladesh.
- Getzner M., Islam M. S (2013) Natural resources, livelihoods, and reserve management: a case study from Sundarbans mangrove forests, Bangladesh. *Int J Sustain Dev Plan* 8:75–87.
- Giessen L., Sarker P. K, Rahman M. S (2016) International and domestic sustainable Forest Management policies: Distributive effects on power among state agencies in Bangladesh. *Sustainability* 8: 335.
- Gurung A., Karki R., Bista R (2011) Community-based forest management in Nepal: opportunities and challenges. *Resour Environ* 1(1):26–31.
- Helal, M. (2005) Training Plan & Guideline. February 2005. Dhaka, Bangladesh. United States Agency for International Development (USAID), Bangladesh Forest Department (BFD), International Resources Group (IRG)
- Hoque M. E (2007) An analysis of fisheries exploitation and management practices in Sundarbans mangrove ecosystem, Bangladesh. *Ocean and Coastal Mnt* 50: 411–427.

- Hoque M. E (2009) Evaluating co-management as a tool for the reduction of poverty and inequality in Chunati Wildlife Sanctuary. In: Connecting communities and conservation: collaborative management of protected areas in Bangladesh. Dhaka: USAID.
- Hossain M. S., Dearing J., Rahman M. M., Salehin M (2015) Recent changes in ecosystem services and human well-being in the Bangladesh coastal zone. *Region Environ Change* 1–15.
- Hossain M. S., Uddin M. J., Fakhruddin A. N. M (2013) Impacts of shrimp farming on the coastal environment of Bangladesh and approach for management. *Environ Sci Biotechnol* 12:313–332.
- Huda K. S (2005) Operationalization of co-management in protected areas. March 2005. Dhaka, Bangladesh United States Agency for International Development (USAID)
- Huda K. S (2018) Co-Management of Protected Areas in Bangladesh: A Strategy for Establishing an Institutional Framework. August 2007. Dhaka, Bangladesh. United States Agency for International Development (USAID), Bangladesh Forest Department (BFD), International Resources Group (IRG).
- Iftikhar M. S (2006) Forestry in Bangladesh: An overview. *J of For*, 104(3), 148–153.
- Ionita A., Jungmeier M., Huber M (2013) Analysis of organizational structures of protected areas along the Danube. Study commissioned by Donau-Auen National Park. DANUBE PARKS Step 2.0. Phase II, E.C.O. Institute of Ecology, Klagenfurt, 45 p. + Annex.
- Islam M. M., Sunny A. R., Hossain M. M., Friess D. A (2018) Drivers of mangrove ecosystem service change in the Sundarbans of Bangladesh. *Sing J of Trop Geo* 39 (2), 244–265.
- Islam M. T (2013) People's participation in Protected Areas of Bangladesh. First Asia Park Congress, Sendai City, Japan, 13-17 November 2013.
- IRG (2003) Co-management of tropical forest resources in Bangladesh project report for year 1, 2nd quarter Sept 01, 03 to Nov 30, 03. Dhaka, Bangladesh, United States Agency for International Development (USAID), Bangladesh Forest Department (BFD), International Resources Group (IRG).
- IRG (2003.a) Co-management of tropical forest resources in Bangladesh project report for year 1, 1st quarter Jun 01, 03 to Aug 31, 03. Dhaka, Bangladesh, United States Agency for International Development (USAID), Bangladesh Forest Department (BFD), International Resources Group (IRG).
- Ka S., Saha S (2012). Corruption, Shadow Economy and Income Inequality: Evidence from Asia, Discussion Paper, No. 7, 106.
- Kibria M. G., Rahman S. A., Imtiaj A., Sunderland T (2011) Extent and consequences of tropical forest degradation: successive policy options for Bangladesh. *J Agric Sci Technol* 1:29–37
- Luc V. H (2010) Co-management: an alternative to enforcement? *J of Mar Sci* 67: (2), 395–401.
- Mamun M. M. A. A., Masum K. M., Sarker A. H. M. R., Mansor A (2017) Ecosystem services assessment using a valuation framework for the Bangladesh Sundarbans: livelihood contribution and degradation analysis. *For. Res.* (2017) 28: 1.
- Mahmood A. R. J (2008) Assessment of human well-being under comanagement initiatives in Chunati Wildlife Sanctuary. In: Fox J, Mustafa MG, Bryan RB, Stephen MB, Laurie D

- (eds.) Connecting communities and conservation: Co-management initiatives implemented by IPAC in Wetlands and Forests of Bangladesh.
- Mustafa M (2002) A review of forest policy trends in Bangladesh. Bangladesh forest policy trends. Policy Trend Report 2002, 114–121.
- Mohammed M. R., Rahman M. M., Islam K. S (2010) The causes of deterioration of Sundarban mangrove forest ecosystem of Bangladesh: conservation and sustainable management issues. *AACL Bioflux*, 3 (2): 77-90.
- Muhammed N., Koike M., Haque F (2008) Forest policy and sustainable forest management in Bangladesh: An analysis from national and international perspectives. *New Forests* 36: 201.
- Muhammed N., Koike M., Sajjaduzzaman M., Sophanarith K (2005) Reckoning social forestry in Bangladesh: Policy and plan versus implementation. *Forestry*, 78(4), 373–383.
- Mukul S. A., Quazi S. A (2007) Communities in conservation: changing protected area management and enhanced conservation in Bangladesh. *The Future of Forests in Asia and the Pacific: Outlook for 202*.
- Mukul S. A., Uddin M. B., Uddin M. S., Khan M. A. S. A., Marzan B (2008) Protected areas of Bangladesh: current status and efficacy for biodiversity conservation. *Pakistan Acad Sci*. 45:59–68.
- Murshed M., T (2007) Designing and Operating an Eco-Cottage around Nishorgo Protected Areas: A Guideline for Local Entrepreneurs. January 2007. Dhaka, Bangladesh. United States Agency for International Development (USAID), Bangladesh Forest Department (BFD), International Resource Group (IRG).
- Nath T. K., Jashimuddin M., Inoue M (2015) Bangladesh: Do Changes in Policy Ensure Good Forest Governance? In: Inoue M, Ganesh P, Shivakoti (eds), *Multi-level forest governance in Asia: concepts, challenges, and the way forward*. SAGE, Los Angeles, pp. 21-39.
- Nath T. K (2012) Management of natural resources and community forestry in Chunati Wildlife Sanctuary, Chittagong, Bangladesh. Chittagong: B Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
- Payo A., Mukhopadhyay A, Hazra S, Ghosh T, Ghosh S, Brown S, Nicholls R, Brichenno L, Wolf J, Kay S, Lazar AN, Haque A (2016) Projected changes in area of the Sundarban mangrove forest in Bangladesh due to SLR by 2100. *Climatic Change*, 139: 279-291.
- Quasem M. A (2011). Conversion of Agricultural Land to Non-agricultural Uses in Bangladesh: Extent and Determinants. *Bd Dev St*, 34(1).
- Rahman M. R., Laskar M (2016) Development initiatives of the Sundarbans of Bangladesh. *Mal For* 79(1&2):77-88.
- Rahman M. S., Giessen L (2016) The power of public bureaucracies: Forest-related climate change policies in Bangladesh (1992–2014), *Clim. Policy*
- Rahman M. R., Asaduzzaman M (2010) Ecology of Sundarban, Bangladesh. *J of Sci Foun*, 8(1&2): 35-47.

- Rashid M. H (2007) Guideline for the management of co-management committee (CMC) funds. Bangladesh. United States Agency for International Development (USAID), Bangladesh Forest Department (BFD), International Resources Group (IRG). December 2007. Dhaka
- Rashid A. Z. M. M., Craig D., Jeffery M., Mukul S. A (2016) Shifting paradigm of governance in the natural resources management of Bangladesh: centralist to pluralistic approach in the forest protected areas management. In: Mukul, SA, Rashid, AZMM (eds), Protected Areas: Policies, Management and Future Directions. Nova Science Publishers, USA.
- Roy B. C. S (2009) Fuelwood, alternative energy and forest user groups in Chunati Wildlife Sanctuary. In: Connecting communities and conservation: collaborative management of protected areas in Bangladesh. Dhaka: USAID.
- Roy M. K., DeCosse P (2006) Managing demand for protected areas in Bangladesh: poverty alleviation, illegal commercial use and nature recreation. *Pol Matters*, 14:93–102.
- Sarkar S. K., Bhattacharya A. K (2003) Conservation of biodiversity of the coastal resources of Sundarbans, Northeast India: an integrated approach through environmental education. *Mar Poll Bull*, 47:260–264.
- Sarwar M. G. M., Woodroffe C. D (2013) Rates of shoreline change along the coast of Bangladesh. *J of Coas Con*, 17(3): 515–526.
- Sawhney P., Kobayashi M., Takahashi M., King P. N., Mori H (2007) Participation of civil society in management of natural resources. *Int Rev for Env Stra*, 7(1): 117–132.
- Sharma R. A (2011) Co-management of protected areas in South Asia with special reference to Bangladesh, *Asia-Pac J Rural Dev*. 21:1–28.
- Sudtongkong C., Webb E. L (2008) Outcomes of state-vs. Community-based mangrove management in southern Thailand, *E&S*. 13:27.
- Sunderlin W. D., Angelsen A., Belcher B., Burgers P., Nasi R., Santoso L., Wunder S (2005) Livelihoods, forests, and conservation in developing countries: an overview. *World Dev*. 33:1383–1402
- USAID (2013) Performance Evaluation of the Integrated Protected Areas Co-management Project: Democracy and Governance Components (Available at <https://www.climatelinks.org/resources/performance-evaluation-integrated-protected-areas-co-management-ipac-project>)
- Winrock International (2015) Climate Resilient Ecosystems and Livelihoods: Overview. (Available at <https://www.winrock.org/>).

Identifying Optimal Location for Cyclone Shelters of Patuakhali District in Bangladesh: A GIS Based Approach

Murad Billah*

Bibi Hafsa**

Ummul Momanin Coalee***

Abstract: Although cyclone shelter programs are one of the most important cyclone mitigating measures in Bangladesh current cyclone shelter network is unevenly distributed among varied communities. The aim of this study is to determine how optimally cyclone center locations can be chosen in order to satisfy the immediate demand. In this study, variables such as cyclone hazard, flood hazard, surrounding population, vulnerable houses and nearest existing cyclone shelter are used as criteria for selecting optimal location. After the formulation of criteria different sub-parameters are fixed for scoring. Based on the sub-parameters, relevant scores have been assigned for each identified locations. Finally, an aggregated score is obtained combining all the scores of all the criteria by means of integrated spatial and mathematical analysis on a GIS platform. The result proposed some indicators and potential sites that could be taken under consideration while choosing for construction of new cyclone shelters.

Background

Bangladesh is under high risk from hydro-meteorological disasters. In addition, its poor economy and its high population density make Bangladesh extremely vulnerable to tropical cyclones (Haque and Jahan, 2016). A typical cyclone hits the coast of Bangladesh almost every year. Among these, at least one severe cyclone in every three years causes significant damage along the part of the coast (Ahammad, et al., 2013). Loss of lives and livelihoods; damage to agriculture, infrastructure and settlements; and disruption of communication networks are the major impacts of these cyclones in Bangladesh (Haque and Jahan, 2016).

With 53% of the worldwide cyclones that caused over 5,000 casualties taking place in Bangladesh, it is rated as one of the world's most vulnerable countries to tropical cyclones (UNDP, 2004). Although the number of cyclones originated in the Bay of Bengal is not extremely significant in the global total, they are often the most destructive among all the cyclones. About 80-90% of worldwide losses due to cyclones are blamed on those formed in Bay of Bengal (Chowdhury, 2002).

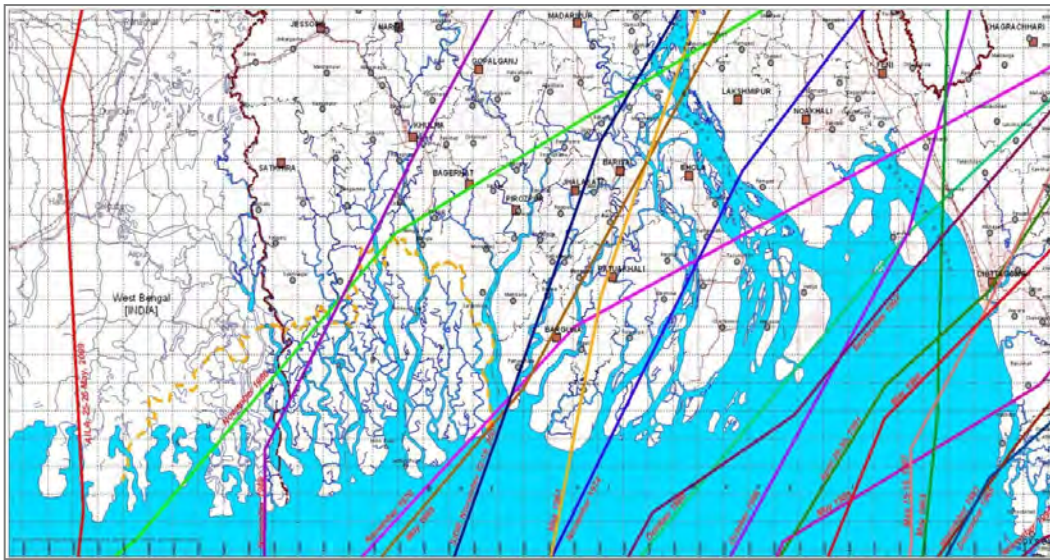
In recent decades, three super cyclones have led to huge losses in terms of lives and properties. The 1970 Bhola Cyclone hit the entire coast of Bangladesh with a storm surge of 10m height which led to a total death toll of about 5,00,000 in the former East Pakistan before the independence of the People's Republic of Bangladesh in 1971 (Khalil, 1992). It is the most fatal cyclone recorded and one of the deadliest natural disasters in modern

* Consultant, LGED

** Assistant Professor, Department of Geography and Environment, Jahangirnagar University,
Email: hafsa.geography@gmail.com

*** Research Student, Department of Geography and Environment, Jahangirnagar University

history (Hossain et al., 2008). The 1991 Bangladesh Cyclone, which killed around 1,50,000 people in Bangladesh, is also one of the most terrible natural hazards. It serves as a continuous reminder about the destructiveness of cyclones for Bangladeshi people. The 2007 Cyclone Sidr with a wind speed up to 240 km/hour resulted in 3,406 casualties, 1,001 missing and over 55,000 injuries. It affected livelihoods of 8.9 million people and losses totaled US\$1.67 billion (GOB, 2008).



Source: World Bank, 2010

Figure 1: Tracks of major cyclones that crossed the coast of Bangladesh from 1960 to 2009

A study in assessing the risk at global level has been conducted by UN, using past records, simulations and modelling revealed much crucial information (UNISDR, 2009). For cyclones, the report places Bangladesh at the highest Mortality Index 8.5 out of 10 (Figure 2). The index was determined using population, exposure, cyclone deaths and the occurrences of cyclones. Further given below is the absolute and relative mortality risk for tropical cyclones and with modelled fatalities per million per year in terms of relative and absolute counts.

The existing number of cyclone shelters in Bangladesh is not sufficient to accommodate the vulnerable populations in coastal areas. Hence, action is needed in the state to bridge the existing gaps. The location of new cyclone shelters to be built largely depends on the location of vulnerable populations to be sheltered during emergencies as well as existence and condition of the existing shelters. The effectiveness of a new cyclone shelter, thus, depends on the assessment for optimal location which can serve the un-served community first.

Study Area

This study focused in Patuakhali District on Bangladesh. Patuakhali, a coastal district of Barisal Division, is situated at the fringe of the Bay of Bengal (Figure 2). The study area is located in the south coast of Bangladesh between the Sundarbans mangrove forest and

the estuary of Ganges, Meghna and Brahmaputra Rivers. The Dhulashar Union, Lata Chapli Union and Kuakata Paurashava are located in the south most point of the district in Kalapara and Rangabali Upazila. The total area of the district is 3221.31 sq.km. (1243.75 sq. miles). It lies between 21°48' and 22°36' north latitudes and between 90°08' and 90°41' east longitudes. The district is bounded on the north by Barisal District, east by Bhola District, south by the Bay of Bengal and west by Jhalakathi & Barguna District.

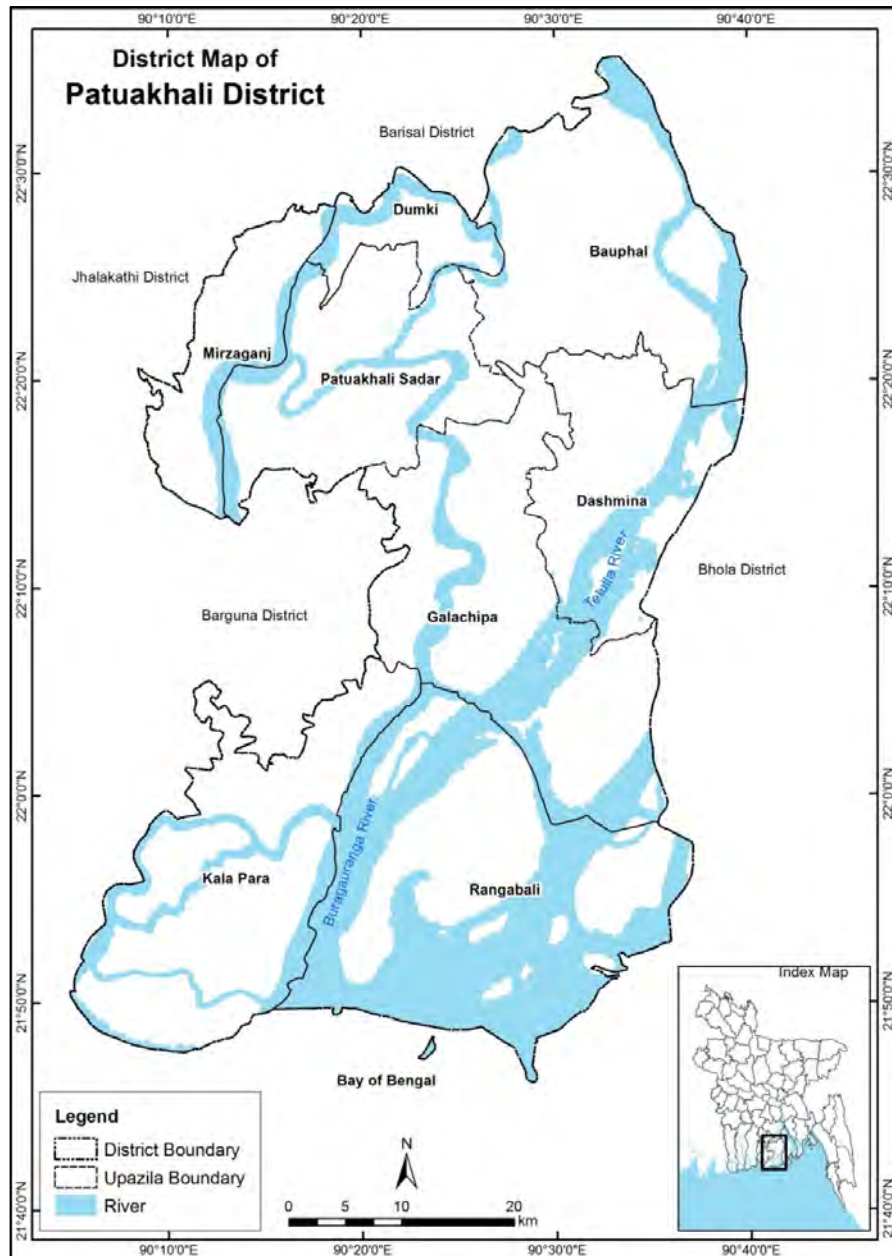


Figure 2: Map of the Study Area

Sources of Data

Existing Shelters

Existing shelter data has been collected from different published sources and their location has been compiled in GIS. However, for the purpose of this research work GPS survey has been conducted in the study area cyclone shelters to collect the latitude and longitude of each shelter to geotag those and other relevant information. Other information like structural conditions were collected through questionnaire to develop the tabular data for further analysis. In total there are 531 shelters found in Patuakhali at present (Figure 3).

Locations for New Shelters

There are some criteria set by the "Cyclone Shelter Construction, Maintenance and Management Policy, 2011" (GoB, 2012) for selection of location for new cyclone shelter construction among which one of the most important criterion is- "Unless it is absolutely necessary, no shelter should be constructed as standalone shelters. Multi-purpose use of shelters should be ensured." This and some other criteria indicates that to ensure the multipurpose use of a cyclone shelter the location for construction of a new cyclone shelter should be an educational institute.

Considering the criteria educational institutes, where there is no existing cyclone shelters, of the study area has been surveyed with GPS device to geotag all the possible locations for new cyclone shelters. In this case all types of educational institutes, like- primary schools, high schools, madrasas, colleges, etc. has been covered under the survey. There are 579 locations have been revealed from the survey where new cyclone shelters could be constructed (Figure 4).

Cyclone Hazard

There is no specific hazard map for Patuakhali. For cyclone hazard map of cyclone affected areas developed by SPARRSO has been used. The map has been geo-referenced and then digitized to develop the hazard map for Patuakhali (Figure 5). This map classifies the hazard zones in three classes- i) High Risk Area , ii) Risk Area and iii) High Wind Area .

Storm Surge Hazard

Department of Disaster Management (DDM) Conducted a study on "Multi Hazard Risk and Vulnerability Assessment, Modeling and Mapping" and published the findings in 2015 (GOB, 2015). Under the scope of the study DDM developed map of Storm Surge induced flood for 25, 50 and 100 year return periods. The map classifies the inundation in 7 classes. Map of 50 years return period has been considered for this study as the intensity of 50 year return period represents historical severe cyclones and shelter buildings are built for a long period of time. Later storm surge hazard map for Patuakhali has been developed from this map (Figure 6).

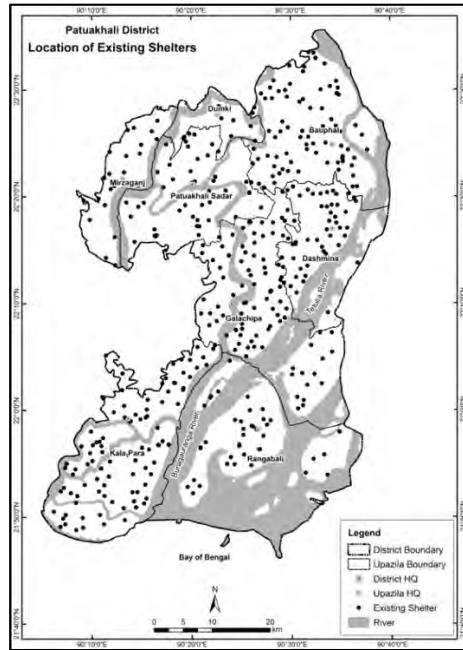


Figure 3: Location Distribution of Existing Shelters

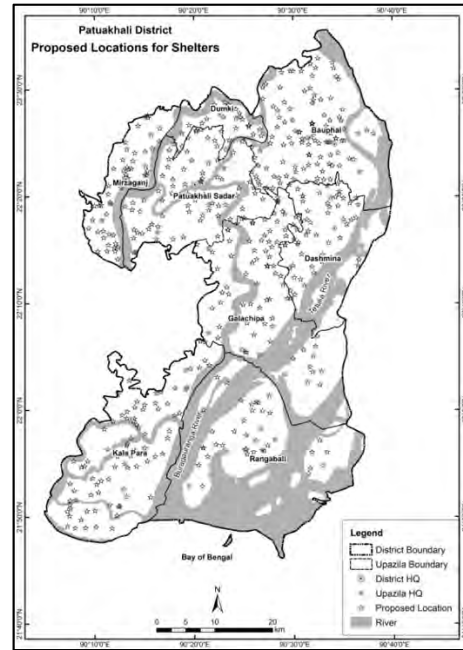


Figure 4: Possible Locations of New Cyclone Shelters

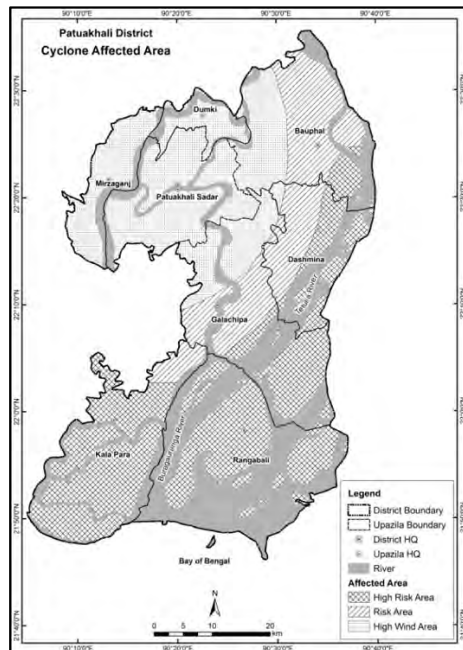


Figure 5: Cyclone Hazard Zones of Patuakhali District

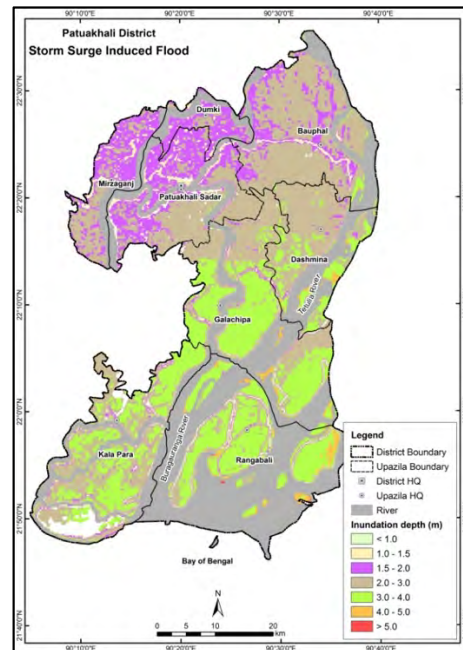


Figure 6: Storm Surge Induced Flood Hazard of Patuakhali

Methods

At the beginning relevant criteria for the optimal location analysis have been formulated. The criteria used for the optimal location identification are-

- i. Cyclone Hazard Zone
- ii. Storm Surge Induced Flood
- iii. Location of New Shelter in Relation to the Closest Existing Shelter
- iv. Population Around 1.5km radius of the Proposed Location
- v. Catchment Population's Vulnerability Represented by Housing Type

After the formulation of criteria different sub-parameters have been fixed for scoring. Based on the sub-parameters, relevant scores have been assigned for each location depending the parameter it fulfils. Finally, an aggregated score is obtained combining all the scores of all the criteria. Spatial analysis tools in ArcMap have been used during the analysis process. Geo-referencing and geo-processing tools were also in operation for collecting and standardization of secondary data. Map classification tool has been utilized for demographic data. Raster reclassification tool has been used to reclassify the hazard data. Point distance calculation has been conducted using near tool to identify the distance of nearest existing shelter from the possible proposed locations. Spatial overlay operation has been utilized to transfer information of different layers to the geo-database of the proposed shelter locations layer. Finally, field calculator tool has been used to generate scores for individual criteria.

Data Analysis

Data Analysis has been compartmentalized to several sections as per the requirement and methodology of the study. Data review and analysis on following issues has been undertaken during the assessment.

- i. Existing shelters and their condition based on physical parameters.
- ii. Proximity of Proposed locations with reference to closest usable existing shelter.
- iii. Distribution of population in catchment area
- iv. Distribution of vulnerable houses in catchment area
- v. Position of the proposed location in the cyclone hazard zone
- vi. Position of the proposed location in the storm surge induced flood hazard zone

Condition of Existing Shelter

Based on the results from field survey, condition of the existing shelters has been evaluated from the engineering points of view such as major/minor repairs on concrete elements, floor, structure, doors and windows, replacements etc. An overall rapid visual screening of the needs was carried out. To acquire the above building characteristics, all the shelters were physically surveyed. Condition has been categorized in five categories- i) Good Condition; ii) Need Minor Repairs; iii) Need Major Repairs; iv) Reconstruction Required and v) Under Construction. During the survey some structures were found still under construction. As these structure will shortly serve as a shelter these are also considered in the existing shelter database.

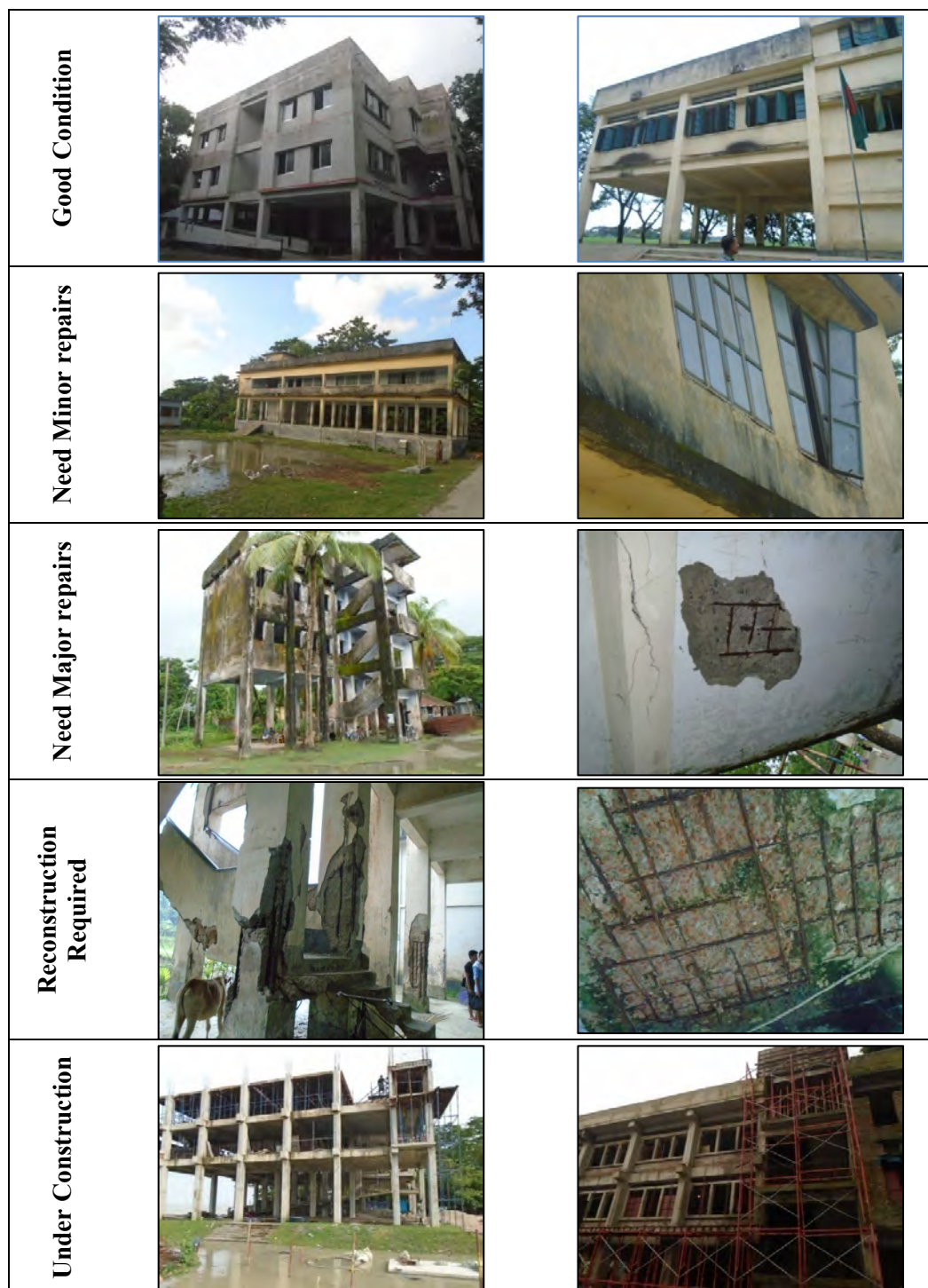


Figure 7: Illustration of Different Shelter Conditions

From analysis it was found that among 531 Existing Shelters 255 shelters are in Good Condition; 176 shelters require minor repairs; 64 shelters were found under construction during the survey; 30 shelters require major repairs and 6 shelters are in need of reconstruction as the repair is neither possible or the repair would be costly compared to reconstruction. Thus, those 36 shelters were considered not usable and kept out of the further analysis process.

Proximity Analysis

For an even distribution of shelters all over the study area it is necessary to make sure that the new shelter location should be placed at a certain distance from an existing usable shelter. Thus proximity analysis is the important step for the process. Distance of the nearest existing shelter from each of the proposed locations have been calculated using the "Near" tool in ArcGIS environment. In this case the rivers and canals have been considered as a barrier.

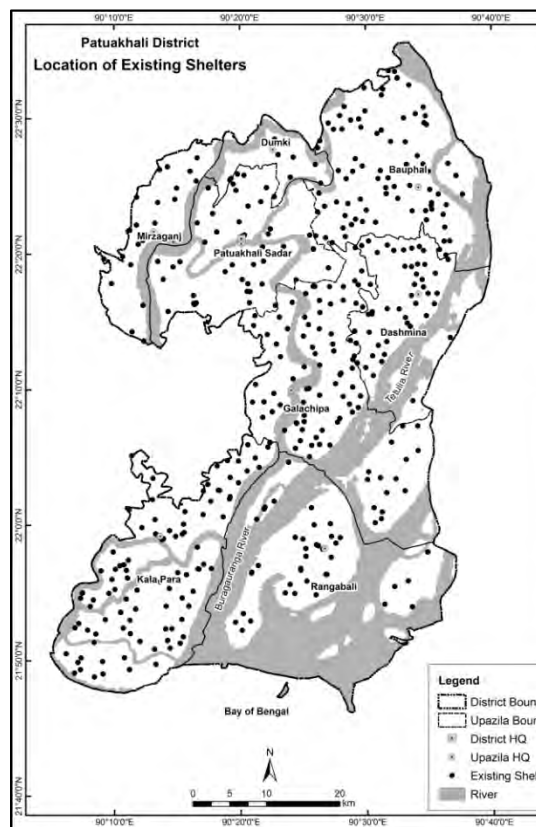


Figure 8: Spatial distribution of Existing Shelters Showing their Condition

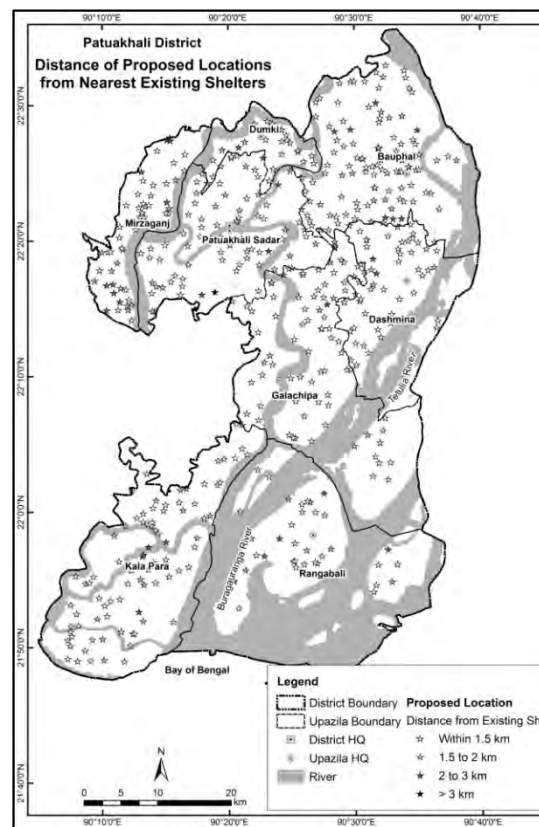


Figure 9: Map Showing Distance of Nearest Existing Shelter from Proposed Location

Distribution of Population

Population distribution is an important criterion for assessing the shelter need. Locations with higher number surrounding of population are more important than the one with lower population coverage. Population data collected from BBS were in tabular format. These were then joined with administrative geo-database to get the population distribution up to union level. These mauza level GIS data of population has been used for analyzing the catchment population.

According to the "Cyclone Shelter Construction, Maintenance and Management Policy, 2011" (GOB, 2012) a shelter has a coverage of 1.5 km radius. Considering this as a standard the population coverage has been analyzed. Mauza level spatial distribution of demographic data has been analyzed here to study the problem. Settlement data has also been used to verify the spatial population distribution pattern. It can be considered that population is distributed in settlements only. Thus settlements somehow represent population. Area of each settlement has been calculated at the first step. Then total settlements area in each locality has been aggregated. Afterward population has been distributed in each settlements based on the area it represents compared to the total area of settlements within the union. In next step settlements within 1.5km of each proposed locations have been identified and the total population of the settlements have been transferred to the proposed locations database.

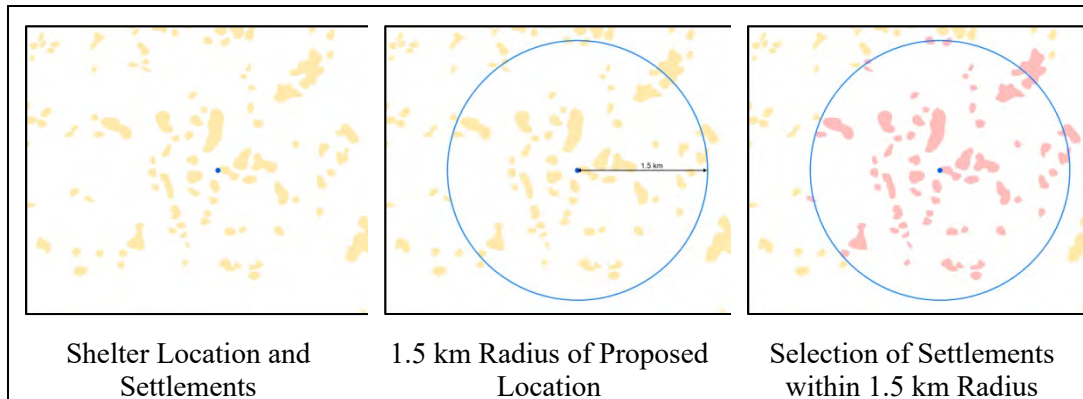


Figure 10: Illustration of Coverage Population Delineation

Distribution of Vulnerable Housing Structures

Distribution of vulnerable house is another important criterion for assessing the shelter need. People living in an area where the numbers of vulnerable houses are predominant are more in need of shelter. As like as population data housing data were also collected from BBS in tabular format and then joined with administrative geo-database to get the distribution up to union level. These union level GIS data of housing structure type has been used for analyzing the catchment population.



Figure 11: Illustration of Different Housing Structure Type

In this case the housing categories presented by BBS (Figure 11) are considered for vulnerability analysis. Houses those are "Katcha" and "Jhupri" are vulnerable to cyclone. Keeping this in mind the vulnerability analysis of housing has been conducted representing the percentage of vulnerable house types surrounding a proposed location. Later the distribution of vulnerable houses for catchment area of each shelter has been identified using the same method as used for calculation population coverage.

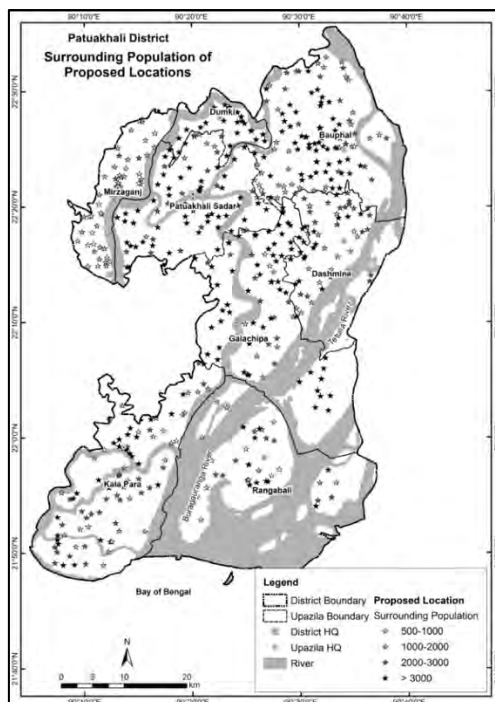


Figure 12: Distribution of Population Surrounding the Proposed Location

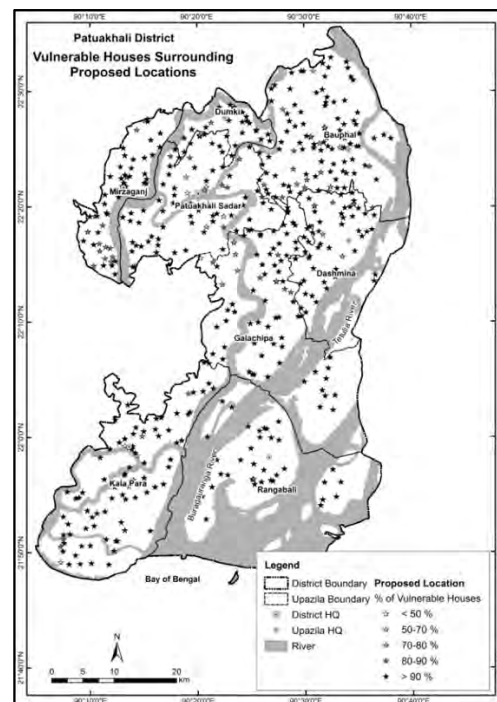


Figure 13: Distribution of Vulnerable Houses Surrounding the Proposed Locations

Position of Proposed Location in Cyclone Hazard Zone

To decide where to locate a new cyclone shelter, it is very important to assess the cyclone intensity of the location. Locations severely prone to cyclone should get more priority compared to the locations moderately or relatively low cyclone prone.

To assess the cyclone hazard intensity of the proposed locations overlay operation has been carried out between proposed locations and cyclone hazard zones. This helped to combine the information of cyclone hazard intensity with the information of proposed shelter locations. Thus it gives an idea about the spatial distribution of proposed locations according to its hazard intensity.

After the overlay operation it has been found that among 579 proposed locations 164 locations are falling in "High Risk Area", 137 shelters are falling in "Risk Area" and remaining 278 shelters are falling in "High Wind Area".

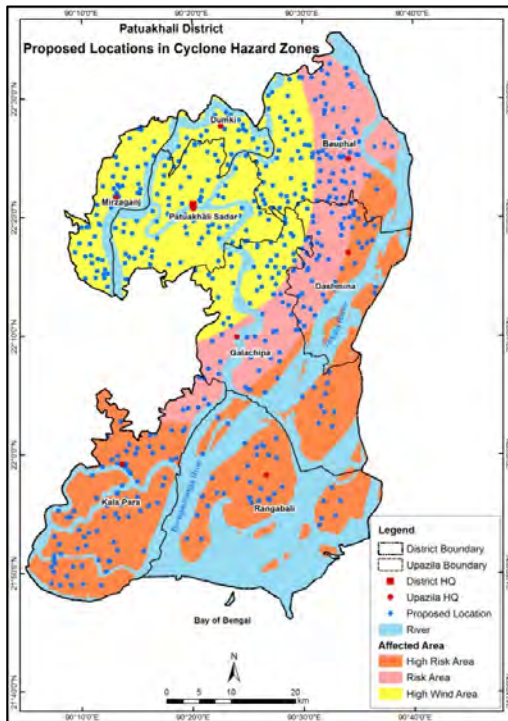


Figure 14: Overlay Operation of Proposed Locations and Cyclone Hazard Zones

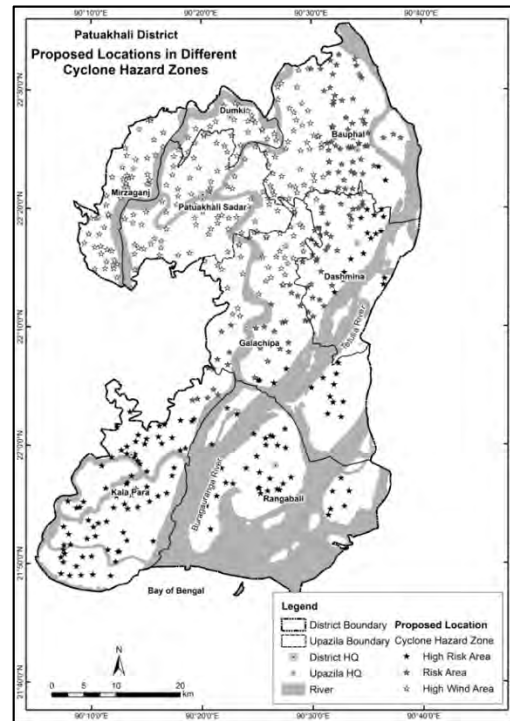


Figure 15: Proposed Shelter Locations in Different Cyclone Hazard Zones

Position of Proposed Location in Storm Surge Induced Flood Hazard Zone

Cyclone triggered storm surge is another devastating hazard for low lying coastal areas of Patuakhali. These storm surges causes the flood in low lying zones and inundate a vast area for several days to months. Thus, it is also important to assess the Storm Surge Induced Flood situation for the locations. In similar way like the one for the case of cyclone this information has been generated through spatial overlay between proposed locations and inundation layer.

After overlay the inundation depth classes has been reclassified in five classes- Less than 1 meter; 1-2 meter, 2-3 meter, 3-4 meter and more than 4 meter. After overlay analysis it

was found that 137 locations are falling in areas where flood inundation is more than 3 meter and thus the people of these areas are in need of shelters most.

Weighing the Criteria

After several spatial analysis locations fulfilling different sub-parameters of the criteria are identified. These criteria and their associated sub-parameters are independently evaluated so far. Now for identifying optimal locations it is necessary to combine all the criteria together. But not all the criteria are equally important to decide whether a location is optimal or not. So, there is a need for weighing the criteria and their sub-parameters. Following weights have been assigned for these criteria-

- i) Cyclone Hazard Zones - 30%
- ii) Storm Surge Inundation Depth - 20%
- iii) Location of New Shelter in Relation to the Closest Existing Shelter - 15%
- iv) Population Around the 1.5km Radius of the Location - 15%
- v) Catchment Population's Vulnerability Represented by Housing Type - 20%

Table 1: Scoring for Identifying Optimal Location

Serial No.	Criteria of Scoring	Score Allocation
1	Cyclone Hazard Zone	
	I. High Risk Area.....30	30
	II. Risk Area.....20	
	III. High Wind Area.....10	
2	Inundation Depth	
	I. Very High(> 4 Meter).....20	20
	II. High (3 Meter to 4 Meter).....15	
	III. Medium (2 Meter to 3 Meter).....10	
	IV. Low (1 Meter to 2 Meter).....5	
	V. Very Low (< 1 Meter).....0	
3	Location of New Shelter in relation to the closest Existing Shelter	
	I. > 3 Km.....15	15
	II. 2 Km to 3 Km.....10	
	III. 1.5 Km to 2 Km.....5	
	IV. <1.5 Km.....0	
4	Population around the 1.5 Km radius of the Location	
	I. High (>3000).....15	15
	II. Medium (2000-3000).....12	
	III. Average(1000- 1999).....8	
	IV. Below Average(500-999).....5	
5	Catchment Population's Vulnerability represented by the Housing Type	
	I. >90% Vulnerable Houses.....20	20
	II. >80% To 90 % Vulnerable Houses.....15	
	III. >70% To 80% Vulnerable Houses.....10	
	IV. 50% To 70% Vulnerable Houses.....5	
	V. <50% Vulnerable Houses.....0	
	Total	100

Results and Discussion

Afterward all the proposed locations have been assigned with the scores of different sub parameters it fulfills. For, each of five criteria and all associated parameters each location got a score. Then, scores of all the criteria have been combined together to get the total score for each location. Spatial distribution of locations according to their assigned score for each criterion and total score for all the criteria are presented in the following maps.

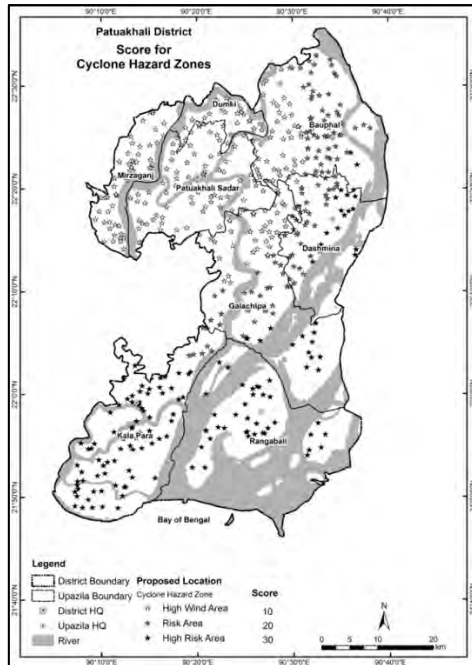


Figure 16: Proposed Location According to their Score for Cyclone Hazard

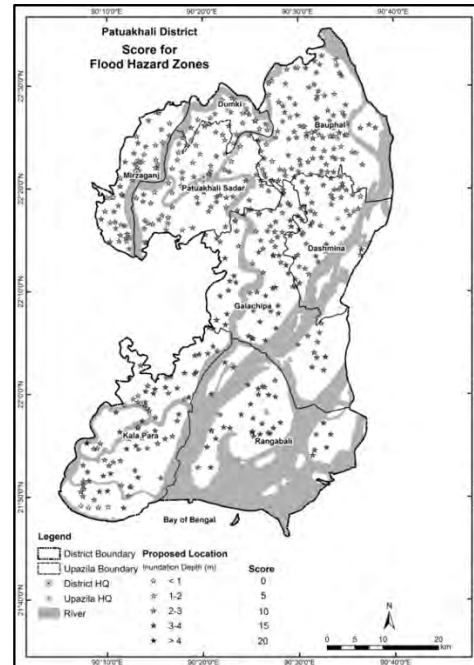


Figure 17: Proposed Locations According to their Score for Storm Surge Induced Flood Hazard

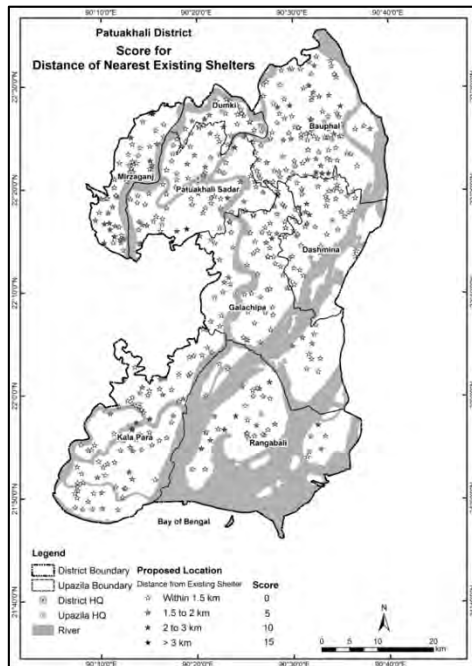


Figure 18: Proposed Locations According to their Score for Nearest Cyclone Shelter

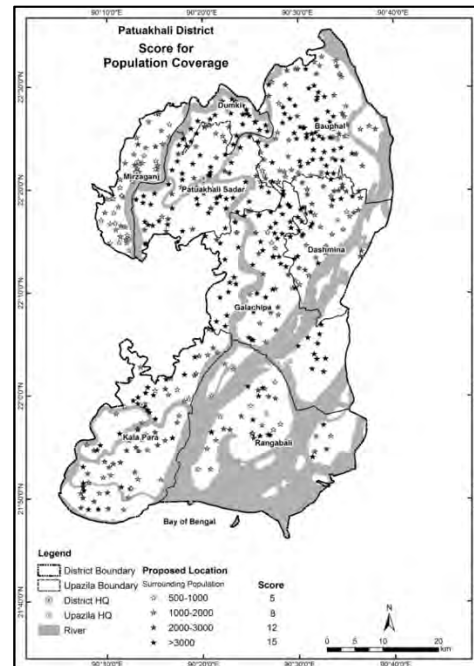


Figure 19: Proposed Locations According to their Score for Possible Population Coverage

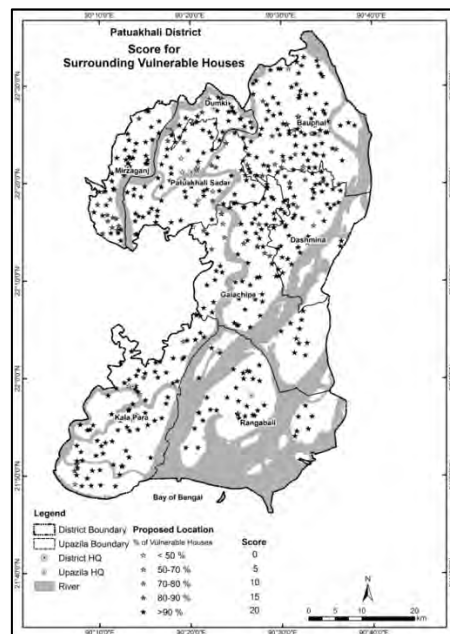


Figure 20: Proposed Locations According to their Score for Catchment Population's Vulnerability

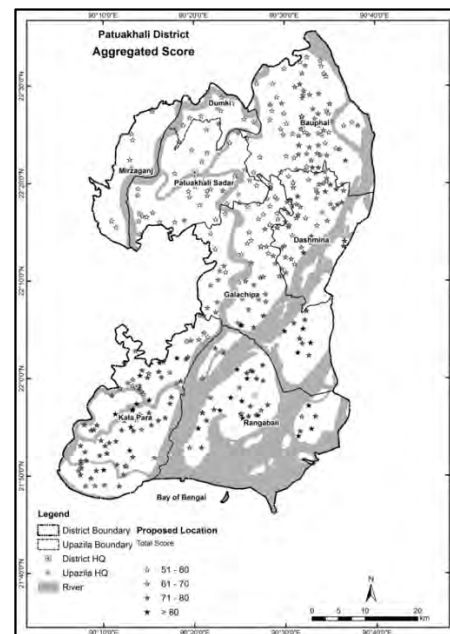


Figure 21: Proposed Locations According to their Total Score

Optimal Locations

After analyzing and aggregating the scores all the locations are found with a total score ranging from 30 to 97. After observing all the criteria and their relevant scores it can be decided that locations with an aggregated score 50 are likely to fulfill only two criteria- Cyclone Hazard Zone & Storm Surge Inundation Depth as 30 & 20 scores have been allocated respectively for these two criteria. Locations falling within the highest cyclone and flood hazard zones can get a score of 50 even if they do not fulfill any of the other three criteria. So, these locations are not at all suitable as the population coverage or housing vulnerability, two criteria for which a shelter is required, is zero (0). As a result these locations are not required to be considered for shelter construction. There are 197 such locations found.

Rest 382 shelters are somehow suitable for shelter construction. But not all the shelters are equally optimal. So, there is a need for categorizing the optimality in a range of total score. For this, a range difference of 10 score has been adopted for this. Thus the study gets 5 classes afterward 50 (51-60; 61-70; 71-80; 81-90 and 91-100).

However, it is observed that the locations with a score more than 80 are fulfilling all the criteria significantly. In that case the locations are found either in high or medium hazard zones, surrounded by significant number of vulnerable houses with large population coverage and nearest existing shelter is either far away or not enough to accommodate all the population within coverage area.

For Example, if the location is situated in moderate hazard zone for both cyclone and flood it is getting 30 scores for that (20 & 10 scores respectively). Then if the surrounding population is more than 3000 and percentage of vulnerable houses are more than 90% it will get 15 & 20 scores respectively. The total is only 65 and it requires to fulfill the highest score parameter for the distance of existing shelter criteria to get a score of more than 80. So, the nearest shelter is more than 3 km away making those locations highly optimal in all the aspects.

On the other hand if the location is situated in high hazard zone for both cyclone and flood it is getting 50 scores for that. Then if the surrounding population is more than 3000 and percentage of vulnerable houses are more than 90% it will get 15 & 20 scores respectively. The total is already 85 even there is a shelter within 1.5km (0 score). But it is still highly optimal as the number of population living in vulnerable houses is very high for the existing nearest shelter to accommodate all the population.

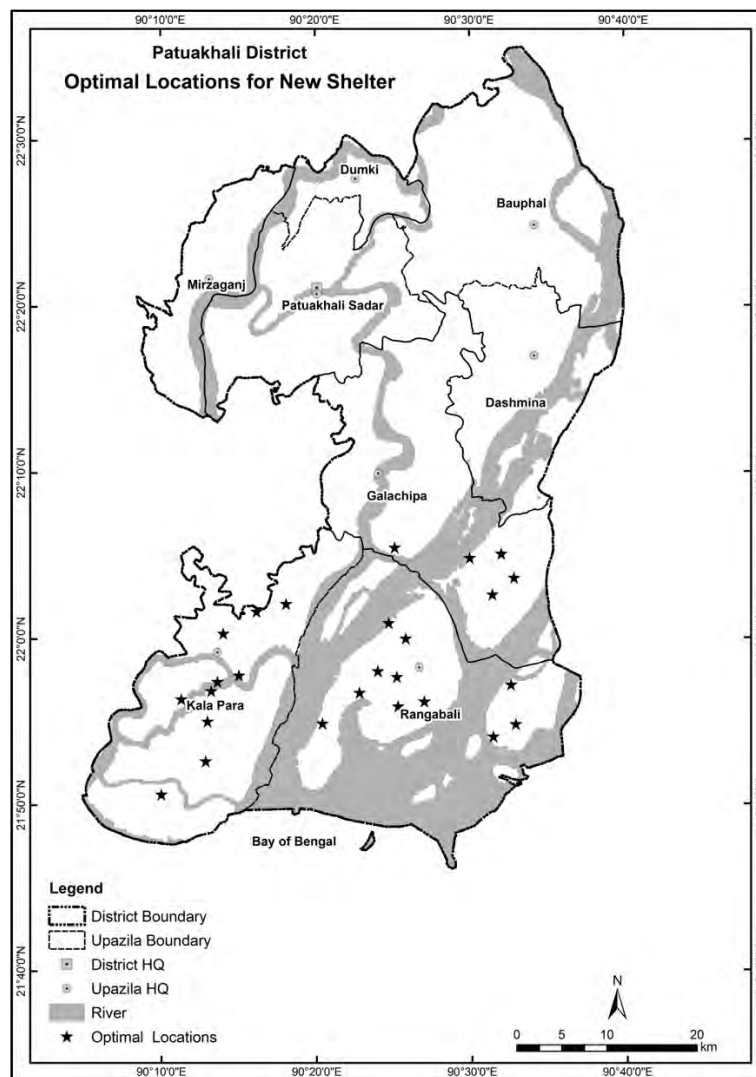
After the observation and analysis it is decided that last two classes need to be merged together and the merged new class is the most optimal location for new shelters.

Detail breakdown of the optimal shelter locations according to above mentioned classes are given in the table below.

Table 3: Breakdown of optimal locations according to their scores

Score Class	Number of Locations
51-60	136
61-70	129
71-80	91
81-100	26

For 26 shelters in last class, hazard intensity is very high, surrounding population is large, all most all the houses are vulnerable and nearest existing shelter are located far away. As a result finally it has been found that 26 locations are most optimal for new shelter construction where there is need to build shelters immediately.

**Figure 22:** Most Optimal Locations for New Shelter Construction

Conclusion

The results of this research demonstrate the importance of evaluating both hazard and vulnerability from several perspectives for cyclone emergency management purposes. Yet, much more considerations to be done to develop dynamic, effective, and efficient evacuation plans. For example, the location and capacity of evacuation routes will greatly influence the success (or lack of success) of any evacuation process. Within the spatial analysis, transportation networks can be incorporated in order to identify optimal evacuation routes.

In order to integrate spatial analyses it is essential that the government and its agencies and others, keep up, or better, increase the compilation of spatially referenced data sets and share them as well. Future project planning and evaluation could significantly benefit from detailed, accurate and complete data sets that allow for comprehensive vulnerability assessments and cross-checks of existing findings at the national and sub-national level.

References:

- Ahammad, R., Nandy, P. and Husnain, P. (2013). Unlocking ecosystem based adaptation opportunities in coastal Bangladesh. *J. Coast. Conserv.* vol 17, pp. 833–840. Springer.
- Ali, A. (1999). Climate Change Impact and Adaptation Assessment in Bangladesh. *Climate Research*. vol 12, pp. 109-116. Inter-Research Science Center.
- BBS. (2015). *Bangladesh Population and Housing Census 2011. Socio Economic and Demographic Report- National Report: Volume-4*. Dhaka: Bangladesh Bureau of Statistics.
- BBS. (2012). *Bangladesh Population and Housing Census 2011. Community Report- Barguna Zila*. Dhaka: Bangladesh Bureau of Statistics.
- BUET & BIDS. (1993). *Multipurpose Cyclone Shelter Programme, Final Report*. UNDP/ World Bank/GOB Project BGD/91/025. Bangladesh University of Engineering & Technology and Bangladesh Institute of Development Studies.
- CDMP. (2009). *Cyclone Shelter Information for Management of Tsunami and Cyclone Preparedness*. Comprehensive Disaster Management Programme, Ministry of Disaster Management and Relief, Government of the People's Republic of Bangladesh.
- GOB. (2015). *Final Report of Multi Hazard Risk and Vulnerability Assessment, Modeling and Mapping in Bangladesh- Volume1: Hydro-Meteorological Hazard Assessment*. Department of Disaster Management (DDM), Ministry of Disaster Management and Relief, Government of the People's Republic of Bangladesh.
- GOB. (2012). *Cyclone Shelter Construction, Maintenance and Management Guideline 2011*. Ministry of Disaster Management and Relief, Government of the People's Republic of Bangladesh.
- GOB. (2009). *Climate Change Strategy and Action Plan 2009*. Ministry of Environment and Forest, Government of the People's Republic of Bangladesh.
- GOB. (2008). *Cyclone Sidr in Bangladesh: Damage, Loss and Needs Assessment for Disaster Recovery and Reconstruction*. Economic Relations Division, Ministry of Finance, Government of the People's Republic of Bangladesh.
- GOB. (1991). *Shelter Proposal for the Population in the Cyclone and tidal Surge Prone Coastal Areas and Offshore Island of Bangladesh*. Ministry of Works, Government of the People's Republic of Bangladesh.

- Haque, A. and Jahan, S. (2016). Regional impact of cyclone sidr in Bangladesh: A multi-sector analysis. *Int. J. Disaster Risk Sci.* vol 7, pp. 312–327. Springer.
- Hossain, M. Z. et al. (2008). Impact of Tropical Cyclones on Rural Infrastructures in Bangladesh. *the CIGR E-journal. Invited Overview.* vol 10, issue 2, pp. 1-13. *Agricultural Engineering International.*
- Islam, A. S. et al. (2011). Performance of Coastal Structures During Cyclone Sidr. *Natural Hazards Review.* vol 12, issue 3, pp. 111-116. ASCE.
- International Monetary Fund (IMF). (2017). *World Economic Outlook Database. Report for Selected Countries and Subjects: Bangladesh.* Available at: <https://www.imf.org/external/pubs/ft/weo/2017/02/weodata/weorept.aspx?pr.x=92&pr.y=7&sy=2017&ey=2017&scsm=1&ssd=1&sort=country&ds=.&br=1&c=513&s=PPPPC&grp=0&a=> (accessed 14 December 2017)
- Karim, M. F. and Mimura, N. (2008). Impacts of Climate Change and Sea-Level Rise on Cyclonic Storm Surge Floods in Bangladesh. *Global Environmental Change.* Vol 18, issue 3, pp.490-500. Elsevier.
- Khalil, G. M. (1992). Cyclone and Storm Surges in Bangladesh: Some Mitigative Measures. *Natural Hazards.* vol 6, issue 1, pp. 11-24. Springer.
- Mallick, B., Rahaman, K.R. and Vogt, J. (2011). Coastal livelihood and physical infrastructure in Bangladesh after cyclone Aila. *Mitig. Adapt. Strateg. Glob. Chang.* vol 16, pp. 629–648.
- Mukherjee, R. (1938). *The Changing Face of Bengal- A Study in Riverine Economy.* Calcutta: Calcutta University Press.
- O'Malley, L. S. S. (1914). *Bengal District Gazetteer: 24 Parganas.* Indian Civil Service. New Delhi: Concept Publishing Company.
- Paul, B. K. (2009). Why Relatively Fewer People Died? The Case of Bangladesh's Cyclone Sidr. *Natural Hazards.* vol 50, issue 2, pp. 289-304. Springer.
- UNDP. (2004). *A Global Report: Reducing Disaster Risk: A Challenge for Development.* Bureau of Crisis Prevention and Recovery, United Nations Development Programme.
- UNISDR. (2009). *Risk and Poverty in a Changing Climate. Global Assessment Report on Disaster Risk Reduction.* Geneva, Switzerland: United Nations Office for Disaster Risk Reduction (UNISDR).
- World Bank. (2010). *Vulnerability of Bangladesh to Cyclones in a Changing Climate, Potential Damages and Adaptation Cost.* Policy Research Working Paper 5280. The World Bank Development Research Group, Environment and Energy Team.

Reproduction of the selected historical maps at present coordinate system used at the Great Voyage of Christopher Columbus

Khairunnahar*
Khandakar Hasan Mahmud**
Md. Abu Sayeid***

Abstract: Maps play a vital role in exploration of the past evidences. As the earth surface is spherical and maps always represents different size and shape on varied projection parameters. Hence, a standardization of historical maps is essential to explore and compare the earth surface. To achieve this, both qualitative and quantitative data from different historical sources has been considered to georeference some selected maps at a uniform projection system which were used for the great voyages of Christopher Columbus. World map of Eratosthenes, Ptolemy, Toscanelli, and Martellus of different projection system and at different scale has been considered here as Columbus uses these four maps as base study for his voyage. Simple cartographic techniques of map digitization have been adopted in GIS software to produce uniform projection and scale based world map of all these four historical maps. The reproduction of the historical maps represents the spatial extent, size and shape of the known world of that time. The knowledge gap about the size and shape of the earth thereby easily identified and documented in this research work.

Introduction

Map is an important element which shows the present as well as historical evidence. The history of map making is not a recent issue. The beginning of geographic knowledge started with the idea of the shape of the earth. In the ancient time earth was considered as flat and in Babylonian map it is shown flat and floating on water (Lovell, 1981). However, Pythagoras (570 B.C – 495 B.C) and Aristotle (384 B.C - 322 B.C) proved that the earth is spherical (Demar, 1995). Along with this approved idea; the geographic location was being confusing to different scholar from different place and time.

Strabo (64 B.C -24 A.D) from Roman school had a perception of open Indian Ocean (Hussain, 2001). Whereas later, Ptolemy (90 A.D -168 A.D) from same school had a perception of land lock Indian Ocean (Allen, 1997). Both of them talked about Indian Ocean in different perception. After many exploration, discovery and voyages; these dispute came to a conclusion that Indian Ocean is open (Suarez, 1999; Washburn, 1985).

However, the earliest evidence of map (6th B.C) comes from Middle East which shows the earth as a flat circular disk (Lovell, 1981). After that, Eratosthenes (276 B.C – 195 B.C) measured the size of the earth as 250,000 stadia or 25,000 mile (Wilson, 1997).

* Former Research Student, Department of Geography and Environment, Jahangirnagar University

** Associate Professor, Department of Geography and Environment, Jahangirnagar University,
Email: khmmahmud@juniv.edu

*** Research Student, Department of Geography and Environment, Jahangirnagar University

When these cartographers tried to produce a map of the world; they faced many problems. Cartographers from different places used different types of scale and projection which made their maps different in size, shape and direction.

Based on the above circumstances, this research work aimed to focus on the generalization of the selected historical maps of the world at present coordinate system. Two broad objectives have been considered to achieve the goal of the research:

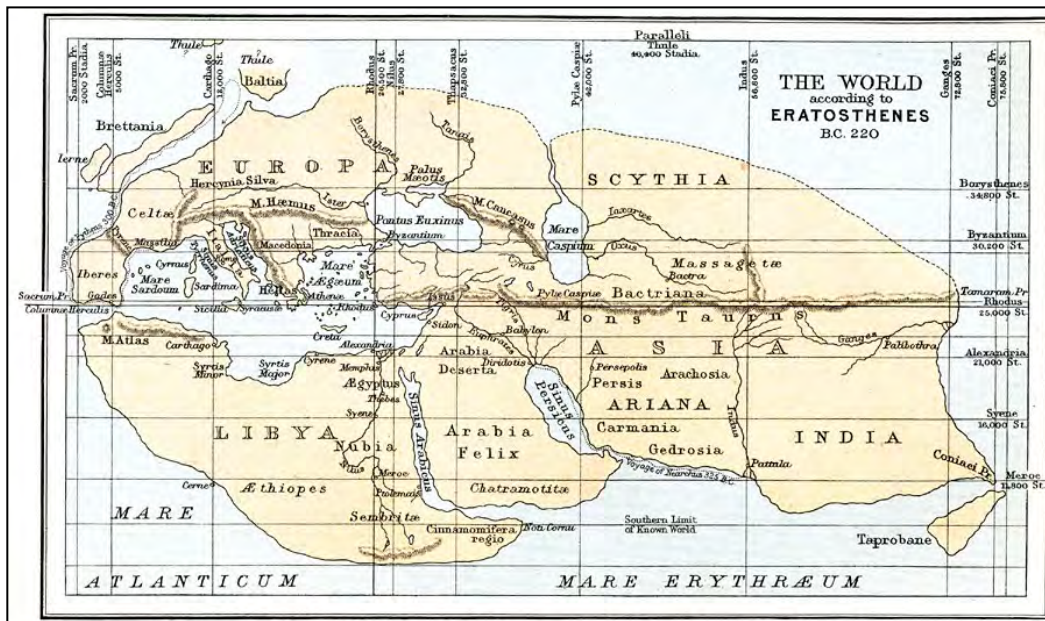
- a) Firstly to analyze the knowledge gap of map production in past. This knowledge gap is analyzed to examine historical maps.
- b) Secondly to reproduce selected historical maps to compare with present world maps.

Data and methods

For the purpose of the research work both qualitative and quantitative data were required. Both of the types were required to understand the calculation procedure and contemporary geographic knowledge.

To explore the geographical knowledge gap this research considers some historical evidence e.g. historical maps of Eratosthenes (Figure-1), Ptolemy (Figure-2), Toscanelli (Figure-3), and Martellus (Figure-4). Following maps has been widely used for the great voyages of the world in the middle to renaissance age. Knowledge about the earth is a subject of interest from the very beginning of human's quest. The size and shape of the earth is one of them which are completely unknown for a long time. The circumference of the earth is calculated by Eratosthenes as a consequence of discovering the earth (Gow, 2009). Therefor it played a vital role in the voyage of Columbus. Ptolemy calculated a different circumference of the earth and Columbus followed him (Gow, 2009). Columbus also used Toscanelli's map to identify Atlantic islands and calculated distance from Europe to Asia (Kleinschmidt, 2003). According to Harald Keinschmidt, "The map was structured on a square grid of latitudes and longitudes, the latter of which Toscanelli used to specify the distance between Europe and Africa on the right side and Asia on the left side of his map." Columbus also used Martellus's map which is consider as only surviving non-Ptolemic map (Duzer, 2012). This is the map which used to find out the location of Japan (Gunn, 2003).

Figure - 1: Map of Eratosthenes



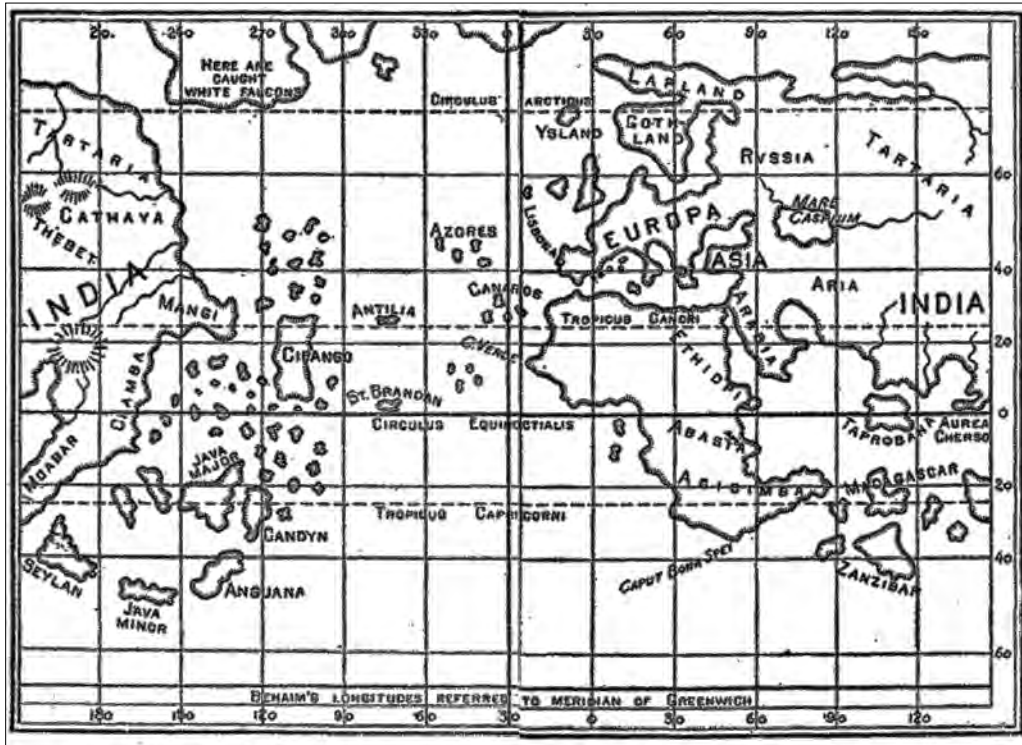
Source: After, <http://www.heritage-history.com/maps/ancient/class003.jpg>

Figure - 2: Map of Ptolemy



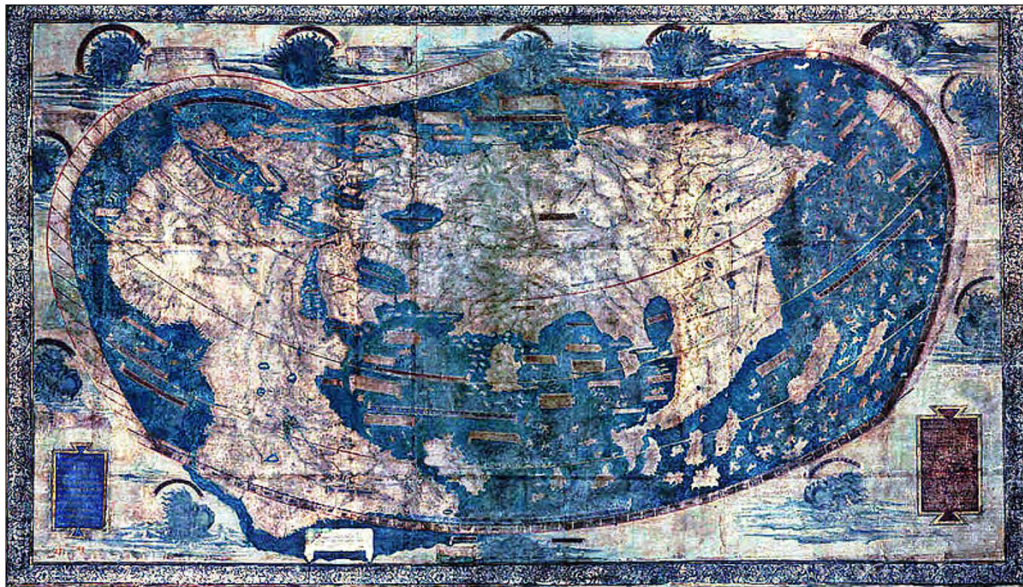
Source: After, <http://www.mlahanas.de/Greeks/images/PtolemyMapLarge.jpg>

Figure - 3: Map of Toscanelli



Source: After, <http://www.hellenicaworld.com/USA/Literature/JohnFiske/en/images/img017b.jpg>

Figure - 4: Map of Martellus



Source: After, <http://www.ancient-origins.net/sites/default/files/field/image/Yale-world-map.jpg>

Another source of his geographical knowledge is from Pierre d'Ailly's "*Ymago Mundi*" from where he got the idea of world land-mass (Grant, 1974). It is noteworthy that of the books which Columbus read and annotated between 1485 and 1490, the "*Ymago Mundi*" was one of the most important." It is said that Columbus's personal copy contains 898 marginal notations (Kadir, 1992). Columbus also followed some of his previous sailors to have a concept about the earth. He read about their writings, their adventures and gathered knowledge from them. Columbus got his idea about the earth and the location of Japan from Marco Polo (Davidson, 1997). As Sam Rogers said, "When he (Columbus) made his historic journey to the New World in 1492, among the things he brought with him was a well-used copy of *The Travels of Marco Polo*. Columbus had even written noted in the margins of the book, showing how much time he spent thinking about Marco Polo's experience and journey."

The second objective is to reproduce the historical map in present coordinate system. To reproduce those historical maps GIS tool has been used. Every map is reproduced in a uniform projection e.g. is "Simple Cylindrical Projection."

Reproduction of Eratosthenes's map

The distance between Alexandria and Syene was 5000 stadia which represents an angle of 7.2° measured by Eratosthenes.

$$\text{So, } 5000 \text{ stadia} = 7.2^\circ$$

$$1 \text{ stadia} = 0.00144^\circ$$

$$\text{And } 1^\circ = 694.44 \text{ stadia}$$

$$\text{Again, } 1 \text{ stadia} = 0.1 \text{ mile (present unit)}$$

$$5000 \text{ stadia} = 500 \text{ mile}$$

Eratosthenes chose Alexandria as the prime meridian for his map. If the stadia of Alexandria 26,500 turns into 0 stadia then 75,800 stadia of Coniaci Pr. turns into 49,300 stadia.

Total length from Alexandria to Coniaci Pr. is 17.3 cm over the map. It represents 17.3 cm = 49,300 stadia.

$$\text{As, } 694.44 \text{ stadia} = 1^\circ$$

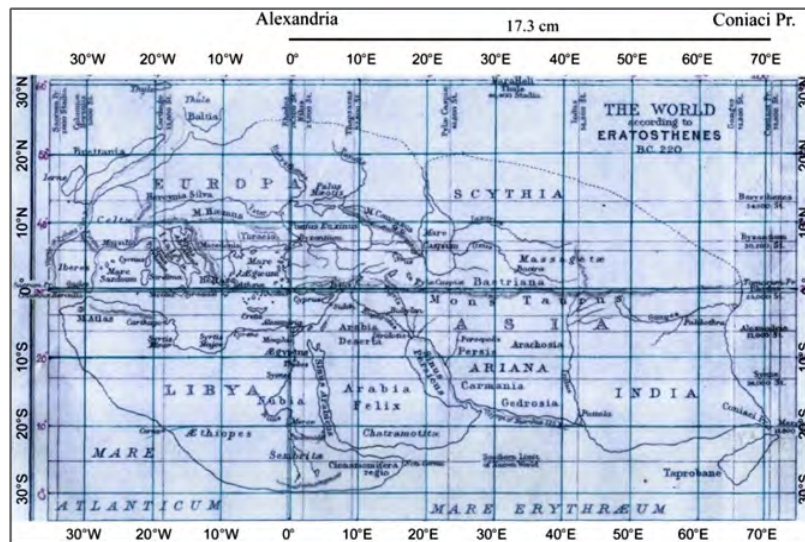
$$\text{So, } 49,300 \text{ stadia} = (49,300/694.44)^\circ = 70.99^\circ \text{ (around } 71^\circ)$$

It represents 17.3 cm = 71° . So, $1^\circ = (17.3/71) \text{ cm}$ or 0.24 cm. According to longitude, each 10° represents 2.4 cm.

According to latitude, 34,800 stadia of Borysthenes turn into 13,800 stadia. As, 1 stadia = 0.00144° so 13,800 stadia = 11.952° or 12° .

As, $1^\circ = 0.24 \text{ cm}$ so $2^\circ = 0.48 \text{ cm}$. Measuring that distance 10°N is found on the map from Borysthenes. Again, 10° interval represent by 2.4 cm. From Borysthenes, 0° is found according to latitude.

Figure - 5: Eratosthenes's map - Stadia converted into degree

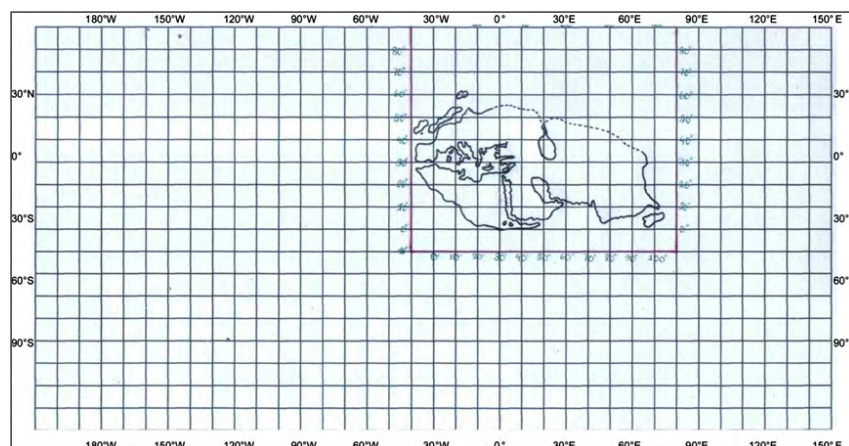


Source: Eratosthenes's map (276-194 B.C.) compiled by Author, 2015

After making grid in to the Eratosthenes's map, next step is to reproduce this into uniformed "Simple Cylindrical Projection". According to the present coordinate system, the earth is divided into 360 degree and 180 degree in east-west and north-south respectively.

As Figure-5 shows that Eratosthenes's map interval with stadia as a unit is similar to present day 10 degree interval, hence the researchers produce a simple cylindrical map projection with 10 degree interval at present coordinate system. Figure-5 then traced in the present coordinate system as presented in Figure-6 below, which shows that it covers about 20 percentage of the real world as we know today.

Figure - 6: Eratosthenes's map in Present Coordinate System



Source: Compiled by Author, 2015

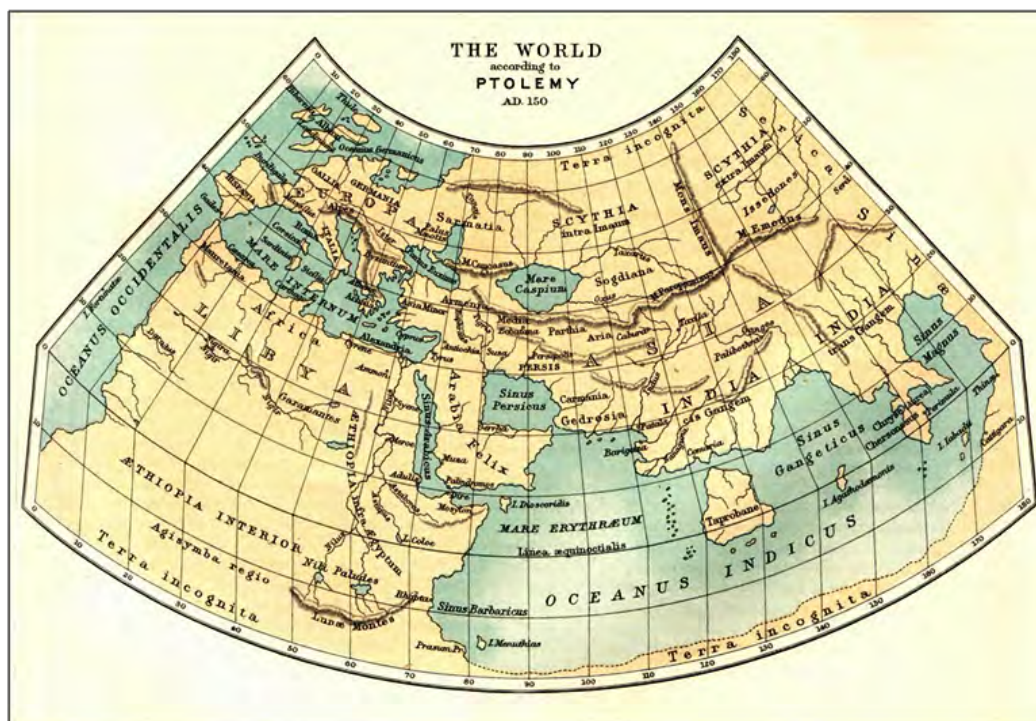
This map which is projected into “Symple Cylindrical projection” then scanned and georeferenced in present coordinate system in ArcView GIS. With the known coordinate system the map has been digitized and relevant shape files has been produced with projection and scale.

Reproduction of Ptolemy’s map

Ptolemy's work probably originally came with maps, but none have been discovered. Instead, the present form of the map was reconstructed from Ptolemy's coordinates by Byzantine monks under the direction of Maximus Planudes shortly after 1295. It probably was not that of the original text, as it uses the less favored of the two alternate projections offered by Ptolemy. Significant contributions of Ptolemy's maps are the first use of longitudinal and latitudinal lines as well as specifying terrestrial locations by celestial observations. The Geography was translated from Greek into Arabic in the 9th century and played a role in the work of al-Khwārizmī before lapsing into obscurity. The idea of a global coordinate system revolutionized European geographical thought, however, and inspired more mathematical treatment of cartography.

To simplify Ptolemy’s map into Simple Cylindrical Projection, reconstructed Ptolemy’s map is used. This map is carefully traced in the 10° interval grid paper then scanned and georeferenced in ArcView GIS.

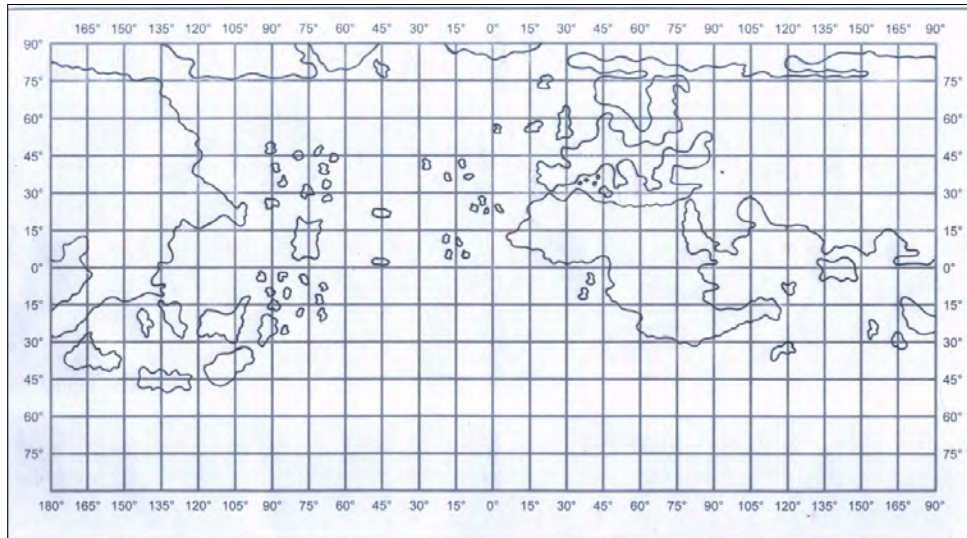
Figure - 7: Reproduced Ptolemy’s map



Source: After, <http://19thcenturyscience.org/HMSC/HMSC-Reports/1895-Summary/Plates-150ppi/Plate-4c.jpg>

This map is carefully drawn in the 15° interval grid paper then scanned and georeferenced in ArcView GIS.

Figure - 10: Toscanelli's map in Present Coordinate System

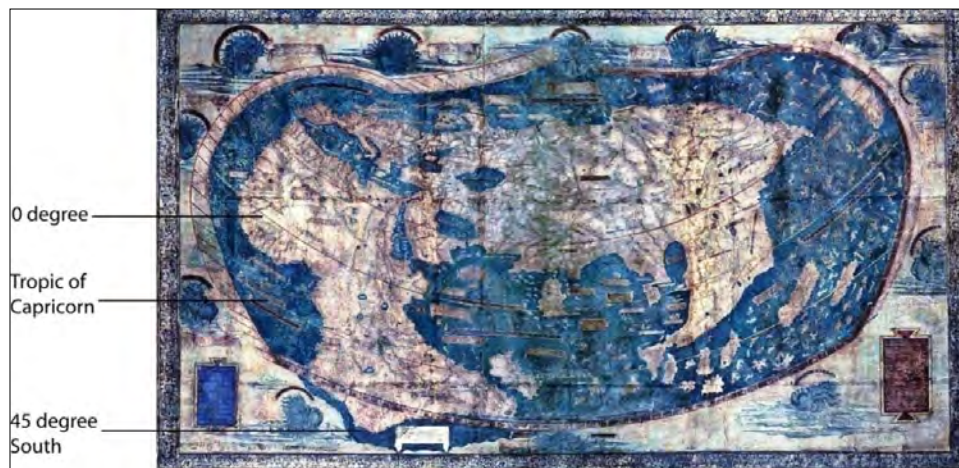


Source: Compiled by Author, 2015

Reproduction of Martellus's map

In Martellus's map Africa has been extended to 45° S. Equator and Tropic of Capricorn is shown in his map. It shows total 280 degree on map and divided into 360 degree. To digitize the map more accurately some parallel lines have drawn on the map. The map is carefully drawn in 45° interval grid paper then scanned, georeferenced and digitized in ArcView GIS. After georeference, a grid interval map has been produced in GIS (Figure-13), which is then converted into simple cylindrical projection (Figure-14).

Figure - 11: Martellus's map shows 0°, Tropic of Capricorn and 45° S



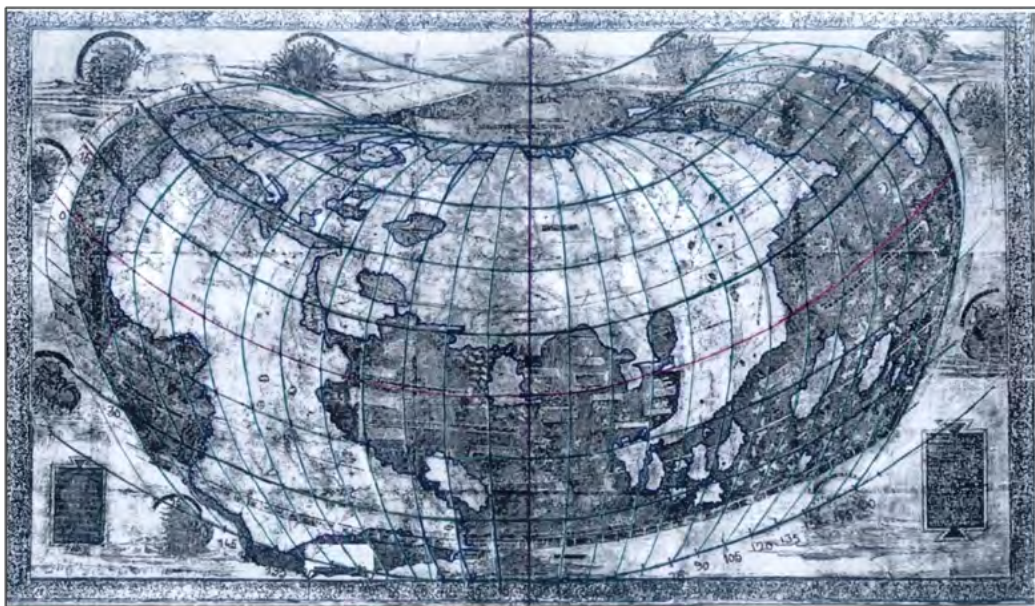
Source: After, <http://www.ancient-origins.net/sites/default/files/field/image/Yale-world-map.jpg>

Figure - 12: Martellus's map shows 270° and 360°



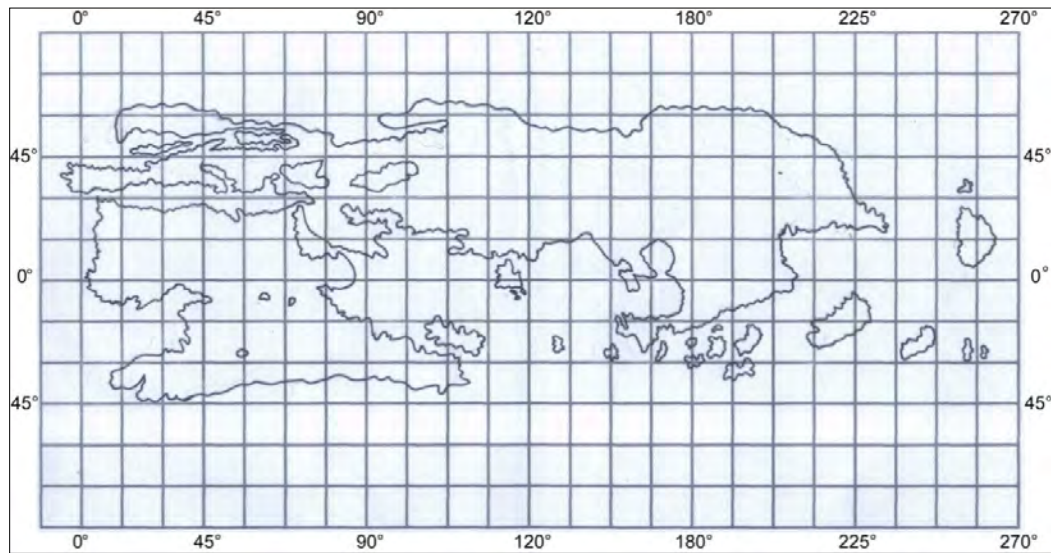
Source: After, <http://www.ancient-origins.net/sites/default/files/field/image/Yale-world-map.jpg>

Figure - 13: Martellus's map showing grid



Source: Martellus's map (1491) compiled by Author, 2015

Figure - 14: Martellus's map in Present Coordinate System



Source: Compiled by Author, 2015

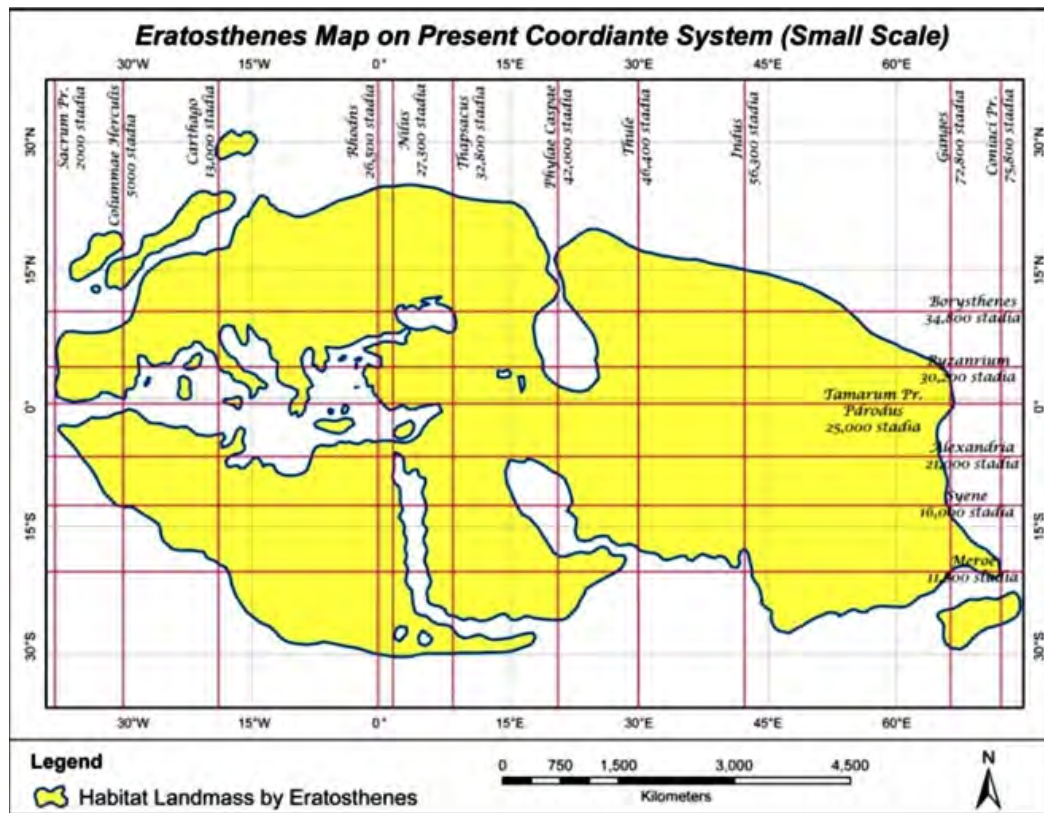
Data presentation and Analysis

In this section, evolving geographical paradigm is discussed as it is one of the important motivations of Columbus's thought about the world. As geographical knowledge have developed day by day, the consequences and influencing parameters of different geographical thoughts are important to discuss. Columbus also influenced by different types of geographical thoughts from ancient time to his time.

Eratosthenes's Map

Although, there is no evidence that Columbus follow Eratosthenes's idea of the world but it is discussed here because Columbus followed Ptolemy who had a great argument with Eratosthenes's idea about the earth. He showed only habitat landmass that he knew. He determined those locations not with graticules but stadia. A stadium is a method of measuring distances. It is an ancient Greek unit of measurement. This unit may vary from place to place and time to time. In the time of Eratosthenes there were two types of stadium was popular, one is Egyptian stadium and another is Greek stadium.

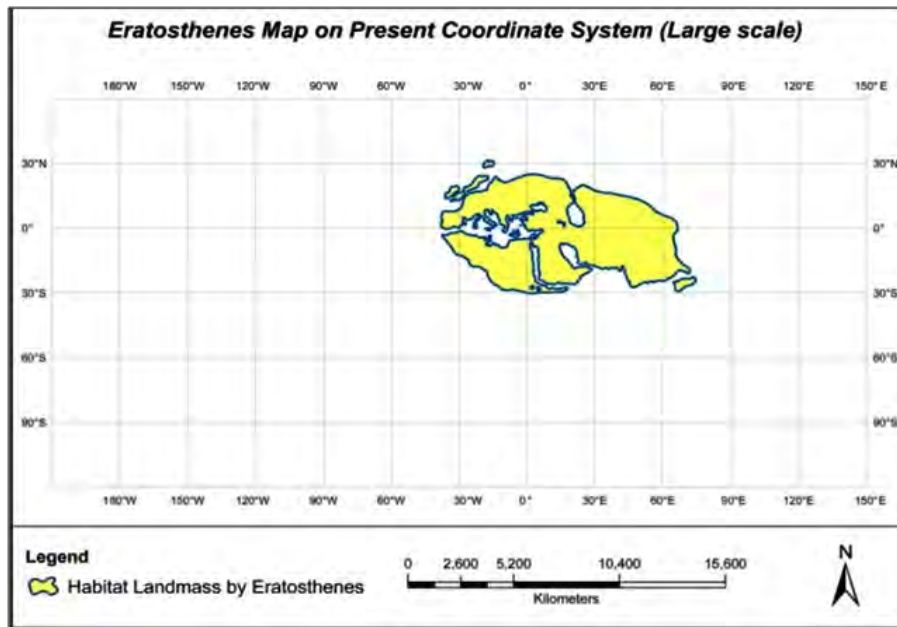
Figure – 15 (A): Eratosthenes map with stadia



Source: Compiled by author, 2015

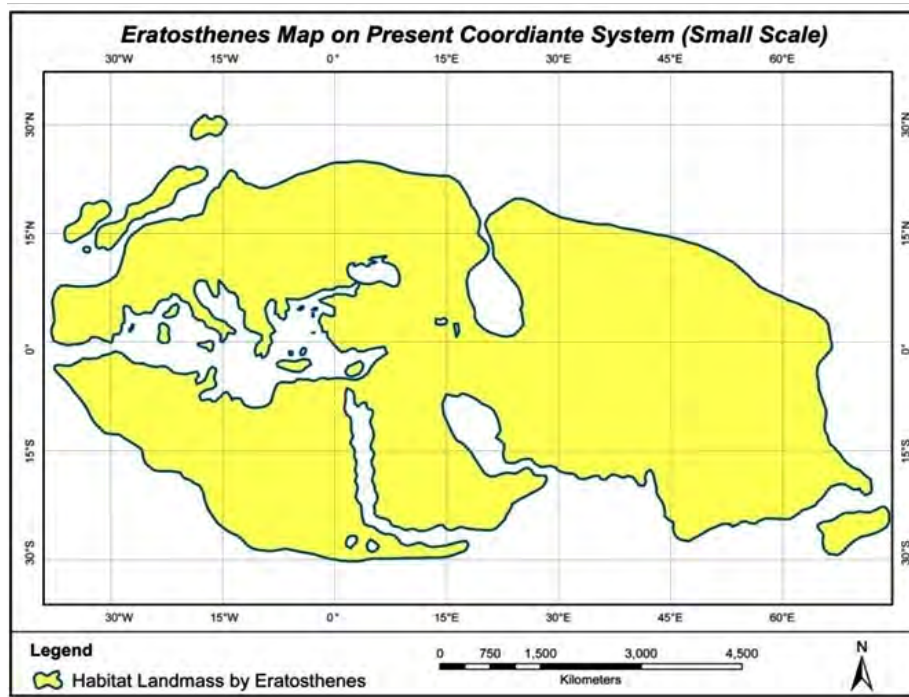
From Eratosthenes map it is shown that his prime meridian was gone through Alexandria (Vrettos, 2010) while present prime meridian is gone through Greenwich. Alexandria is located at 30°E at present coordinate system.

Figure – 15 (B): Eratosthenes map (large scale)



Source: Compiled by author, 2015

Figure – 15 (C): Eratosthenes map (small scale)



Source: Compiled by author, 2015

Eratosthenes measured the earth circumference at summer solstice. He observed that at midday the sun rays fell directly over Syene. At the same time of the day he observed that it casted a shadow in Alexandria. He measured the angle between the ray and the pole was 7.2° which is equal to the centre as parallel lines create equal alternate angle. He knew that the distance between these two cities are 5000 stadia. And also knew that the circle is consisted of 360° (Adhikari, 1992; Dansion, 2005). So he could set up the equation:

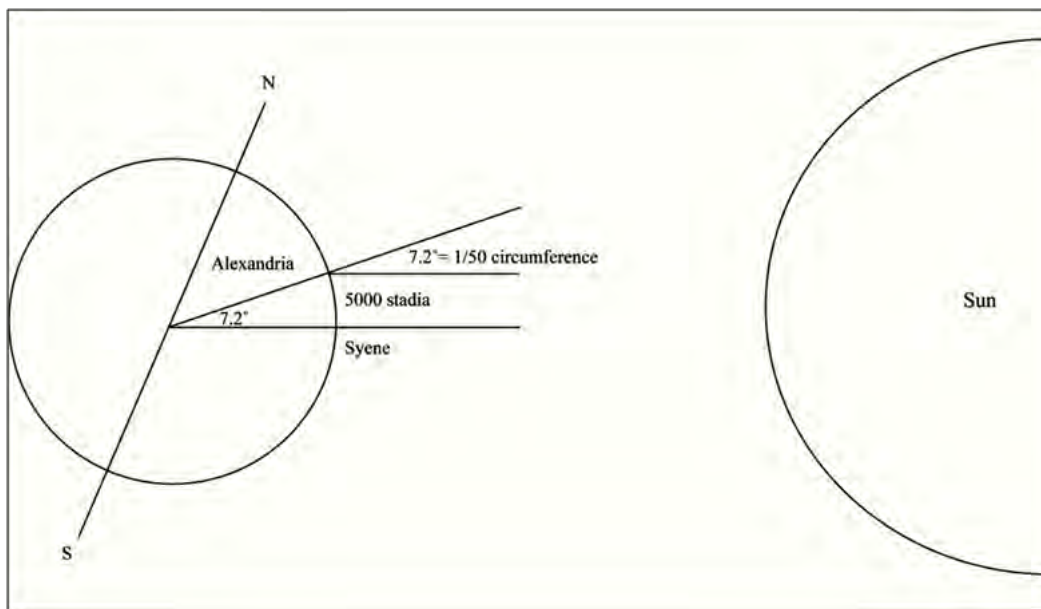
$$\frac{360 \text{ degrees}}{7.2 \text{ degrees}} = \frac{\text{Total circumference of the earth}}{\text{Distance from Alexandria to Syene}}$$

Or, $50^\circ = \frac{\text{Total circumference of the earth}}{5000 \text{ stadia}}$

Or, $50^\circ \times 5000 \text{ stadia} = \text{Total circumference of the earth}$

So, $\text{Total circumference of the earth} = 250,000 \text{ stadia}$

Figure - 16: Calculation procedure of Eratosthenes



Source: Compiled by author, 2015

Knowledge gap of Eratosthenes

As stadium is an ancient measurement; the correct unit of measurement of stadium is unknown. It is different from place to place. Though it is not known what unit was followed by him but it is still known that he considered roughly $1^\circ = 694.44$ stadia which is nearly as round figure as 700 stadia.

Eratosthenes calculated the circumference as 250,000 stadia or 25000 mile which has around 1% error. The true figure is 24,901 mile. Probably this error created because Eratosthenes considered the earth as a perfect round shape rather than a sphere.

Again, He assumed that: Syene and Alexandria lie under the same direction, although there is a difference of 2° (Henry Devis Consulting, 1994).

The true location of Syene is near the Tropic of Cancer which is $24^\circ 5'30''$. Alexandria is about 5300 stadia from Syene.

But these errors are considered as negligible as they are from the ancient history. Still there is a confusion of which unit of measurement did Eratosthenes use in his calculation because there were application of two types of stadium (Brown, 2015).

1 Greek stadium = 185 meters (ancient unit) = 0.115 miles (present unit)

So, 250,000 stadia = 28,750 miles.

Real circumference of the earth is 24,901 miles. So, there is 15.5% error from real.

1 Egyptian stadium = 157.5 meters (ancient unit) = 0.098 miles (present unit)

So, 250,000 stadia = 24,500 miles.

Real circumference of the earth is 24,901 miles. So, there is 1.61% error from real.

If he used the Egyptian stadium his calculation is nearly correct with negligible error. Columbus from 15th century followed Ptolemy rather than Eratosthenes who calculated the real circumference.

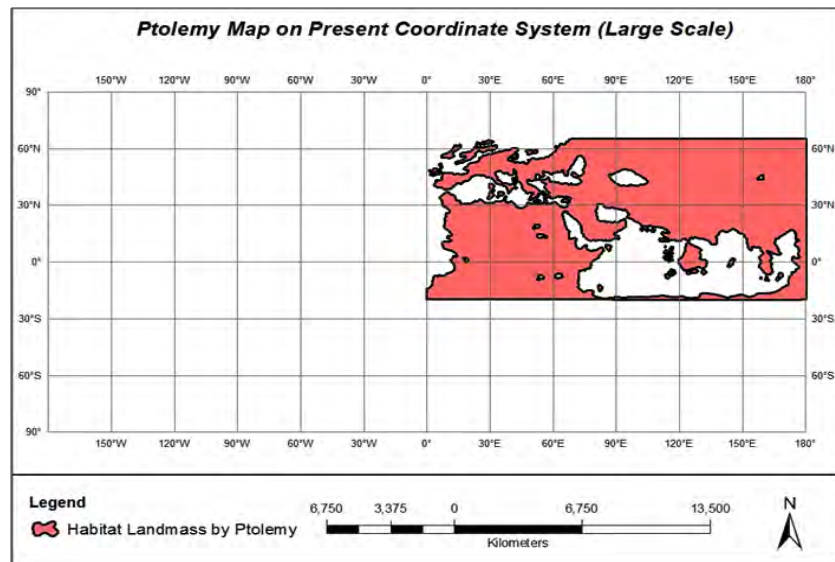
Ptolemy's Map

Ptolemy is one of the greatest geniuses in the period of ancient classical geographical thought. His popular book "*Almagast*" deals with universe and another book "*Geographia*" deals with the position of places by means of latitudes and longitudes (Hussain, 2001). According to Ptolemy, geography is a science which deals with the art of map-making. The basic objective of Ptolemy was "to reform the map of the world" (Hussain, 2001). In describing places; he gave their longitudes (calculated from Ferro in the Canaries) and latitudes (parallel of Rhodes) (Negi, 1993-1994).

He had to rely upon the distances computed by travelers and navigators. These estimations of travelers were invariably inaccurate and many a time was highly exaggerated (Hussain, 2001).

As a result he produced the length of the known world, from the Fortunate Islands in the west of the city of Sera in China towards the east, was 180° , whereas in reality it is about 130° (Hussain, 2001).

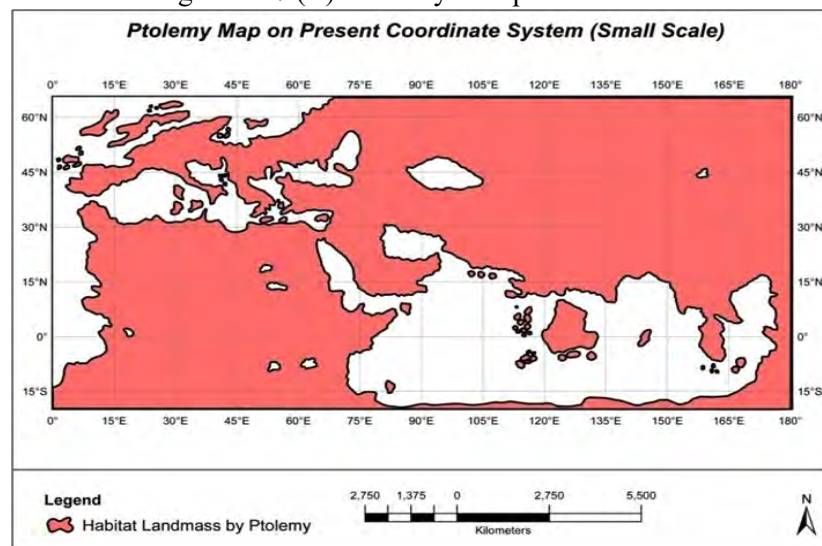
Figure – 17 (A): Ptolemy's map in large scale



Source: Compiled by author, 2015

Ptolemy believed on a hypothesis that Indian Ocean is closed. He indicated on his map that the Indian Ocean was closed by land on the south, an idea he probably borrowed from Hipparchus (Adhikari, 1992; Emiliani, 1992). He rejected the idea of open Indian Ocean by Hecateus, Herodotus, and Strabo etc. From Ptolemy map it is shown that his prime meridian was gone through Canary Island or Fortune Island while present prime meridian is gone through Greenwich. So the location of different places must be displaced. His placement of different geographical locations is distorted.

Figure – 17 (B): Ptolemy's map in small scale



Source: Compiled by author, 2015

Ptolemy's perception about the world

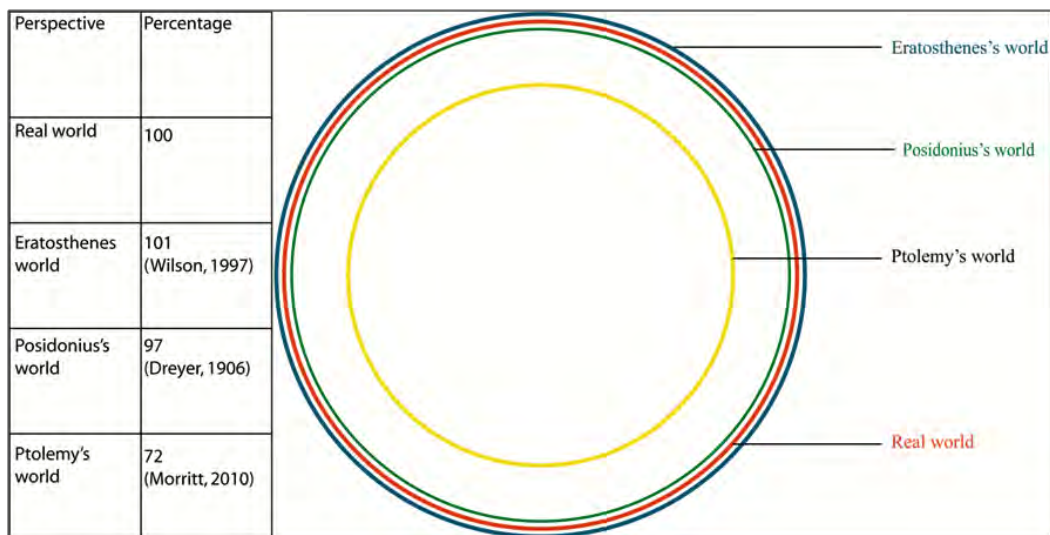
Ptolemy's biggest mistake was to underestimate the size of the earth, rejecting almost correct estimate of Eratosthenes in favor of Posidonius who recalculated the circumference of the earth. Posidonius (135 - 51 B.C) measured the location of 'Canopus' and observed that it touches the horizon while at Alexandria it reaches an altitude of 7.5° or 7.3° . It covered around $1/48^{\text{th}}$ of a circle. He measured the distance between Rhodes and Alexandria was 5000 stadia. So, the calculated circumference was 240000 stadia which have three percent error from true circumference .

The truth is the angle of Canopus is 5.15° rather than 7.5° or 7.3° and the distance between Rhodes and Alexandria is 3750 stadia instead of 5000 stadia. Ptolemy revised the procedure of Posidonius and changed the value.

7.3° should be $5^\circ 15'$ and 5000 stadia should be 3750 stadia.

Ptolemy changed the distance but not the degree. So, the earth circumference is 180000 stadia which made the circumference nearly 28% smaller than real. As, Ptolemy used this measurement in his book "Geographia" and Columbus followed that book; he relied on this circumference of the earth (Morritt, 2010).

Figure – 18: Different circumferences of the world by different scholars



Source: Compiled by author, 2015

Knowledge gap of Ptolemy

- Ptolemy gave position to geographical locations and those positions should be determined by direct astronomical observations. Unfortunately, the number of such observations at his command was very small (Hussain, 2001).
- Following Hipparchus, Ptolemy divided the circle into 360° and considered every degree equal to 500 stadia (50 miles) instead of 600 stadia (60 miles) (Hussain, 2001).

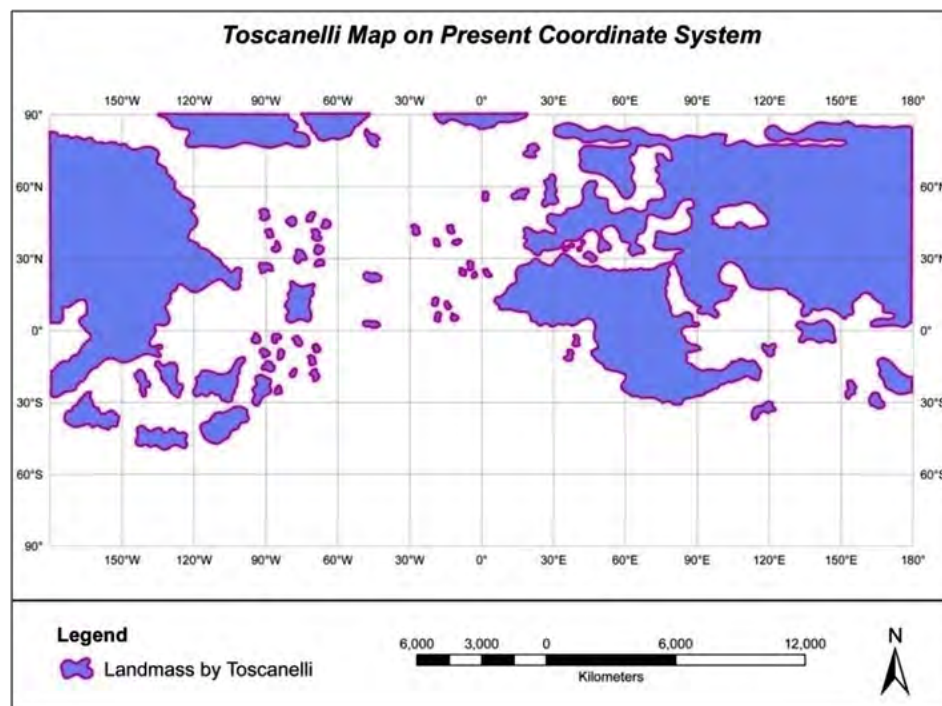
- Owing this wrong notion, the error about the circumference of the earth got multiplied. Apart from this, since the travelers and navigators would exaggerate the distances on their travels between different places and since Ptolemy relied on these accounts and itineraries the world map prepared by him got distorted (Hussain, 2001).
- Ptolemy also rejected the perception of open Indian Ocean by Starbo. According to him, it is closed and there lies the “unknown world” (Terra InCognita).
- Ptolemy exaggerated the length of the Mediterranean by about 30% and thus also that of Asia. This concept reducing the distance between the western tip of Spain and the east coast of Asia.

As Ptolemy located some geographical location in displaced position and believed on an extended area of continent or landmass; his knowledge about the earth may guide misdirection. Again, he believed on a smaller perception of earth circumference. All of these might influenced Columbus positively to make his voyage.

Toscanelli's Map

Toscanelli; a cartographer from 15th century believed that Far East (Asia continent) could be reach more easier by sailing west rather than cross the Indian Ocean or rounding the Cape of Good Hope. He is one of them by whom Columbus was inspired (Panchyk, 2011).

Figure – 19: Toscanelli's map



Source: Compiled by author, 2015

Toscanelli's idea about the passage to India across western route was important in the time of Columbus because this route would be more feasible and safe than cross the Indian Ocean.

Toscanelli's knowledge gap

There were some displacement of location that Toscanelli believed that they are supposed to be correct.

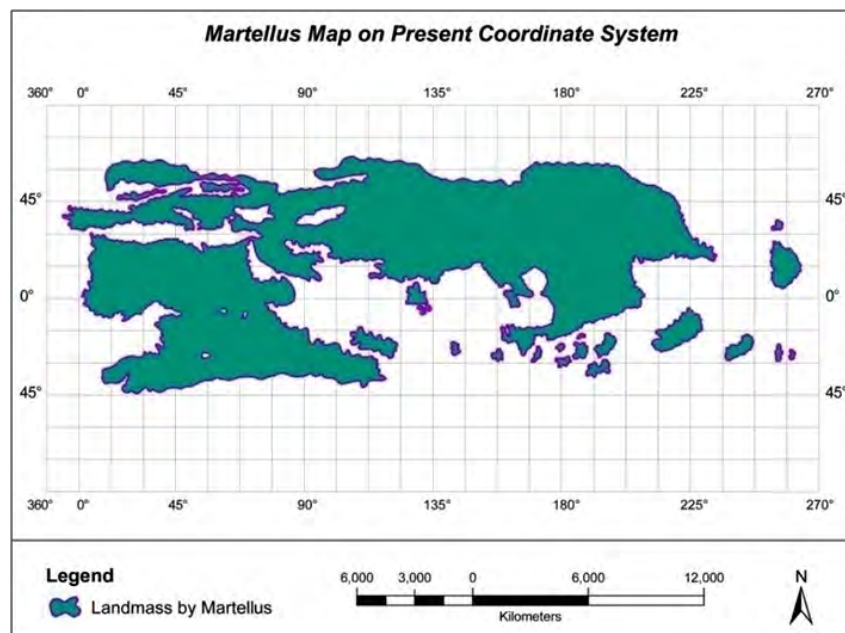
- Toscanelli calculated the distance between Lisbon and Quinsai 130° longitude where the actual is about 220°.
- He assumed Antillia lays 35° west of his prime meridian through the Canaries.
- Toscanelli calculated 85° of longitude between the Canaries and Cipangu.

The calculation procedure of Toscanelli helped Columbus to navigate westward with some mathematical evidences. And his placement of different geographical location encouraged Columbus enough to make this voyage.

Martellus's Map

Another map from 15th century that might be used by Columbus is Martellus map this has some important features that Columbus might inspired of (Henderson, 2005; McCormick, 2012; Rogers, 2014). As Chet Van Duzer (2012) said, "This map is of particular importance because it is the best contemporary representation of Columbus's geographical ideas, and in fact it seems quite likely that Columbus had studied this map or one very similar to it." The location of Japan in Martellus map was important to Columbus because one of his primary aims was to anchor in Japan as an entrance of Asia.

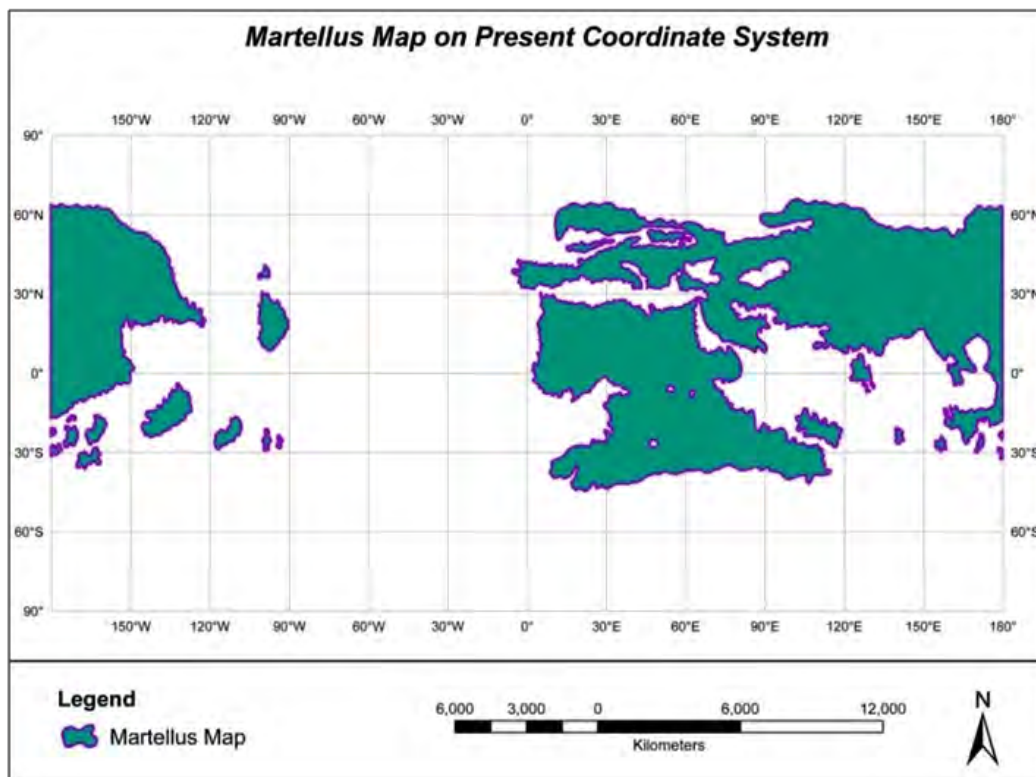
Figure – 20: Martellus's map



Source: Compiled by author, 2015

Interesting characteristics of Martellus map is he drew the landmass only 0° to 270° and rest of the world were not drawn. According to his concept rest of them was ocean part which means he thought about the rest of 90° was Ocean. But he didn't present them in his world map. So the real picture would be like the map which is given below:

Figure – 21: Martellus's map presenting 360°



Source: Compiled by author, 2015

Martellus's knowledge gap

There are some cartographic and geographic knowledge gaps of Martellus which are given below:

- In his map, the distance between the coast of China and Lisbon is 120° .
- May be Martellus calculated his measurement in League (measurement unit).
 - On land, 1 league = 3 miles
 - At sea, 1 league = 3 nautical miles
 - Again, 1 league = 1.5 Roman mile
- Africa has been extended 45° S in his map.
- The most important location on his map "Japan" (Cipangu) is located in the ocean 30° east of China (Cathay). It extends from 7° N to 31° N of the equator.
- Asia extended up to 240° .

Conclusion:

Study of maps had played important role during the age of discovery (middle age of 1200 AD to 1600 AD). Navigators around the world sailed towards unknown world based on the perception of the ancient maps. Area and direction of the maps played crucial role on the success rate of the voyages. Christopher Columbus, one of the great voyagers of the middle age also relies on the findings of the maps to build his hypothesis to reach India. However, although, he fails to reach Indian, he discovers the great land mass of the west (present day North America). Present study standardized the maps which were considered as the backbone study of the voyage of Columbus, which reveals the geographical knowledge gap between times of the maps.

References

- Adhikari, S. (1992). *Fundamentals of Geographical Thought*. India, Allahabad-2: Chaitanya Publishing House.
- Brown, C. S. (2015). Eratosthenes of Cyrene. Retrieved December 10, 2015, from <https://www.khanacademy.org/partner-content/big-history-project/solar-system-and-earth/knowning-solar-system-earth/a/eratosthenes-of-cyrene>.
- Danson, E. (2005). *Weighing the World: The Quest to Measure the Earth*. Oxford University Press. ISBN-13: 978-0-19-518169-2.
- Davidson, M. H. (1997). *Columbus Then and Now: A Life Reexamined*. University of Oklahoma Press. ISBN: 0-8061-2934-4.
- Demar, G. (1995). *America's Christian History: The Untold Story*. American Vision. ISBN-13: 978-0915815166.
- Duzer, C. V. (2012). *Waldseemüller's World Maps of 1507 and 1516: Sources and Development of his Cartographical Thought*. The Portolan, 8-20.
- Emiliani, C. (1992). *Planet Earth: Cosmology, Geology, and the Evolution of Life and Environment*. Cambridge University Press. ISBN: 978-0-521-40123-4.
- Gow, M. (2009). *Measuring the Earth: Eratosthenes and His Celestial Geometry*. Library of Congress. ISBN-13: 978-0-7660-3120-3.
- Grant, E. (1974). *A source Book in Medieval Science, Volume 1*. Cambridge, Massachusetts, Harvard University Press.
- Gunn, G. C. (2003). *First Globalization: The Eurasian Exchange, 1500 to 1800*. Rowman & Littlefield Publishers, Inc. ISBN: 0-7425-2662-3.
- Henderson, J. (2005). *Caribbean & the Bahamas*. New Holland Publishers.
- Henry Devis Consulting (1994). 252_Toscanellis_World_Map. Retrieved September 20, 2015, from http://cartographic-images.net/Cartographic_Images/Cartographic_Images.html.
- Husain, M. (2001). *Evolution of Geographic Thought*. India, Jaipur and New Delhi: Rawat Publications. ISBN: 81-7033-675-9.
- Kadir, D. (1992). *Columbus and the Ends of the Earth: Europe's Prophetic Rhetoric as Conquering Ideology*. University of California Press. ISBN: 0-520-07442-4.
- Kleinschmidt, H. (2003). *People on the Move: Attitudes Toward and Perceptions of Migration in Medieval and Modern Europe*. Greenwood Publishing Group. ISBN: 0-275-97417-0.
- Lovell, B. (1981). *Emerging Cosmology*. USA: Columbia University Press. ISBN: 1-58348-113-3.

- McCormick, D. (2012). *Columbus's Geographical Miscalculations*. Retrieved 8 October, 2012 from <http://spectrum.ieee.org/tech-talk/at-work/test-and-measurement/columbuss-geographical-miscalculations>.
- Morrith, R. D. (2010). *Echoes from the Greek Bronze Age: An Anthology of Greek Thought in the Classical Age*. UK, Cambridge Scholars Publishing. ISBN (10): 1-4438-2489-5.
- Negi, B.S. (1993-1994.). *Geographical thought*. India, New Delhi: Kedar Nath Ram Nath.
- Panchyk, R. (2011). *Charting the World: Geography and Maps from Cave Paintings to GPS with 21 Activities*. Chicago Review Press. ISBN: 978-1-56976-344-5.
- Rogers, S. (2014). *What's So Great About Marco Polo?: A Biography of Marco Polo Just for Kids!*. KidLit-O Press. Retrieved from <https://books.google.com.bd/books?id=Zk2YAgAAQBAJ&printsec=frontcover#v=onepage&q&f=false>.
- Vrettos, T. (2010). *Alexandria: City of the Western Mind*. New York, The Free Press. ISBN: 0-7432-0569-3.
- Wilson, R. (1997). *Astronomy Through The Ages: The story of the human attempt to understand the universe*. UK, London: Taylor and Francis. ISBN: 0-203-21273-8.

Spatial and Temporal Dynamics of the Coastal Vegetation: A Case Study of the Maheshkhali Island, Cox's Bazar, Bangladesh

Ebadullah Khan*

Abstract: Mangroves are the coastal forest which is influenced by inter-tidal actions of the sea. It is a unique geographical habitat having distinct ecological characteristics. This research mainly emphasized on the exploration of the spatial and temporal dynamics of coastal mangroves of the Maheshkhali Island, Cox's Bazar, Bangladesh. Besides, it also focused on the stresses developed on the mangrove forest area and their minimizing measures. Maheshkhali is an offshore island of the Bay of Bengal, Bangladesh. From the spatio-temporal and environmental point of view, the mangrove forest of this island is dynamic. Both of primary and secondary data have been used. For 1975, Landsat Multi-spectral Scanner (MSS) imagery and near infrared band (NIR, Band-4) have been used for detecting coastal vegetation. Landsat TM imageries and near infrared band (NIR, Band-4) have been used for detecting coastal vegetation in 1995. For 2017, Landsat Operational Land Imager (OLI) imagery and near infrared (NIR, band-5) have been used for coastline and vegetation detection. Bangladesh Transverse Mercator (BTM) have been used as coordinate system for spatial analysis. The coastal mangroves have been demarcated through Visual image interpretation techniques using ArcMap 10.4.1. For primary data, a questionnaire survey has been conducted among the 120 respondents whom has been selected through random sampling method for getting the information about the stresses on mangroves in the coastal belt. The collected data have been processed through MS Excel 2013 and critically discussed with comparative analysis. Gradually, the areal extent of mangroves has been increased. The increase rate is 158.36% from 1975 to 2017. Several stresses are developed on Mangroves such as- Cutting Mangroves enormously and Habitat destruction. 65% of the respondents have given their opinion in this regard. Several possible measures should be taken for minimizing stress on mangroves such as- Raising Local Awareness, Declare the mangroves habitat as No entrance Red zone, Institutional Monitoring and Strictly implementation of legislation. A historical data archive of spatial and temporal change of mangroves is essential for this island.

Key words: Mangroves, off-shore, Geo-physical, GIS

Introduction

Mangrove forest is one of the unique coastal ecosystems in the tropic and subtropical region. It offers various economic, ecological resources such as firewood, timber production, different food items, and provides nursery and breeding ground for juvenile fishes. In addition, coastal forest acts as the inter-weaving zone between sea and the land and plays a vital role in protecting the coast from cyclone and other coastal hazards (Sanyal, 2003). A wide range of land type with their associated natural hazards, economical potency of each land type, biodegradation due to the impact of recent anthropogenic activities and versatile sedimentary depositional system have made the Maheshkhali Island unique, inasmuch to come in interest to the geologist as well as the

* Assistant Professor, Dept. of Geography and Environment, Jahangirnagar University, Savar, Dhaka-1342

other scientific community of Bangladesh since last one decade (Islam et al., 2012). Maheshkhali is an offshore island of the Bay Bengal, Bangladesh. Series of Hills are located at the Northern and North-Eastern part of the island. On the contrary, the western and south-western part of the island is open to the sea. So strong wind flow and tidal wave action are prevailing in this part. Tidal mangrove forest is located in this site. Once this island was not connected with mainland, but from 2007 onwards, this island became connected with Chakaria upazila from the Northern side. Due to this change, all resources such as mangroves, agricultural arable land, forestry vegetations etc. were more exposed to the local inhabitants and incoming people. Consequently, mangroves supposed to increase naturally but due to exploitation and expropriation of several greedy people, increasing rate of mangroves is not substantial. So there are stresses developed on mangroves of coastal area of the island. Most of the previous research work (Khan & Alam, 2017; Islam et al., 2012) mainly emphasized on only spatio- temporal change of Mangrove forest and overall land use, land cover of the Maheshkhali island. This study has focused on spatio-temporal dynamics of Mangrove forest including the environmental stresses developed on it over the years.

Aim and objectives

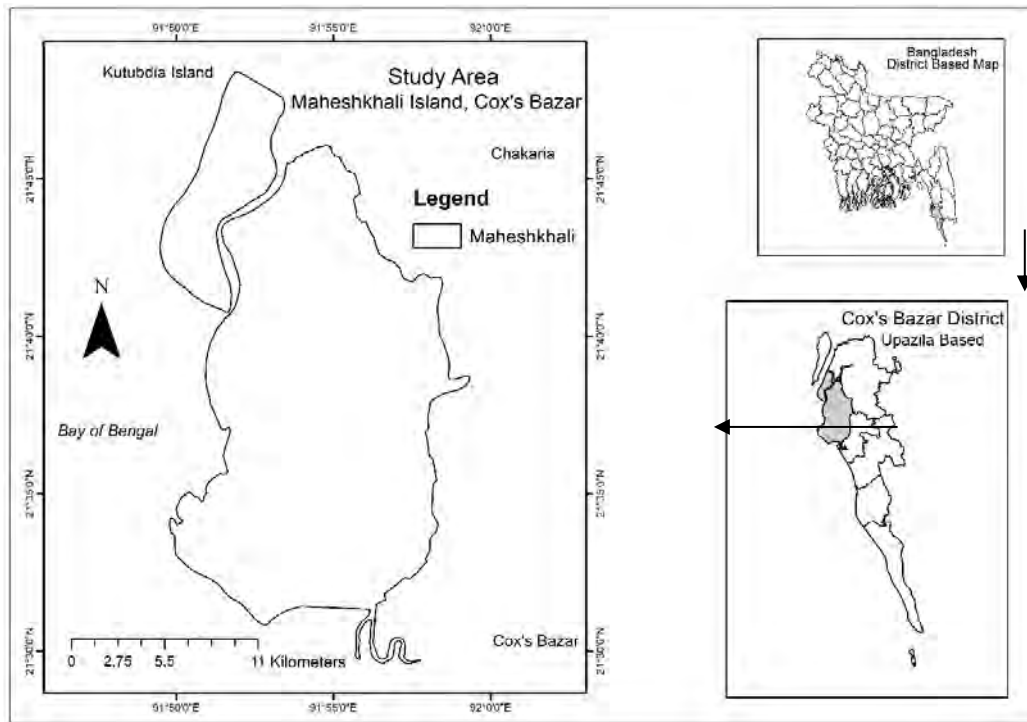
The main aim of this study is to explore the spatial and temporal dynamics of mangroves and to analyze the prevailing stresses developed in the mangroves area. To fulfill this aim, the specific objectives are as follows:

- i. To demarcate the spatial extent of the coastal mangrove vegetation area for 1975, 1995 and 2017 using satellite image interpretation;
- ii. To analyze the spatio-temporal change of mangroves from 1975 to 2017 imageries;
- iii. To explore the stress developed on mangrove forest in the coastal area and
- iv. To recommendsome possible measures for minimizing the stresses developed on mangrove forest.

Location of the study area

Maheshkhali Upazila (Cox's Bazar distict) with an area of 362.18 sq. kms, is bounded by Chakaria Upazila on the north, Cox's Bazar Sadar upazila and the Bay of Bengal on the south, Chakari and Cox's Bazar sadar upazillas on the east, Kutubdia island and the Bay of Bengal on the west which is observed in the map 1.

Map 1: Location of the study area (Maheshkhali Island)



Source: BCA data, (2007) using ArcMap 10.4.1

The eastern part of the upazila is separated from the mainland by the Maheshkahali channel. Main rivers are Bak-khali and Maheshkhali channel. The absolute location of the island is from $21^{\circ} 28' N$ to $21^{\circ} 46' N$ and from $91^{\circ} 50' E$ to $92^{\circ} 00' E$.

Data and methods

In this research, both primary and secondary data have been used. A questionnaire survey has been conducted among the 120 respondents, selected through random sampling method for getting the information about the stresses developed on the mangrove forest area. There are several technical approaches have been applied to explore the dynamics of mangroves and its spatial change from 1975 to 2017. As secondary data, Landsat satellite imageries have been used for the year of 1975, 1995 and 2017. These approaches flow gradually step-by-step using some techniques and processes. Firstly, Landsat MSS images have been collected from earthexplorer.usgs.gov website. Next data has been converted into vector data set by using GIS technology (ArcMap 10.4.1). Satellite imageries of Landsat series at the same time for each of the time interval. For analyzing the data, same band combination will be used.

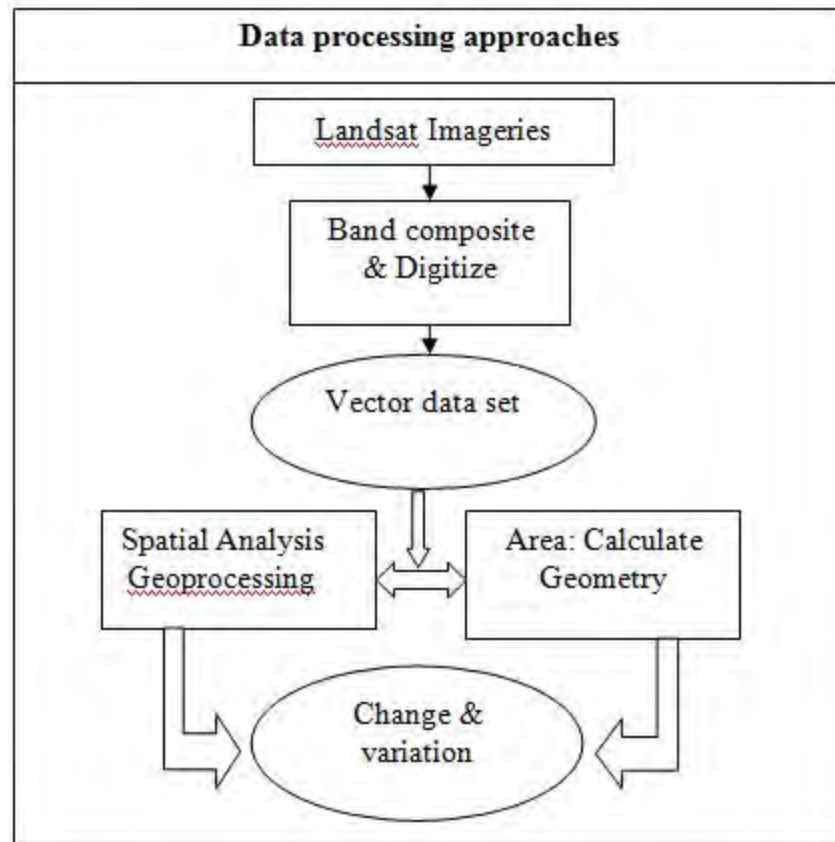


Figure: 1 Technical data processing approaches

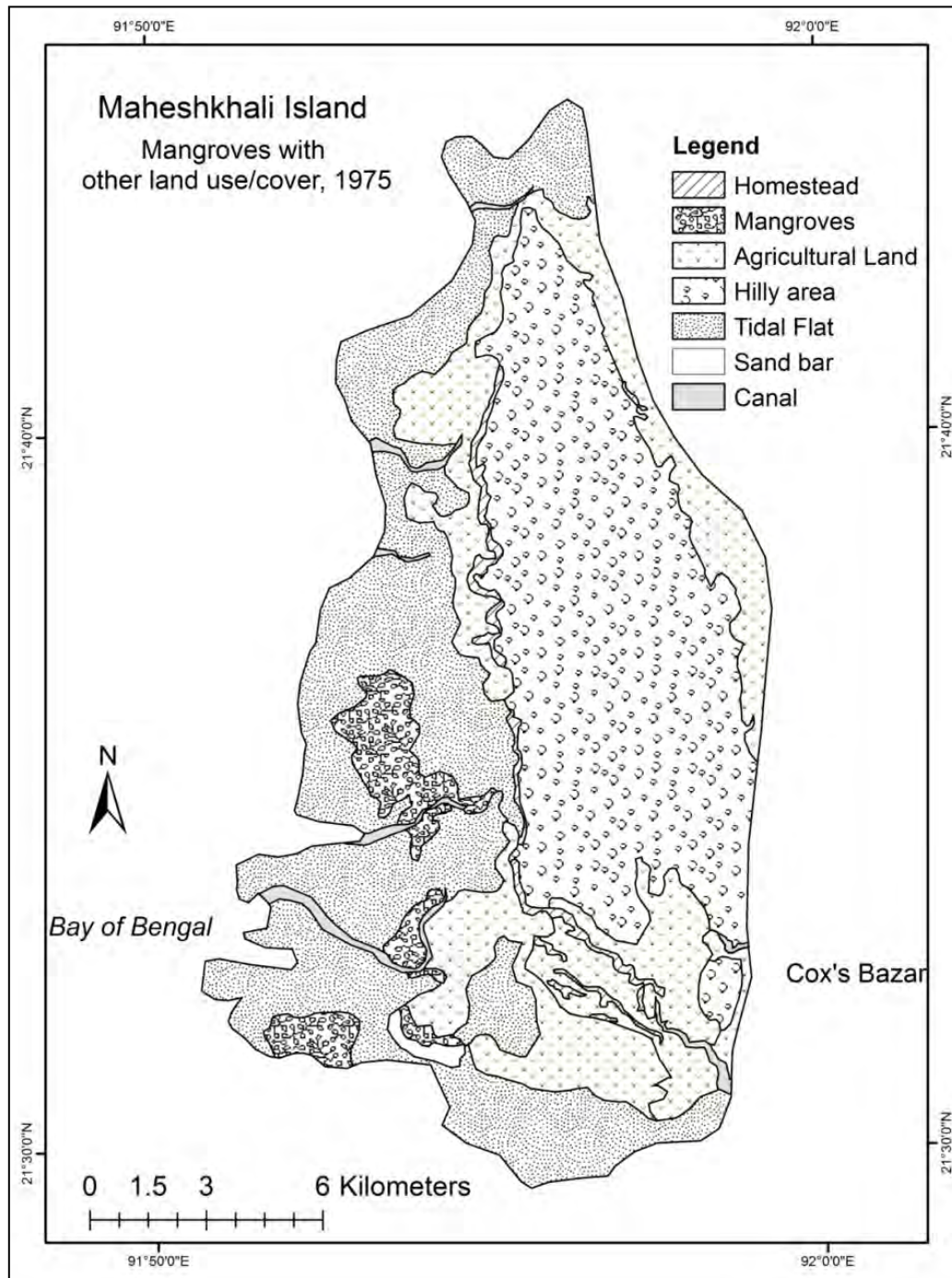
The mid and near infrared spectral bands of satellite images have strong reflectance by soil and vegetation and absorbance by water, which make possible to separate the vegetations (Kuleli, 2010). Landsat Multi-spectral Scanner (MSS) imageries have used for 1975, near infrared band (NIR, Band-4) is effective for coastline detection. Landsat TM imageries and near infrared band (NIR, Band-4) have been used for detecting coastal vegetation in 1995, Landsat Operational Land Image (OLI) imageries of 2017 have been used and for this imageries, near infrared (NIR, band-5) is effective for coastline and vegetation detection. Bangladesh Transverse Mercator (BTM) have been used as coordinate system for spatial analysis. Total scenario of data processing approaches have been illustrated by figure 1. The data has been processed using Microsoft Excel 2013 tools and presented by tables and figures.

Results and Discussion

Areal extent and spatial distribution of Mangrove Forest in 1975

The areal extent of Mangroves with other land uses and land covers are identified with the satellite image interpretation for understanding the surrounding condition of Mangroves (Map 2).

Map 2: The Mangroves with other land use/cover of the Maheshkhali Island, 1975



Source: USGS, Satellite image interpretation using ArcMap 10.4.1

Table 2: Spatial extent of Mangroves and other feature types of the Maheshkhali Island, 1975

Feature name	1975 (hectare)	Percentage(%)
Homestead	404.82	1.65
Mangroves	1180.52	4.82
Agricultural land	5513.23	22.50
Hilly area	8590.21	35.05
Canal	334.22	1.36
Tidal flat	8388.23	34.23
Sand bar	95.48	0.39
Total (in hectare)	24506.7	

Source: USGS, Satellite image interpretation using ArcMap 10.4.1

In 1975, it is delineated from the table 2 and Map 2, that mangroves was only 4.82 % total area. Homestead occupied very small area and it is about 1.65% of the total area. Agricultural land and tidal flat was the highest amount. These are 35.05% and 34.23 % respectively.

Areal extension and spatial distribution of Mangrove Forest in 1995

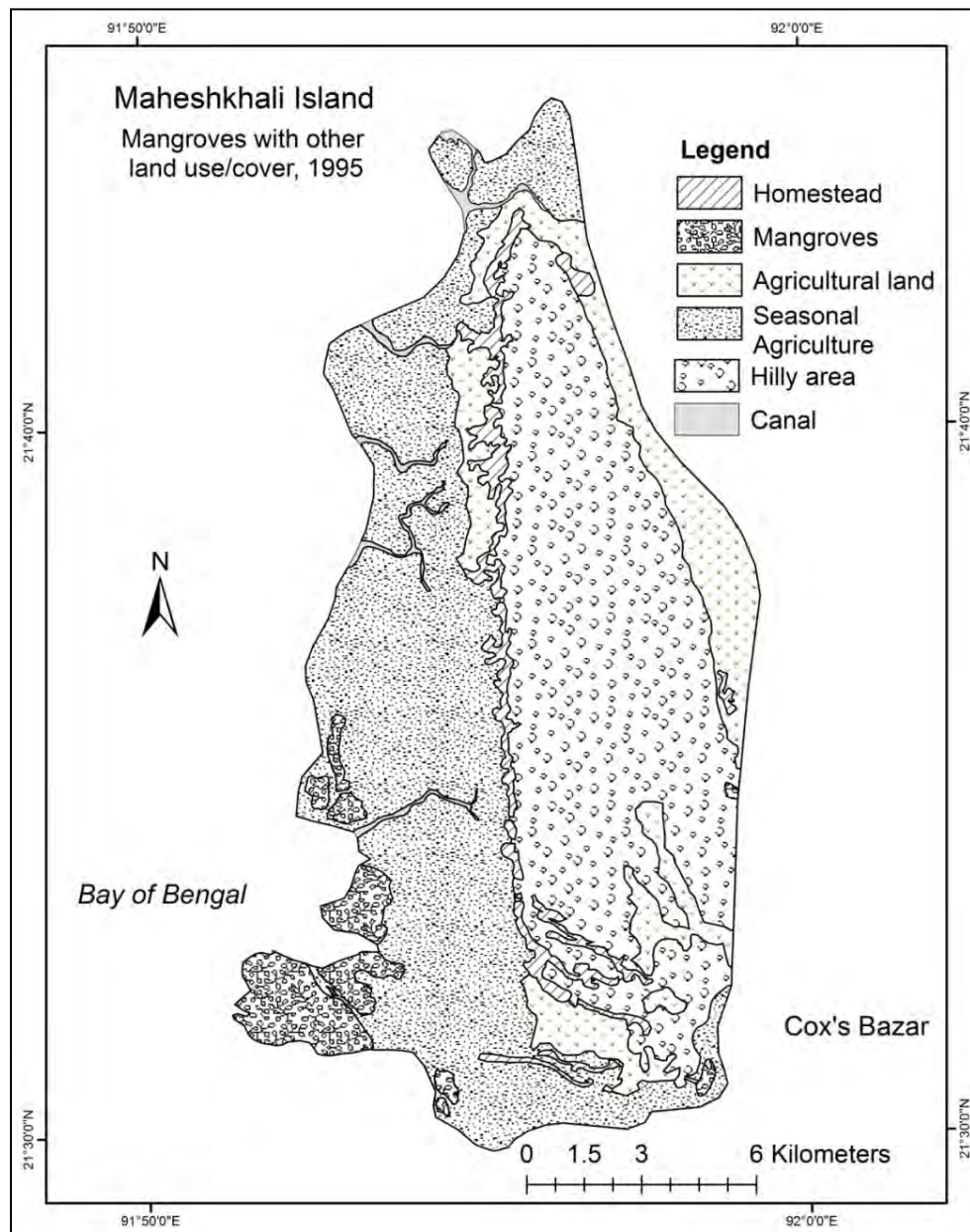
It is observed from the table 3 and map 3 that in 1995, mangroves has been increased and it is about 5.35% of the total area. Seasonal agricultural land covered most of the area of the island and it is about 39.83%. Hilly area was the second highest and it is about 37.24%. Homestead did not cover a large area and it is about 4.26%.

Table 3: Mangroves and the other feature types, spatial extent and its percentage, 1995

Feature name	1995(in hectare)	Percentage (%)
Homestead	974.52	4.26
Mangroves	1224.6	5.35
Seasonal Agriculture	9118.34	39.83
Agricultural land	2807.38	12.26
Hilly area	8524.2	37.24
Canal	242.83	1.06
Total (in hectare)	22891.89	

Source: USGS, Satellite image interpretation using ArcMap 10.4.1

Map 3: The Mangroves with other land uses/covers of the Maheshkhali Island, 1995



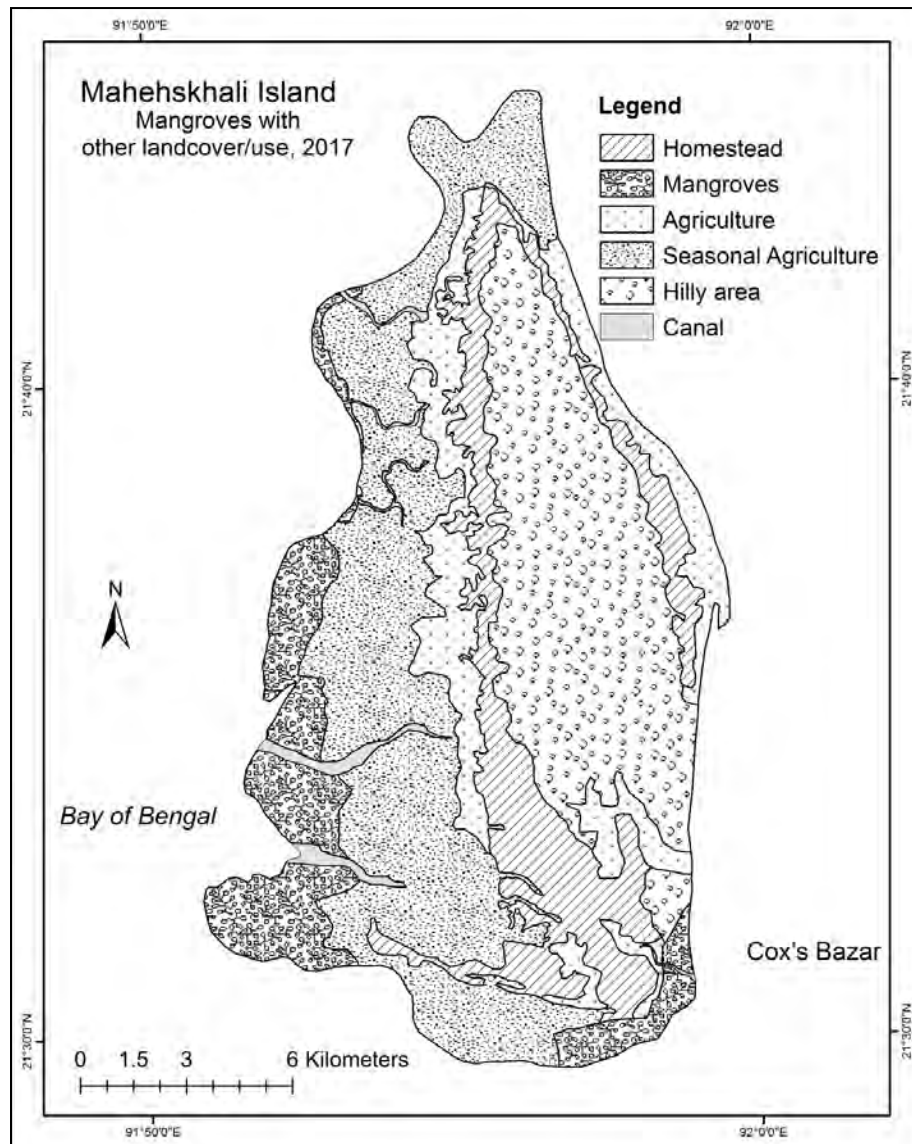
Source: USGS, Satellite image interpretation using ArcMap 10.4.1

Areal extent and spatial distribution of Mangrove Forest in 2017

The study area is very diverse in land use or land cover. Due to its unique geo-physical location, several distinctive landscape features are available here such as; mangroves, seasonal agricultural land, homestead, arable agricultural land, hilly area and canal. It is

observed from table 4, seasonal agricultural land is the highest amount and it is about 7998.88 hectares. From the visual satellite image interpretation of landsat image of 2017, map: 4 is developed which shows that as an offshore island of the Bay of Bengal, mangroves with tidal action, hills with arable agricultural land and tidal plain are observed.

Map 4: The Mangroves with other land uses/covers of the Maheshkhali Island, 2017



Source: USGS, Satellite image interpretation using ArcMap 10.4.1

Table 4: The feature types, spatial extent and its percentage, 2017

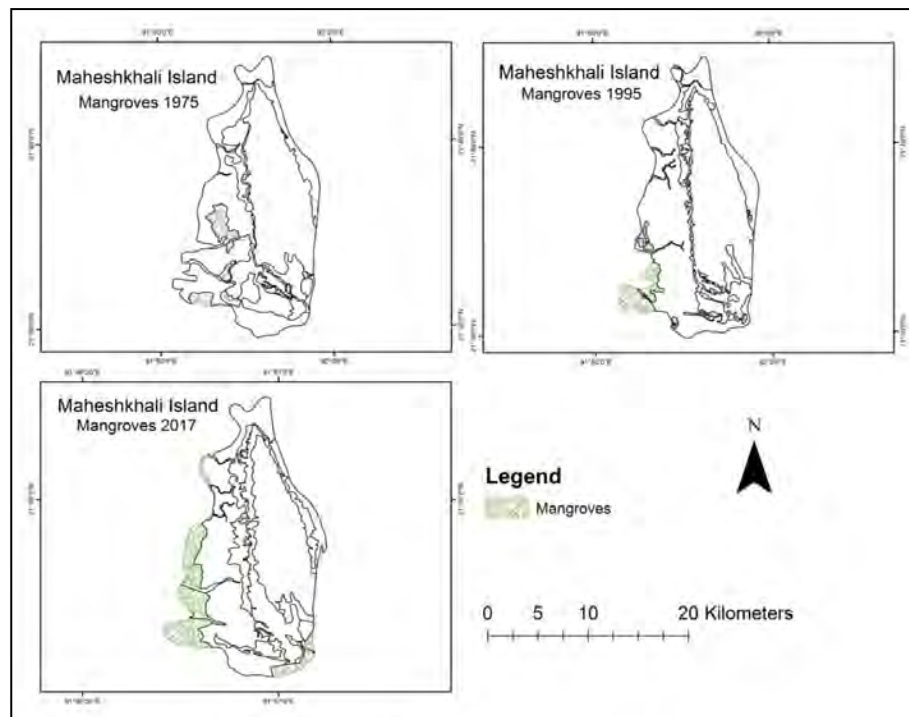
Feature name	2015 (hectare)	Percentage (%)
Homestead	4023.70	16.16
Mangroves	3050.00	12.25
Agriculture (Arable)	3000.21	12.05
Seasonal Agriculture	7998.88	32.13
Hilly area	6480.94	26.03
Canal	344.73	1.38
Total (in hectare)	24898.46	100.00

Source: USGS, Satellite image interpretation using ArcMap 10.4.1

Changes in Areal extent of Mangroves from 1975 to 2017

It is depicted from the table 5 and figure 2 that mangrove forests are gradually increasing. In 1975 it was 1180.52 hectare and in 2017, it is about 3050.00 hectare. The percentage of change is 158.36%. But the percentage of change was supposed to be more because mangroves are gradually cutting down indiscriminately by some greedy powerful people. As the overall areal extent of the island has been increased within 40 years and it is about 1.76%.

Map 5: Changes in extent of Mangroves from 1975 to 2015



Source: USGS, Satellite image interpretation using ArcMap 10.4.1

Table 5: Changes in extent of Mangroves from 1975 to 2015

Feature name	1975 (hectare)	1995 (hectare)	2017 (hectare)	Change in Percentage (%) From (1975 to 2017)
Mangroves	1180.52	1224.60	3050.00	158.36

Source: USGS, Satellite image interpretation using ArcMap 10.4.1

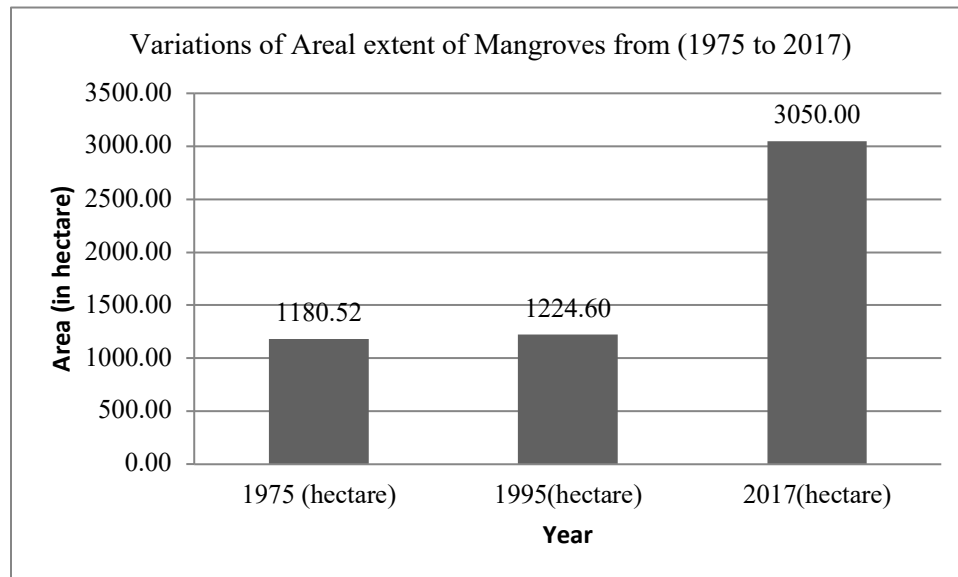


Figure 2: Shows the changes in areal extent of Mangroves from 1975 to 2017)

Source: USGS, Satellite image interpretation using ArcMap 10.4.1 and MS Excel 2013

Stresses developed on Mangroves of the Island

There are several stresses are developed on Mangroves due to unwanted human interference. Human activities shape the cultural landscape of any place and ultimately influence the natural landscape. On the basis of activities, this shape may be constructive or destructive. Decreasing arable agricultural land, decreasing crop and salt production and habitat destructions are mentionable.

Local respondents reporting

There is a questionnaire survey which has been completed during field work. The respondents have been randomly selected. They are selected from different stake holders and status which is mentioned elaborately in methodology part. On the basis of 50 respondents' reporting, it is observed that increasing population pressure and greedy sentiment of muscle people are the root causes of Mangroves destruction. Besides, unethical activities of dishonest people, Lack of social awareness are significant in this respect.

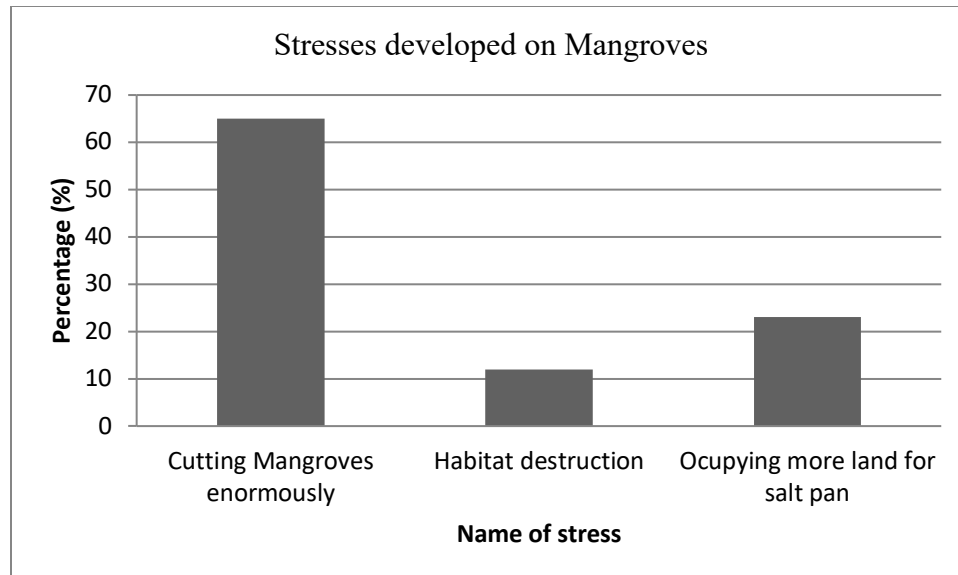


Figure 3: Stresses on Mangrove forest of the island; Source: Field survey, 2018

From the figure 3, it is observed that highest amount of respondents' mentioned about cutting mangroves enormously. It is about 65% of the total respondents. Most of the homesteads are developing indiscriminately on arable agricultural land due to population expansion. The habitats of hilly area and mangrove forests are disturbing due to this land transformation.

Ways of Minimizing the Stresses developed on Mangroves

The landscape of the Maheshkhali Island is transformed enormously. Increasing population pressure and connection by mainland, its geographical location is the main cause of the land transformation. The features and topo-sequences which are identified by using the Satellite such as: homestead, agriculture, forest, hill, tidal plain have different characteristics. The rate of landscape transformation is very rapid. Because increasing population due to excessive birth rate and the nature of exploitation of people of the forest land and hilly area. Decreasing agricultural land, cutting mangrove forest and hill are very acute which can lead to food insecurity, environmental hazards and its catastrophic destruction.

a. Raising Local Awareness

From the figure 4, raising local awareness is the highest percentage. Most of the people of this island are not academically literate. So don't know the importance of maintaining the mangrove forest of the coastal area. Another important reason is that most of the people live under the poverty level. So don't purchase land to build their residence in secured places. They are compelled to build their homestead in a hazardous area. So 55% the local respondents have given their comments to raise awareness among the public by various govt. and non-govt. organizations.

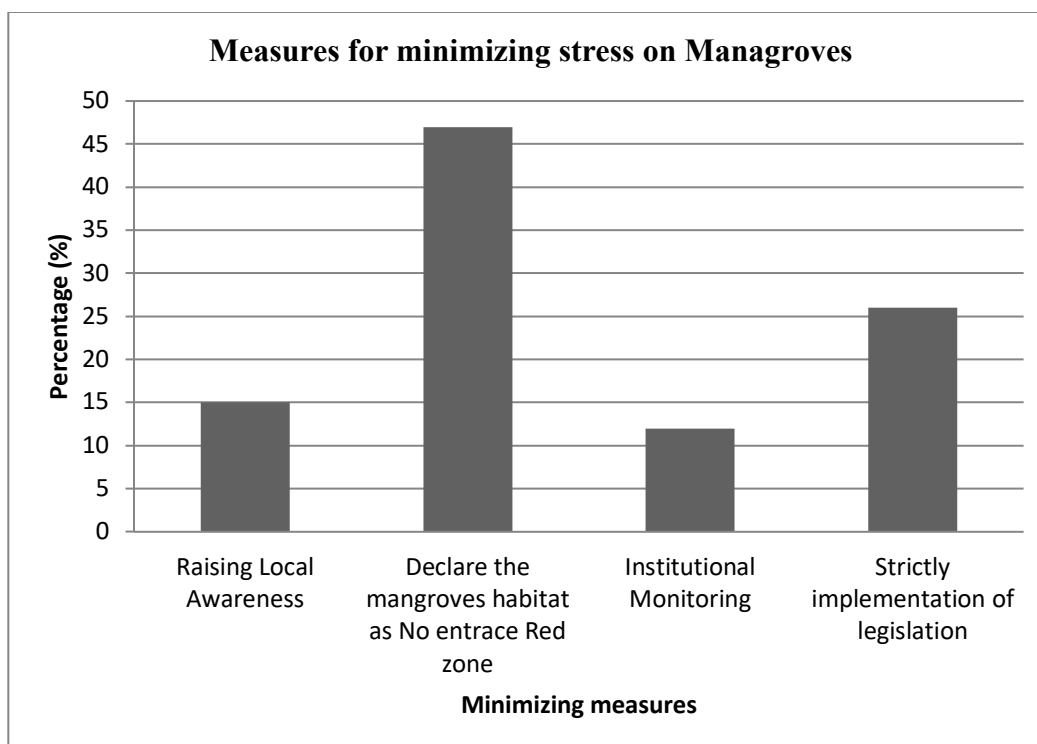


Figure 4: Measures of minimizing stress on Mangroves, Source: Field survey, 2018

b. Declare the Mangroves habitat as No entrance zone

For the eradication of cutting mangroves, government should declare the mangroves are as a no entrance zone. As this mangroves play the significant role for the existence of the island, so no people should enter in this habitat physically. 47 % of the total respondents' have given their opinion in this regard.

c. Institutional Monitoring

Institutional Monitoring is an important effort as a minimizing measure. As per local respondents, sometimes, literate dishonest people know the importance of mangrove forest but they crave for more wealth. So they are habituated to cut mangrove forest. So the local administration should be very much careful in this respect.

d. Strictly implementation of legislation

Specific rule and legislation is very significant for the maintenance of Mangroves. Sometimes, officials of the administration and forestry admit that there are lot of rules and regulations but there is no implementation of those laws. Vigilance team or guard of the forestry should be honest in this regard. If any dishonesty proved, then they have to be seriously punished by the authority.

Findings

- The spatial extent of mangroves from 1975, 1995 and 2017 has been identified through satellite image interpretation. Most of the mangroves are located at the western and south-western part of the island. The percentage of change from 1975 to 2017 is 158.36%.
- There are several stresses are developed on Mangroves such as-Cutting Mangroves enormously and Habitat destruction due to population pressure on land and greedy sentiment of mighty man of the island. 65 % respondents have given their valuable opinion in this regard.
- Several possible measures should be taken for minimizing stress on mangroves such as- Raising Local Awareness, Declare the mangroves habitat as No entrance Red zone, Institutional Monitoring and Strictly implementation of legislation. Weakness is showing from the both side of administration and forestry department.

Conclusion and Recommendation

During the time of questionnaire and field survey it has been observed that there is no data archive about the areal extent of mangroves. No data are found to the local administration or forestry office. So proper documentation of data about mangroves is very significant. In real sense, if administration will be serious for the protection of mangroves, it is possible to preserve. Coastal mangroves are significant for the existence of the Maheshkhali Island. Matter which is carried from the hilly area of the island is settled down at the southern coast of the island. In this case, mangroves play vital role in matter and energy flow. During storm surge and Cyclone, mangroves protect the island from strong wave actions and wind actions respectively. Recently this island observes few hazardous cyclone such as; Roano, Aila etc. So for minimizing the effect of wind movement during cyclone, mangroves are essential. On the contrary, mangroves settled down all eroded materials flowing from high land and sustained landmass of the island.

References

- Ahmed, A., Drake, F., Nawaz, R., & Woulds, C. (2018). Where is the coast? Monitoring coastal land dynamics in Bangladesh: An integrated management approach using GIS and remote sensing techniques. *Ocean and Coastal Management*, 151. 10-24. <https://doi.org/10.1016/j.ocecoaman.2017.10.030>.
- Alam, S., Hossain, L., Foysal, M. A., & Misbahuzzaman, K. (2014). Growth Performance of Mangrove Species in Chakaria Sundarban. *International Journal of Ecosystem*, 4(5), 233–238. <https://doi.org/10.5923/j.ije.20140405.04>
- Arefin, M. S., Hossain, M. K., & Akhter Hossain, M. (2017). Plant diversity of sonadia island - an ecologically critical area of south-east Bangladesh. *Bangladesh Journal of Plant Taxonomy*, 24(1), 107–116. <https://doi.org/10.3329/bjpt.v24i1.33037>
- Aziz, A., & Paul, A. R. (2015). Bangladesh Sundarbans: Present status of the Environment and Biota. *Diversity*, 7(3), 242–269. <https://doi.org/10.3390/d7030242>
- FAO. (2005). Global Forest Resources Assessment 2005: Thematic Study on Mangroves. Nigeria Country Profile. *Forest Resources Development Service Forest Resources Division*

- Forestry, Forestry Department FAO, Rome (Italy)*, 10.
- Ferrari, I., & Ferrarini, A. (2008). From ecosystem ecology to landscape ecology: A progression calling for a well-founded research and appropriate disillusion. *Landscape Online*, 6(1), 1–13. <https://doi.org/10.3097/LO.200806>
- Hussain, N., & Khan, E. (2018). Coastline Dynamics and Raising Landform: A Geo-informatics Based Study on the Bay of Bengal, Bangladesh. *Indonesian Journal of Geography*, 50(1), 41. <https://doi.org/10.22146/ijg.26655>
- Hussain, N., Khanam, R., & Khan, E. (2017). Two and Half Century's Changes of World Largest Mangrove Forest: A Geo-informatics Based Study on Sundarbans Mangrove Forest, Bangladesh, India. *Modern Environmental Science and Engineering*, 03(06), 419–423. [https://doi.org/10.15341/mese\(2333-2581\)/06.03.2017/007](https://doi.org/10.15341/mese(2333-2581)/06.03.2017/007)
- Islam, M. A., Maitra, M. K., Majlis, A. B. K., Murshed, S., & Rahman, S. (2012). Spatial Changes of Land Use / Land Cover of Moheshkhali Island , Bangladesh : A Fact Finding Approach by Remote Sensing Analysis. *Dhaka University Journal*, 2, 43-54.
- Islam, M. M., Sunny, A. R., Hossain, M. M., & Friess, D. A. (2018). Drivers of mangrove ecosystem service change in the Sundarbans of Bangladesh. *Singapore Journal of Tropical Geography*, 39(2), 244–265. <https://doi.org/10.1111/sjtg.12241>
- Khan, E. & Alam, M. S. (2017). Inventorying Landscape Elements and Patterns: A Case on Southern Part of the Maheshkhali Island, Cox's Bazar. *The Jahangirnagar Review*, 37, 189-203.
- Kuleli, T. (2010). Quantitative analysis of shoreline changes at the mediterranean coast in Turkey. *Environmental Monitoring and Assessment*, 167(1–4), 387–397. <https://doi.org/10.1007/s10661-009-1057-8>
- Prince, H. M., Idrees, M. O., Shafri, H. Z. M., Iqbal, M., Iqbal, M. Z., & Aziz, M. T. (2018). Effect of competing landuse practices on Chakaria Sundarbans mangrove in Bangladesh using Landsat imagery. *IOP Conference Series: Earth and Environmental Science*, 169(1). <https://doi.org/10.1088/1755-1315/169/1/012038>
- Rahman, M., & Begum, S. (2013). Land Cover Change Analysis Around the Sundarbans Mangrove Forest of Bangladesh using Remote Sensing and GIS Application. *Journal of Science Foundation*, 9(1–2), 95–107. <https://doi.org/10.3329/jsf.v9i1-2.14652>
- Sanyal, N.(2003). *Use of Multi-Temporal Landsat Images for The Monitoring of Changes of the Mangrove Forest in Maheshkhali , South-East Coast of Bangladesh*.International Institute for Geo-Information Science and Earth Observation Enschede, The Netherlands.
- Sarker, S., & Patwary, M. (2015). Synergistic Use of Passive and Active Remote System Imagery: Review on Bangladesh Perspective. *Physical Science International Journal*, 6(1), 1–14. <https://doi.org/10.9734/psij/2015/13991>
- Society, T., Bulletin, W. S., By, P., & Doi, W. S. (2001). *Convention on Wetlands (Ramsar, Iran, 1971)* 10. 14(June), 27–29. [https://doi.org/10.1672/0732-9393\(2001\)018](https://doi.org/10.1672/0732-9393(2001)018)
- Turner, M. G. (1990). Spatial and temporal analysis of landscape patterns. *Landscape Ecology*, 4(1), 21–30. <https://doi.org/10.1007/BF02573948>

Extracting Thermal Data from Satellite Sensors: A Case Study between Landsat and Weather Observatory of Dhaka Metropolitan Area

Faria Kabir^{*}

Mehedi Iqbal^{**}

Md. Ashraful Habib^{***}

Dr. Md. Shahedur Rashid^{****}

Palash Chandra Karmaker^{*****}

Abstract: This study assessed the comparison of Land Surface Temperature from thermal band with Air Temperature from weather observatory in Dhaka Metropolitan (DMP) area using Remote Sensing Techniques. After collecting the Air Temperature from Bangladesh Meteorological Department, the obtained data is compared with Land Surface Temperature retrieved from Landsat 8 Thermal Bands in three different dates. The obtained data showed the variation in different time frame are quite similar and close to air temperature from weather observatory. The variability of retrieved Land Surface Temperature was investigated with respect to consider the Split Window Algorithm that was developed by Normalized Difference Vegetation Index (NDVI) and Land Surface Emissivity values. The margin difference is attributed the significance of retrieving Land Surface Temperature from thermal bands can be altered by considering atmospheric effect and weather conditions of seasonal variations by processing the time series data over our region of interest. The present study put emphasis on that Land Surface Temperature could be another way of determining temperature values from DN value of pixel. The present study focuses on developing ArcMap 10.5 Raster Calculation by Split Window Algorithm method using the LANDSAT 8 thermal imagery of band 10 and 11 data. The difference between retrieved LST and Air Temperature from Weather Station data indicates that the technique works by giving a difference of $\pm 1.1^{\circ}\text{C}$.

Keywords: Land Surface Temperature (LST), Air Temperature, Thermal Infra-Red Sensor (TIRS), Normalized Difference Vegetation Index (NDVI), Land Surface Emissivity (LSE)

Introduction

Temperature is one of the most significant climatic parameters and the surface temperature varies for various geographical phenomena (Roni, 2013). Remote sensing

^{*} MS Student, Department of Geography and Environment, Jahangirnagar University, Savar Dhaka 1342, Mobile: 01994056935, Email: fariakabir4@gmail.com

^{**} Assistant professor, Department of Geography and Environment, Jahangirnagar University, Savar Dhaka 1342, Mobile: 01712168094, Email: israrju@gmail.com

^{***} MS Student, Department of Geography and Environment, Jahangirnagar University, Savar Dhaka 1342, Mobile: 01744108794, Email: ashrafulhabib71@gmail.com

^{****} Professor, Department of Geography and Environment, Jahangirnagar University, Savar Dhaka 1342, Email: m.s.rashid@gmail.com

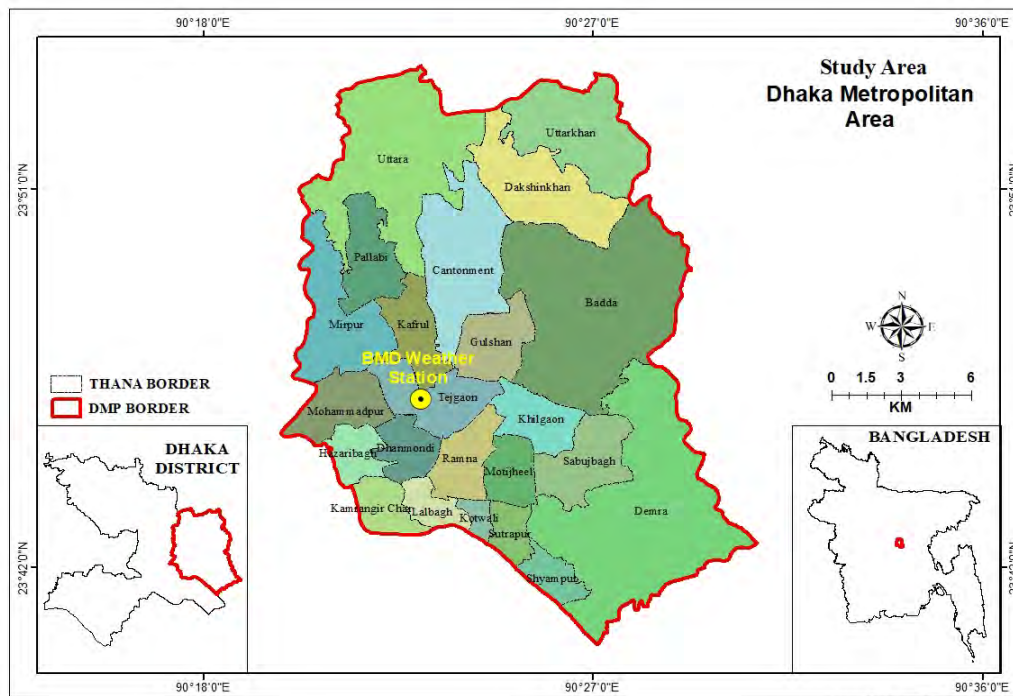
^{*****} Ex. Student Department of Geography & Environment, Jahangirnagar University, Savar Dhaka 1342, Email: palash_geo_ju@yahoo.com

offers the high opportunity to provide a stable, consistent and repeatable methodology, suited equally to both quick pilot studies as well as long term monitoring object, area or phenomenon with the often extensive temporal and spatial coverage available, contributes a marked improvement to traditional fieldwork campaign studies (Tomlinson, Chapman, Thornes, & Baker, 2011). In Remote Sensing, thermal bands of Landsat Satellite images contributes to retrieve temperature from the specific wavelength with Digital Number (DN) that converted into spectral radiance and essence to temperature. This section outlines the theory and the physics behind deriving LST from remote sensing techniques, and covers some fundamental details that need to be understood if data are to be used accurately and usefully for sensing the weather (Dash, Göttsche, Olesen, & Fischer, 2002). Rozenstein, Qin, Derimian, & Kurniati, 2014 further discussed the relation of Land Surface Temperature (LST) with surface energy and water balance, at local through global scales which are principally significant for a wide variety of applications like climate change, urban climate, the hydrological cycle and vegetation monitoring, LST Variation in space and time, measured by Satellite remote sensing, are largely utilized for the estimation and assessment of geophysical variables, such as evapotranspiration, vegetation water stress, soil moisture and thermal inertia. On the other hand, the specification about the sensor and their activities or different platforms can be observed (Tomlinson et al., 2011). Roni, (2013) focused on a sustainable planning with concern of global climate change as well as local micro-climate change due to lack of proper climatic parameters model. According to Valor and Caselles, (1996); Mallick, Kant, & Bharath, (2008); Yu, Guo, & Wu, (2014), air temperature is a necessary quantity for building up many environmental models and there are given examples of energy and water exchange between atmosphere and surface; numerical weather predictions; global ocean circulations; climatic variability etc. From the previous literature of Yang, (2000); Weng (2001); Zhnag et al., (2006); Shei et al., (2011b-2013), Tao, Yong, Hong, Chun-e, & Yuan-jian, (2015); Satellite Remote Sensing, as a recently developed and applicable technique, provides a unique opportunity to observe, monitor, asses and study macroscopically and dynamic-continuous LST in different spatial scales. (Tao et al., 2015) evaluated the Satellite- derived LST data in thermal environment and observational stations' representativeness. The broad aim of this research is to retrieve the Land Surface Temperature from thermal band on Landsat 8 for comparing with Air Temperature collected from weather observatory for estimating a way of extracting temperature values in Dhaka DMP area where weather observatory is absent. In this study, the research has been conducted in the weather observatory location of Bangladesh Meteorological Department (BMD), Dhaka City.

Study Area

In this research, the study area was selected Dhaka Metropolitan (DMP) area, Dhaka District covering the Landsat Image of Path/Row: 137/44, where the selected weather station is situated. Dhaka Metropolitan (DMP) area of Bangladesh is located between latitudes 23°42' and 23°54'N and longitudes 90°20' and 90°28'E and the weather observatory is situated at the point of 23°46' and 90°23'. This point is considered the main criteria of this research as the temperature value and LST value would be compared. The study area map is shown below in Figure 1.

Figure 1: Study Area Map- Dhaka Metropolitan Area



Source: Illustrated by Author

Materials and Methods

The study has been conducted with Satellite image of Landsat 8 which band combinations have two thermal bands-Band 10- Thermal Infrared (TIRS) 1 and Band 11- Thermal Infrared (TIRS) 2, having wavelength of 11.50 - 12.51. Also it needed the Weather Station Database of particular station from Bangladesh Meteorological Department (BMD). The multispectral images of Landsat 8 covering Dhaka district of 3 dates had been collected. Satellite data over Dhaka district of 21st February, 12th May and 20 November of 2018 (day time 10:24am, level-1G product, path/row 137/44) have been used in this study.

Satellite images of three dates of same region were downloaded from USGS website. The band designations of Landsat 8 is given below in Table 1.

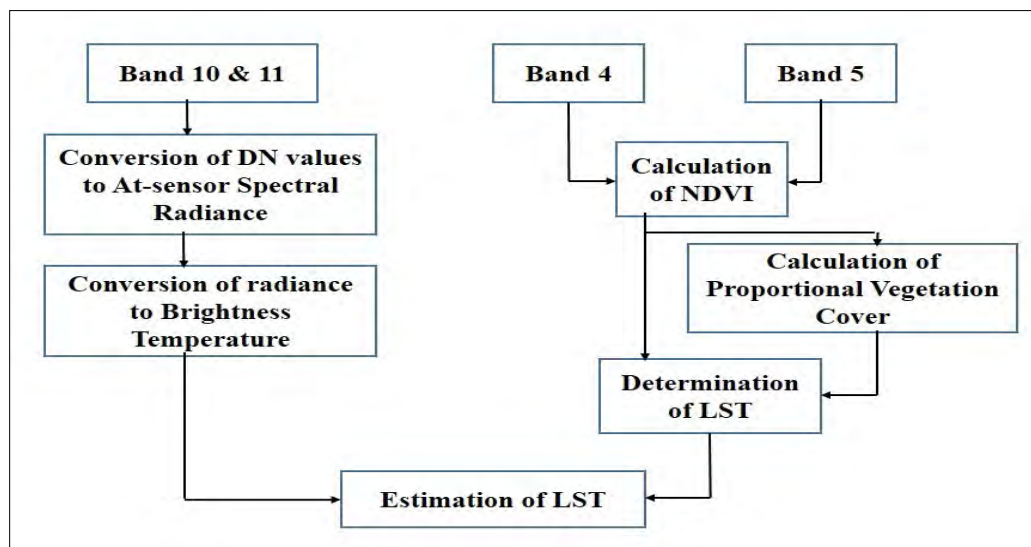
Table 1: Band Designations of Landsat 8

Band Designations	Wavelength (μm)	Resolution (m)
Band 1 (Coastal Aerosol)	0.43 - 0.45	30
Band 2 (Blue)	0.45 - 0.51	30
Band 3 (Green)	0.53 - 0.59	30
Band 4 (Red)	0.64 - 0.67	30
Band 5 (Infrared)	0.85 - 0.88	30
Band 6 (Short wave infrared)	1.57 - 1.65	30
Band 7 (Short wave infrared)	2.11 - 2.29	30
Band 8 (Panchromatic)	0.50 - 0.68	15
Band 9 (Cirrus)	1.36 - 1.39	30
Band 10 (Thermal infrared)	10.6 - 11.19	100
Band 11 (Thermal infrared)	11.50 - 12.51	100

Source: (USGS, 2018)

To fulfill the objectives of the study, various methods are necessary. For the estimation of Land Surface Temperature, it is necessary to enquire some necessary data like air temperature data and secondary information from Satellite Imageries. Some objectives have been set for concluding the factor of estimating LST. Firstly, generating temperature from spectral signatures from selected study area from Landsat thermal band; secondly, integrating remote sensing and weather observatory's data in pixels and ground observatory respectively around the similar localities; and assessing thermal band and field observatory data with validation using Split Window Algorithm. The steps for obtaining the LST of DMP area, following chart in Figure 2 was associated with tasks.

Figure 2: Steps for Retrieving Land Surface Temperature by Split Window Algorithm



Source: Illustrated by Author

Split Window Algorithm

The Split Window Algorithm was first raised by McMillins (Jiménez-muñoz et al., 2014), suggesting the differences in atmospheric absorbance of two bands for the retrieval of Sea Surface Temperature to the letter and according to (Forbearance, 2013) and (Irons, Dwyer, & Barsi, 2012), the two TIRS bands function to enable the atmospheric correction of the thermal data in operating Split Window Algorithm. Caselles, Rubio, Coll, & Valor, 1998 showed the emphasis on using two separate and narrow thermal bands which minimize the error in retrieving the Land Surface temperature. The basic foundation of this algorithm is the attenuation from the radiance for atmospheric absorption which is proportionate to radiance difference at two different wavelengths (José A Sobrino et al., 2008). Then Taylor, Sobrino, Li, Stoll, & Becker, n.d. put emphasis on the mathematical structure for recuperating SW Algorithm.

The algorithm is ((Kamran, Pirnazar, Bansouleh, & Azarbayjan, 2015)):

$$LST = TB10 + C1(TB10-TB11)+C2 (TB10- TB11)^2+ C0 + (C3+C4W) (1- \epsilon) + (C5+C6W) \Delta\epsilon$$

Where,

LST - Land Surface Temperature (K)

From Zhao, Qin, Yang, Xiong, & Qiu, 2005, J A Sobrino & Mattar, n.d. & Taylor et al., n.d., C0 to C6 - Split-Window Coefficient values are found. (Table 2)

TB10 and **TB11** – brightness temperature of band 10 and band 11 (K)

ϵ – Mean LSE of TIR bands

W – Atmospheric water vapor content

$\Delta\epsilon$ – Difference in LSE

Table 2: SW Coefficient Values

Constant	Value
C0	-0.268
C1	1.378
C2	0.183
C3	54.300
C4	-2.238
C5	-129.200
C6	16.400

Source: (Kamran et al., 2015)

From Kamran et al., 2015, the following formulas are collected and utilized for retrieving Land Surface Temperature.

Brightness Temperature (TB)

TB for both the TIRs bands was calculated by the following formula,

$$TB = K2/L[(K1/L\lambda)+1]$$

where,

K1 and **K2**- thermal conversion constant and it varies for both TIR bands (table 3)

L λ – Top of Atmospheric spectral radiance,

Table 3: K1 and K2 Values

Variables	Band 10	Band 11
K1	774.89	480.89
K2	1321.08	1201.04

Source: Metadata of Landsat 8, USGS, 2018

Land Surface Emissivity (LSE)

Calculating LSE is important to retrieving LST of the study area, which is estimated by calculating NDVI.

$$LSE = \epsilon_s (1-FVC) + \epsilon_v * FVC$$

Where, ϵ_s and ϵ_v - soil and vegetative emissivity values of the corresponding bands

For calculating FVC we have to calculate NDVI firstly. The following equation is used to find FVC,

$$FVC = [(NDVI - NDVI_{min}) / (NDVI_{max} - NDVI_{min})]^2$$

$$NDVI = (TIR - RED) / (TIR + RED)$$

Where,

FVC - Fractional Vegetation Cover

NDVI- Normalized Difference Vegetation Index

NDVI max- Maximum of Normalized Difference Vegetation Index

NDVI min- Minimum of Normalized Difference Vegetation Index

After generating LSE for both the bands of TIR, the mean and difference LSE was found as,

$$\epsilon = (\epsilon_{10} + \epsilon_{11})/2$$

$$\Delta\epsilon = \epsilon_{10} - \epsilon_{11}$$

Where, ϵ – Mean LSE

$\Delta\epsilon$ – LSE difference

ϵ_{10} and ϵ_{11} – LSE of band 10 and 11.

Finally, the LST in Celsius was determined using SW algorithm.

LST Validation

Garcia et al in 2006 presented an equation which converted the results into air temperature and that equation helps to do the accuracy assessment (Kamran et al., 2015).

The measured air temperature of weather observatory of BMD located in the study area, compared with the assessed data from the following equation.

$$T_a = 14.6 + 0.44 \cdot T_s$$

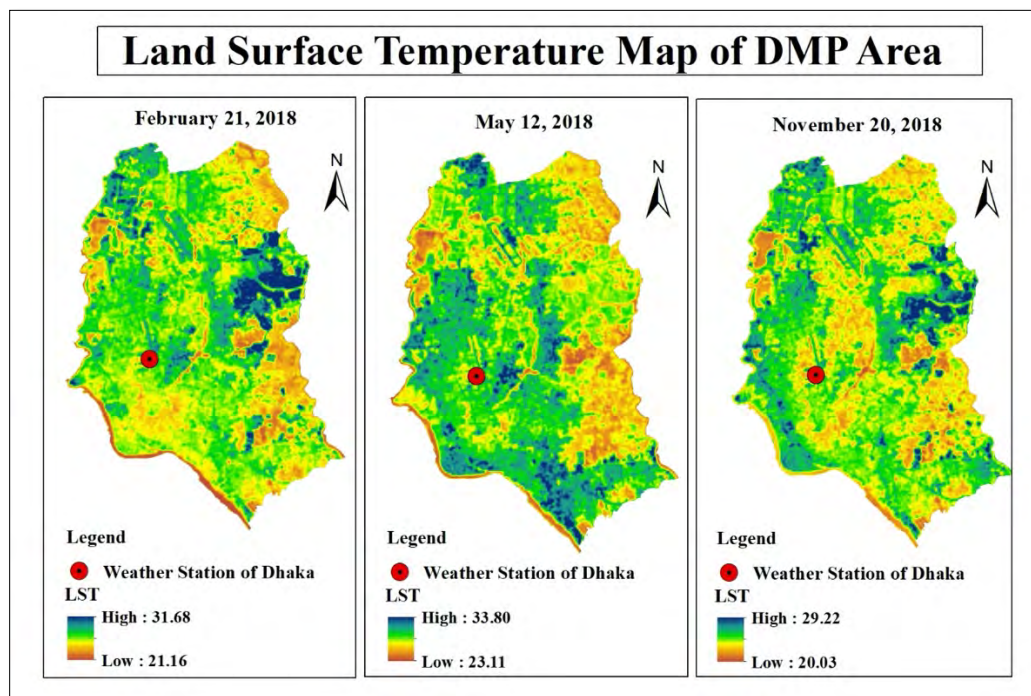
where, T_a - air temperature and T_s - Land Surface Temperature.

Results and Findings

Land Surface Temperature maps of Dhaka DMP area has been obtained in three different dates using Split Window Algorithm, Figure 3 is showing below. The LST mapping had been obtained from calculating the Brightness Temperature, converting DN values to Spectral radiance with the association of assessment of Normalized Difference Vegetation Index (NDVI) and Emissivity from different kinds of Land use and land cover captured by image. As the NDVI was calculated, other formulas hadn't been used. Because of following Split Window Algorithm was developed by calculating NDVI. Additionally, LSE was calculated with minimum and maximum values of NDVI.

On the other hand, emissivity was assessed with the help of NDVI following upper formulas.

Figure 3: LST Mapping of the Study Area



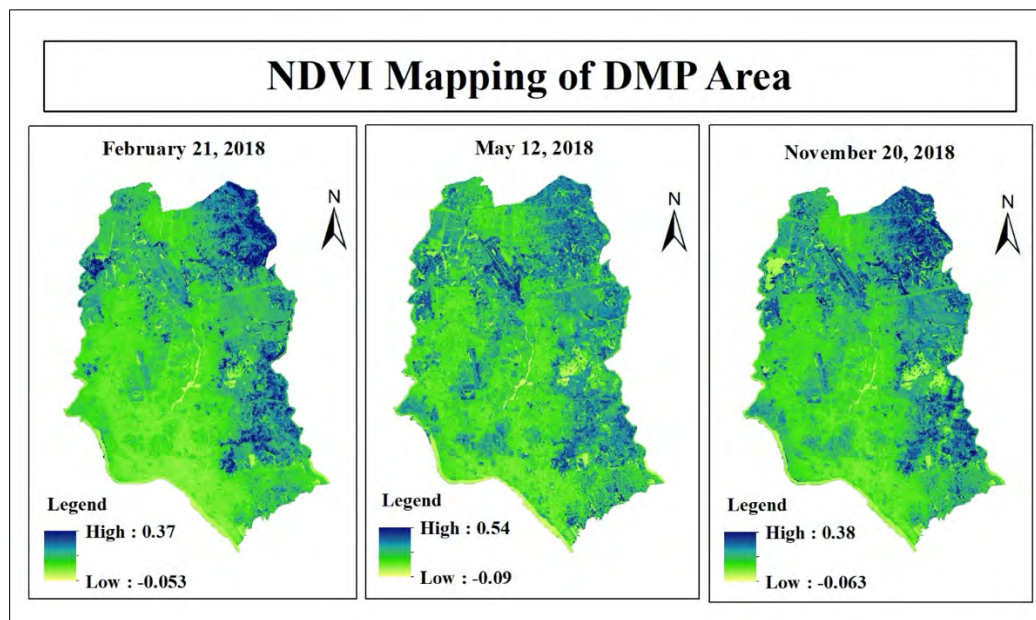
Source: Illustrated by Author

NDVI and Land Surface Emissivity mapping are shown below in Figure 4 and Figure 5 respectively. The three different dates had been chosen for the determination of accuracy obtaining the comparison. As the dates compiled at the study area, these belong to

different seasonal time so the NDVI and Emissivity rate were different. Literally, the background of adopting SW algorithm for retrieving LST and compare with Air temperature from weather observatory had conducted with beneficiaries contents. It would be obvious to collect field observatory data for a large scale regional coverage was quite time consuming and establishing the method of obtaining temperature data with the help of Remote Sensing would be another path for climatic analysis.

The Figure 3, it is shown the whole LST mapping of DMP area rather one location of weather observatory. The three different time had different LST range based on seasonal variations. The LST ranges in February about $\pm 21^{\circ}\text{C}$ to $\pm 31^{\circ}\text{C}$ according to different land cover and land use. Similarly in may and during summer period, it ranged higher that is about $\pm 23^{\circ}\text{C}$ to $\pm 33^{\circ}\text{C}$ and in november, during pre-winter it was lowered which is about $\pm 20^{\circ}\text{C}$ to $\pm 29^{\circ}\text{C}$. As per the mapping, the LST resulted quite similar to the air temperature, that is shown below Table 4.

Figure 4: NDVI Mapping of the Study Area



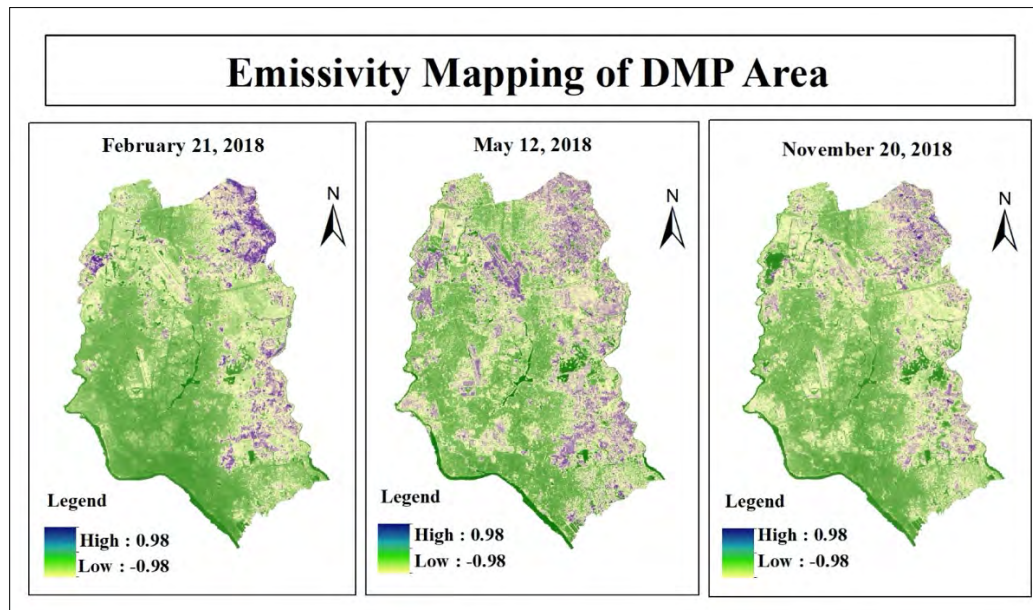
Source: Illustrated by Author

Quantity of vegetation is shown in the NDVI mapping which had a great impact on surface temperature and this impact on DMP area as an urbanized location had lot of emphasis on Emissivity too. That's why emissivity range is quite higher in time of May. LSE had been retrieved for the measurement of LST in the contradictory regards (Jeevalakshmi, 2017).

Figure 4 showing the NDVI mapping of the study area had greater extent NDVI value which varied in time to time because of the different spectral radiance by Red and Infrared bands. The mapping shown declared the majority in May than February and November and this value directly emphasis on Emissivity range. The value of FVC

ranged respectively 0.685 in February, 0.77 in May and 0.69 in November. The LSE difference is very low shown on the map as it ranged in $+0.98$ to -0.98 which had fewer difference on marking the changes in LST.

Figure 5: Land Surface Emissivity (LSE) Mapping of the Study Area



Source: Illustrated by Author

On the contrary, Table 4 shows the comparison between the retrieved values measured with coefficient values, those served massive scattered values to the celcius degree. As per the table, the air temperature data having bigger value than LST. After the conversion of LST to air temperature its difference got lower. On the contrary, the difference carried by results due to different surface changes and Land cover. The result is showing the compared value and final outcome of the result. The mean of difference is about 1.1°C among the values of both sources.

Table 4: Comparison between Air Temperature and LST

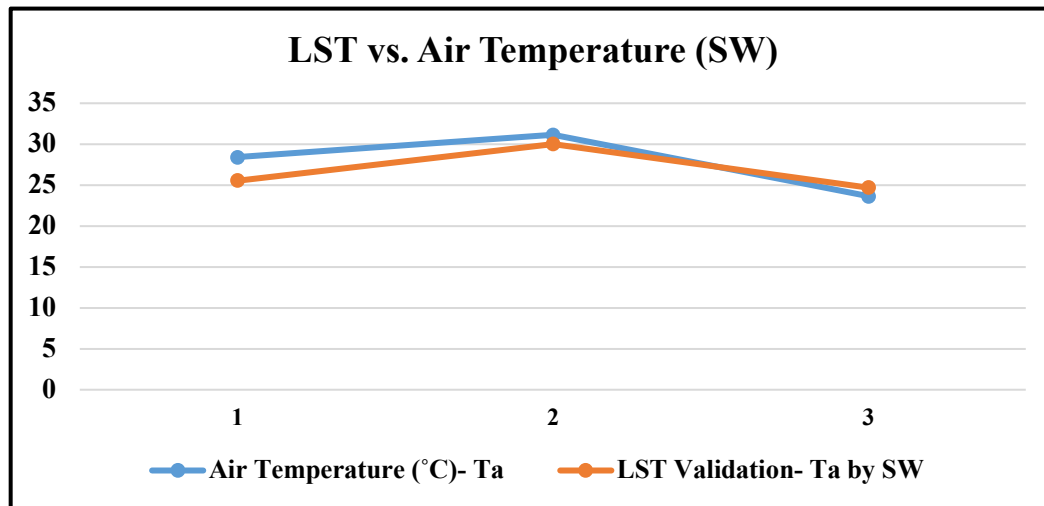
Dates	Air Temperature ($^{\circ}\text{C}$)- Ta	LST Value ($^{\circ}\text{C}$)- Ts	LST Validation- Ta by SW	Difference [Ta (SW)- Ts]
Feb 21, 2018	28.4	24.94	25.57	0.63
May 12, 2018	31.15	29.04	30.01	0.97
Nov 20, 2018	21.65	22.94	24.69	-1.75

Source- Developed by Author

The air temperature carried the bigger value than LST as the NDVI, land use and land cover criteria were not considered in weather observatory. That's why, the validation had

been operated to convert the LST into air temperature and recuperated differences. The simple line graph from Figure 6 represents the curve of accuracy between the thermal terms regarding temperature.

Figure 6: Line Graph of LST vs. Air Temperature (SW)



Source- Developed by Author in Excel

Discussion

The absolute location in one pixel denominating the pixel value of LST. The value estimated from the upper Satellite value in the spectral radiance format. In the contrary, the values are quite similar with less variations. The weather stations only represent the one value ranging large area. But the extensive application and significant importance of temperature in environmental studies and management is the main force driving the study of LST in remote sensing. Under the availability of thermal sensing data anywhere can define the specific regional, area based research for any kind of operational activity. Thus the repositionable database can be acquired and assessed that can re-avoidable for the Meteorological purposes and where the weather stations are not located. The different land covers has different value so one value is quite unappropriated for data analysis and assessment.

The different value is also validated from the comparison and on which the data validation process is operated. After estimating the ground emissivity by the Landsat 8 bands, we retrieved the LST from the image. Both of the temperature value had only $\pm 1.1^{\circ}\text{C}$ error that had been accepted in the mathematical operation in Split Window Algorithm.

Conclusion and Recommendations

From this research, the importance of Land Surface Temperature derivation has been attributed a very significant role. As temperature rising is an alarming issue, detecting temperature using Remote Sensing would support to determine accurate value. That will

help researchers to get data authenticity and comparative analysis has been shown how much differences are captured. This study has brought quite accurate data of temperature, the different formulas are generated and station based information is framed. In future studies, the technique to estimate LST can be altered by considering atmospheric effect and weather conditions of seasonal variations by processing the time series data over our region of interest. And also correlation between NDVI and LST can be demonstrated which helps specifically in urban heat analysis. The research has been done through collecting temperature from thermal bands and mapping of particular weather stations. The data is generated in a specific time that will make the research more defined and sharp. After calculating the data and integration, the result can be in Degree Celsius & the difference is well measured. Thus, the temperature comparison is evaluated. This result will have broad prospect as station-less and remote locations' temperature data can be extracted and analyzed. Satellite-based Land surface temperature (LST) measurements will have a wide variety of applications, including: Climate change, Land/atmosphere feedbacks, Modeling studies, Land cover changes, Crop management, Water management etc. Hopefully, it is another way of collecting temperature in the long run with more terms of Remote Sensing. This study will make further more researches for development of Remote Sensing study in Bangladesh and its application in different sectors.

References

- Caselles, V., Rubio, E., Coll, C., & Valor, E. (1998). $T_s - T_{air} = \frac{q_{net}}{\rho_w C_p} \left(\frac{1}{T_s} - \frac{1}{T_{air}} \right) \left(\frac{1}{T_s} - \frac{1}{T_{atm}} \right)$, 103(section 3), 57–67.
- Dash, P., Göttsche, F. M., Olesen, F. S., & Fischer, H. (2002). Land surface temperature and emissivity estimation from passive sensor data: Theory and practice-current trends. *International Journal of Remote Sensing*, 23(13), 2563–2594. <https://doi.org/10.1080/01431160110115041>
- Forbearance, I. (2013). Remote Sensing, 3776–3802. <https://doi.org/10.3390/rs5083776>
- Irons, J. R., Dwyer, J. L., & Barsi, J. A. (2012). The next Landsat satellite : The Landsat Data Continuity Mission. <https://doi.org/10.1016/j.rse.2011.08.026>
- Jeevalakshmi, D. (2017). Land Surface Temperature Retrieval from LANDSAT data using Emissivity Estimation, 12(20), 9679–9687.
- Jiménez-muñoz, J. C., Sobrino, J. A., Skokovi, D., Mattar, C., Cristóbal, J., & Bands, A. L.-T. (2014). Land Surface Temperature Retrieval Methods From Landsat-8 Thermal Infrared Sensor Data, 11(10), 1840–1843.
- Kamran, K. V., Pirnazar, M., Bansouleh, V. F., & Azarbayjan, E. (2015). Land Surface Temperature retrieval from Landsat 8 TIRS- comparison between Split Window algorithm and SEBAL method, 9535, 1–12. <https://doi.org/10.1117/12.2192491>
- Mallick, J., Kant, Y., & Bharath, B. D. (2008). Estimation of land surface temperature over Delhi using Landsat-7 ETM+, 12(3), 131–140.
- Roni, R. (2013). Surface Temperature and NDVI Generation and Relation between Them : Application of Remote Sensing, 01(01), 5–10.
- Sobrino, J. A., Jiménez-muñoz, J. C., Sòria, G., Romaguera, M., Guanter, L., Moreno, J., ... Martínez, P. (2008). Land Surface Emissivity Retrieval From Different VNIR and TIR Sensors, 46(2), 316–327.

- Sobrino, J. A., & Mattar, C. (n.d.). Calibration and Validation of land surface temperature for Landsat8- TIRS sensor TIRS LANDSAT-8 CHARACTERISTICS.
- Tao, S. H. I., Yong, H., Hong, W., Chun-e, S. H. I., & Yuan-jian, Y. (2015). ScienceDirect Influence of urbanization on the thermal environment of meteorological station : Satellite-observed evidence. *Advances in Climate Change Research*, 6(1), 7–15. <https://doi.org/10.1016/j.accre.2015.07.001>
- Taylor, P., Sobrino, J. A., Li, Z., Stoll, M. P., & Becker, F. (n.d.). International Journal of Remote Sensing Multi-channel and multi-angle algorithms for estimating sea and land surface temperature with ATSR data, (September 2012), 37–41.
- Tomlinson, C. J., Chapman, L., Thornes, J. E., & Baker, C. (2011). Remote sensing land surface temperature for meteorology and climatology: A review. *Meteorological Applications*, 18(3), 296–306. <https://doi.org/10.1002/met.287>
- USGS. (2018). What are the band designations for the Landsat satellites ? Question : Answer :, 4–9.
- Yu, X., Guo, X., & Wu, Z. (2014). Land Surface Temperature Retrieval from Landsat 8 TIRS—Comparison between Radiative Transfer Equation-Based Method, Split Window Algorithm and Single Channel Method, 9829–9852. <https://doi.org/10.3390/rs6109829>
- Zhao, S., Qin, Q., Yang, Y., Xiong, Y., & Qiu, G. (2005). Comparison of two split-window methods for retrieving land surface temperature from MODIS data.

Extracting Building from Very High-Resolution Satellite Image through Object-Based Image Analysis for Dhaka City

Rezaul Roni*

Abstract: Urban complexities can be detected from Very high-resolution (VHR) satellite images and now-a-days VHR reflected as a reliable source of data as well as urban features mapping. Moreover, various methods have been developed to detect urban features especially buildings since the satellite images are available. However, it becomes very difficult to extract building's roof for the cities of developing countries such as Dhaka due to heterogeneities of structures. The main aim of this study was how could buildings be extracted using VHR through a multi-resolution segmentation process in the object-based image analysis method and a rule set was used to extract buildings from World View 2 imagery for Dhaka city. The result indicated that the overall accuracy was 77.75% through error matrix calculation. Furthermore, the rules did not performed well in all the places at a time due to heterogeneity of the spectral and spatial resolution of the study area. Future research may include incorporating more rules and integrated methods to detect the buildings from VHR for this type of complex city.

Keywords: Urban Buildings, VHR Images, OBIA Classification, Dhaka.

Introduction

Buildings are main man-made urban features for a city. VHR satellite images can detect urban complexities and potentially reflected as a reliable source of urban features mapping (Ural, Hussain, & Shan, 2011). Various methods have been conducted to detect buildings using different methods from VHR images. For example, Salah et al. (2009) used Self-Organizing Map (SOM) on VHR images to generate attributes of buildings with a series of image processing techniques. A combination of OBIA and threshold-based approach was applied on VHR and LiDAR data to detect buildings, where the threshold values were set by Normalized Difference Vegetation Index (NDVI) and Normalized Digital Surface Model (nDSM), referring to the presence of vegetation and the height of buildings, respectively (Hermosilla et al., 2011). A combination of clustering and edge detection techniques were used to extract buildings from high-resolution panchromatic QuickBird images, where buildings were separated by selecting histogram threshold in the cluster and they were refined by edge detection techniques (Wei, Zhao, & Song, 2004). Ok (2013), Li et al. (2017) and Ma et al. (2017) conducted a detailed study on previous research on building detection. Thereafter, the authors listed several methods for buildings detection including morphological features (MFs) (Pesaresi & Benediktsson, 2001), fuzzy pixel-based classifier (Shackelford & Davis, 2003), graph-based approach (Kim & Muller, 1999; Huyck et al., 2005; Katartzis & Sahli, 2008), Scale invariant feature transform (SIFT) and graph tools (Sirmacek & Unsalan, 2009), spectral textural (Miura, Midorikawa, & Soh, 2012), support vector machine (SVM) (Fauvel &

* Associate Professor, Department of Geography and Environment, Jahangirnagar University, Email: georoni31@juniv.edu, Mob: +8801716049335

Benediktsson, 2008; Koc-San & Turker, 2014), Morphological building index (MBI) (Huang & Zhang, 2012), conditional random forest (CRF) (Li et al., 2015). Despite this diversity of methodologies proposed for building extraction, none has so far proved to be effective in all conditions and for all types of data (Salah et al. 2009). Extracting buildings from VHR images with high accuracy remains a challenging task (Freire & Santos, 2012). Moreover, various remote sensing characteristics such as spectral range, number of bands, sensor types and spatial resolution play a very important role in detecting buildings. Furthermore, the image classification techniques vary depending on areas and complexities as every urban environment has its own unique spectral characteristics (Herold, Gardner, & Roberts, 2003).

The urban and suburban area is continuously changing due to the construction of new infrastructures. Therefore, GIS database needs to be updated accordingly. Traditionally updating task is done through photo interpretation or physical feature survey, which is a very expensive and time-consuming task (Hermosilla et al., 2011). OBIA method could be one of the effective solutions to detect the buildings from VHR satellite images and could minimize those constraints. Several images classification studies have demonstrated that OBIA method is an alternative to pixel-based classification methods (Blaschke & Strobl, 2001). The OBIA called as a sub-discipline of GIScience by Hay and Castilla (2006), produce visually perceptible image objects from satellite images, which were typically represented by clusters of similar neighboring pixels that share a common referent or meaning (Chen et al., 2018). It assesses the spatial and spectral characteristics of a pixel during the classification process. OBIA can replicate visual interpretation of satellite images in both automated and semi-automated ways, which increases productivity and reduce labor and time consumption. The OBIA technique starts with a segmentation process where an image is divided into regions based objects with specific user-defined parameters (Hamedianfar et al., 2014). In this study, bottom-up image segmentation process was adopted (figure 1).

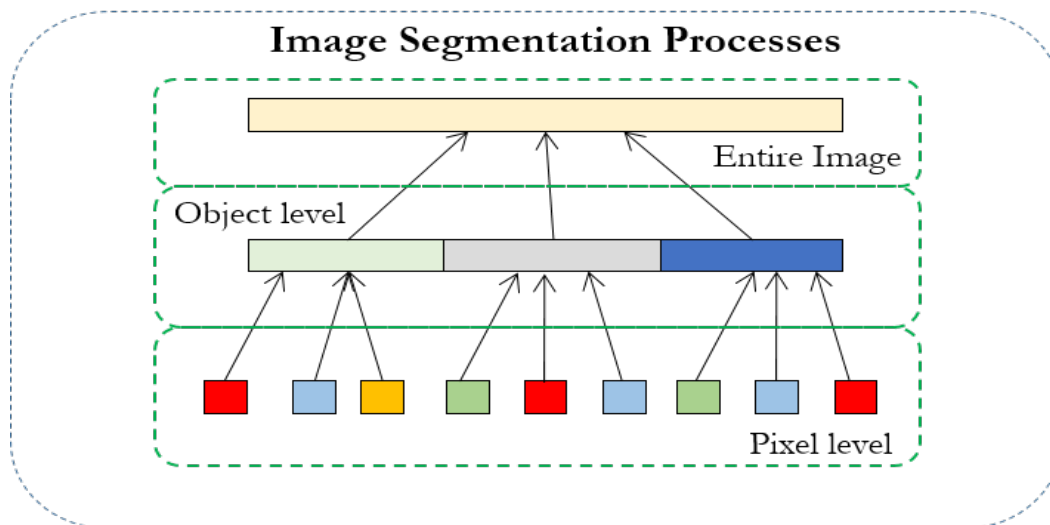


Figure 1: A generalized bottom-up segmentation processes (Lein, 2012).

Munoz et al (2003) describe advantages and disadvantages of different segmentation methods and state that there is no single perfect segmentation procedure to detect objects. Multi-resolution segmentation is the main basic process in the software eCognition to fragment VHR images at multiple scales. The scale of the segmentation controls the heterogeneity of image objects. Determining the optimal scale parameters is challenging task to represent exact objects (Baatz & Schäpe, 2000; Johnson et al., 2015). A lower value will give too many small segments, referred to as over-segmentation, and a higher value will give larger segmented areas, referred to as under-segmentation. In this study, the multi-resolution segmentation algorithm (Baatz & Schäpe, 2000) in eCognition developer software (version 9) was performed. Mismatches between the target object and over- or under-segmented area lead to irrelevant features (Troya-Galvis et al., 2015). As a result, both over and under-segmentation could reduce the classification accuracy. Therefore, the optimum scale for segmentation depends not only on the shape and size of targeted objects (Tian & Chen, 2007) but also on the complexity of the scene. Ziaei et al. (2014) found in his study that, the rule-based system can give better accuracy than support vector machine (SVM) or nearest neighbor (NN). OBIA with random forest (RF) or OBIA with Artificial Neural Network (ANN) also can have better results than rule-based system but they need lots of input variables and training samples. Rule-based classification is one of the common image classification methods, which works on user-defined rules (Ziaei et al., 2014). However, the rules development is the most challenging task to identify the target features as the characteristics of urban features vary from each other's (Zhang & Zhu, 2011). Sometimes brightness or other characteristics such as spatial, spectral, textural features of images objects with NDVI may form a rule set together. Furthermore, rule set building depends on human knowledge on the specific study area and specific characteristics and attributes of target features of that area (Hamedianfar & Shafri, 2015, Ziaei et al., 2014). With the increasing availability of VHR (less than or 1m) such as IKONOS (launched in 1999), QuickBird (2001), OrbView (2003) or WorldView (2007) sensors, OBIA started to be used by remote sensing community for a wide variety of applications (Blaschke, 2010). VHR images help to identify very small detectable objects which are larger than the spatial resolution of the image within heterogeneous urban areas. Sometimes it creates confusion on similar man-made objects in different places due to lack of contextual information of neighborhood pixels (Zhao, Du, Wang, & Emery, 2017).

Considering the advantages of VHR and OBIA techniques, the main goal of this research is to develop a method to detect buildings from complex structural setup like Dhaka city. As a result, the answer of the following research questions was tried to find- Which building extraction method could be used for Dhaka city and how accurate that method for the study area?

Study area

Dhaka is the capital city of Bangladesh and has a long history of 400 years. It is located on the bank of Buriganga river and surrounded by others six rivers such as Balu and Sitalakhya on the eastern side, Turag, and Buriganga on the western side, Tongi *Khal* to the north and Dhaleshwari to the south (Zaman, 2017). There is no clear evidence of the

exact time of starting of settlement at this area where present Dhaka is located (Ahmed et al., 2014). However, it is assumed that human settlement as urban growth center started here from the seventeenth century. From that period, Dhaka faced five different period, which has different contribution to its development and the periods are - Pre-Mughal Period (Before 1604), Mughal Period (1602–1764), British Period (1764–1947), Pakistani Period (1947–1971) and Bangladesh Period (Since 1971) (Chowdhury & Faruqui, 2009).

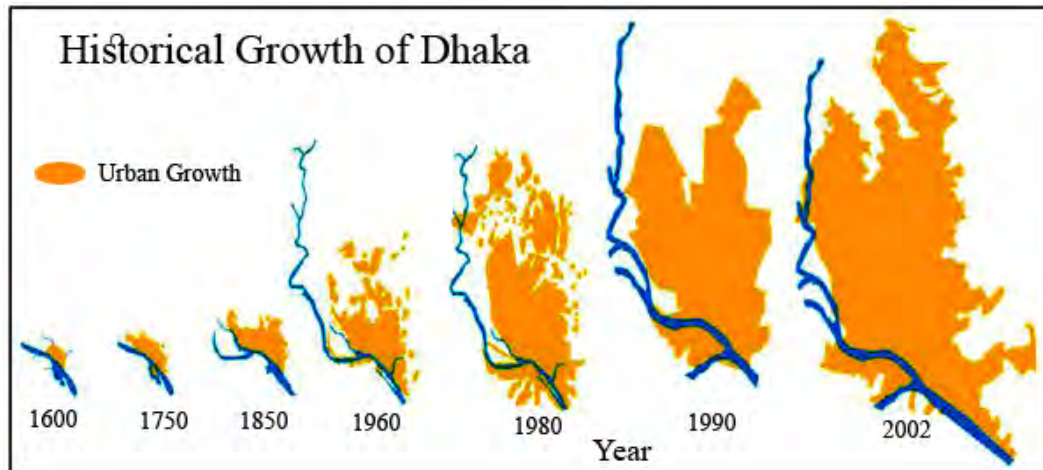


Figure 1: The Historical growth of Dhaka City from the 16th century. Source: Urban Planning Department, Dhaka City Corporation, 2004.

Figure 2 shows the physical extent of the Dhaka city at different periods. It was established as Municipality in 1864 and the name was replaced to Dhaka Municipal Corporation in 1983 and finally in 1991, to Dhaka City Corporation (BBS, 2011a). Now, Dhaka City Corporation (DCC) has two parts (Dhaka North and Dhaka South) with 136.34 km² and consists of 92 wards. Dhaka North City Corporation (DNCC) consists of 36 wards, which covers 82.638 km² and Dhaka South City Corporation (DSCC) consist of 56 wards, which covers 43.7 km² (BBS, 2011). Figure 3 shows the location of the study area as compared to Dhaka Zila and surrounding areas.

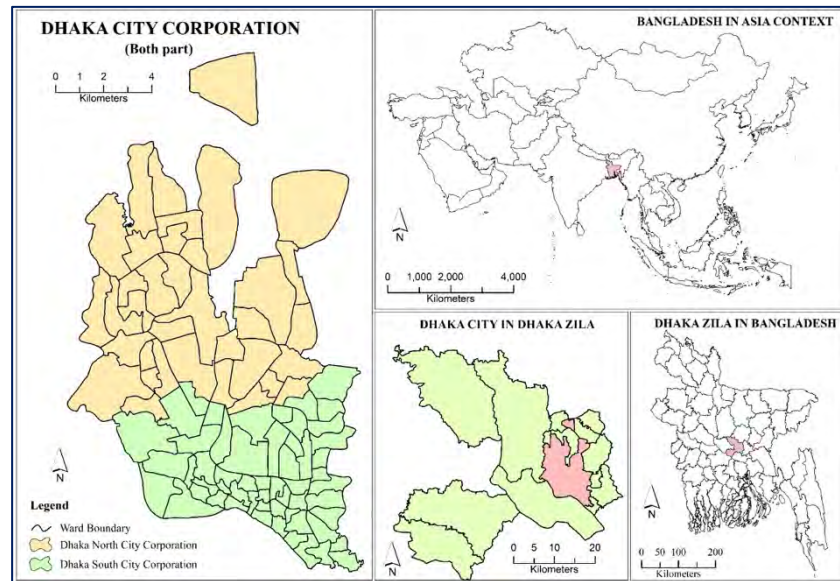


Figure 2: Location map of the study area in the context of Zila, Bangladesh and Asia

Data and Methods

Very high-resolution satellite image (VHR)

We select WorldView-2 (WV2) image to extract the buildings for Dhaka City. WV2 has one panchromatic (450-800 nm) band with a resolution of 0.50 meter and eight multi-spectral bands (blue, coastal blue, green, yellow, red, red edge, NIR, NIR2) with a spatial resolution of 2 meters for enhanced multispectral analysis (Figure 4). Together they are designed to improve classification of land and aquatic features beyond any other space-based remote sensing platform (WorldView-2, 2017). The spectral characteristics of the WV2 image are given in table 2. European Space Agency (ESA) provided the image used in this research.

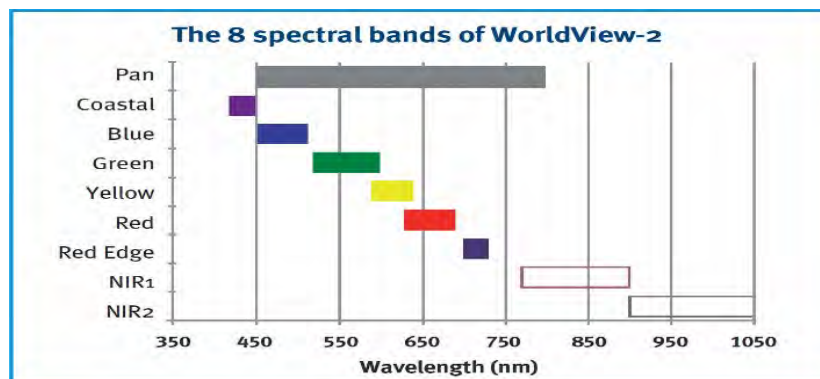


Figure 4: Various wavelength of the multispectral image of WorldView2 with 8 bands.

Source: <https://content.satimagingcorp.com/static/galleryimages/worldview-2-satellite-spectral-bands.jpg>

Table 2: Characteristics of the WorldView2 Image used in this research.

Acquisition date	: 2017-05-15	Resolution	
Image Clouds	: 7.0%	Panchromatic	: 0.50 meter
Image Nadir	: 15.6°	Multispectral	: 2.0 m
Bands	: 8	Image Extent:	
Max GSD	: 0.49m	Top	: 23.88444°
Sun Elevation	: 72.5°	Bottom	: 23.68083°
Max Target Azimuth	: 277.4°	Left	: 90.32556°
		Right	: 90.45389°

Image pre-processing

The image was obtained from an ortho-rectified and radio-metrically corrected by the DigitalGlobe. A high pass filter (HPF) pan-sharpened method was used for enhancing the spatial resolution as it could help to detect both buildings and shadows (Li et al., 2015). The resulting pan-sharpened image not only maintained the original spectral resolution from multispectral bands but also obtained the same spatial resolution of the panchromatic band (i.e. 0.5m). Figure 5 shows the sample of panchromatic, multispectral band and the result of the pan-sharpened image. Spectral enhancement technique was not implemented here during image pre-processing.

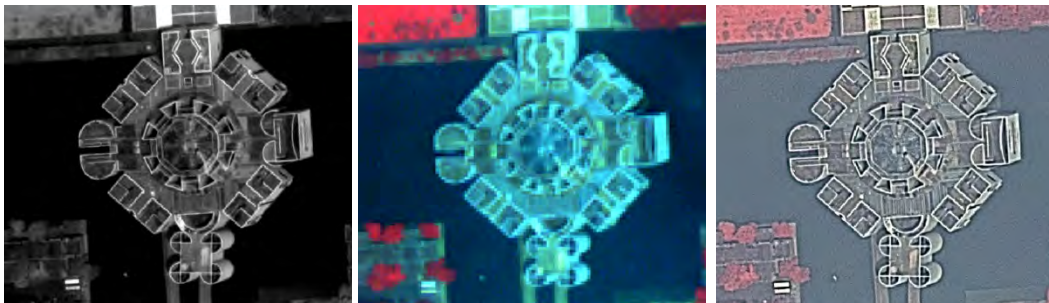


Figure 5: Result of pan-sharpened by HPF method. A panchromatic band with a resolution of 0.5m (left), multispectral bands with a resolution of 2m (middle), and the resulting pan-sharpened image with a resolution of 0.5m (right) through HPF method.

Object-based Image Analysis (OBIA) for buildings extraction

OBIA can incorporate not only spectral, but also textural and spatial information during the classification process, and therefore, it can contribute to distinguishing similar objects from the others (e.g. buildings, roads, etc.). Considering these advantages, in this study, a multi-resolution segmentation process and a rule sets were used in OBIA method to extract the buildings for Dhaka city. A detailed buildings extraction process is described in figure 6.

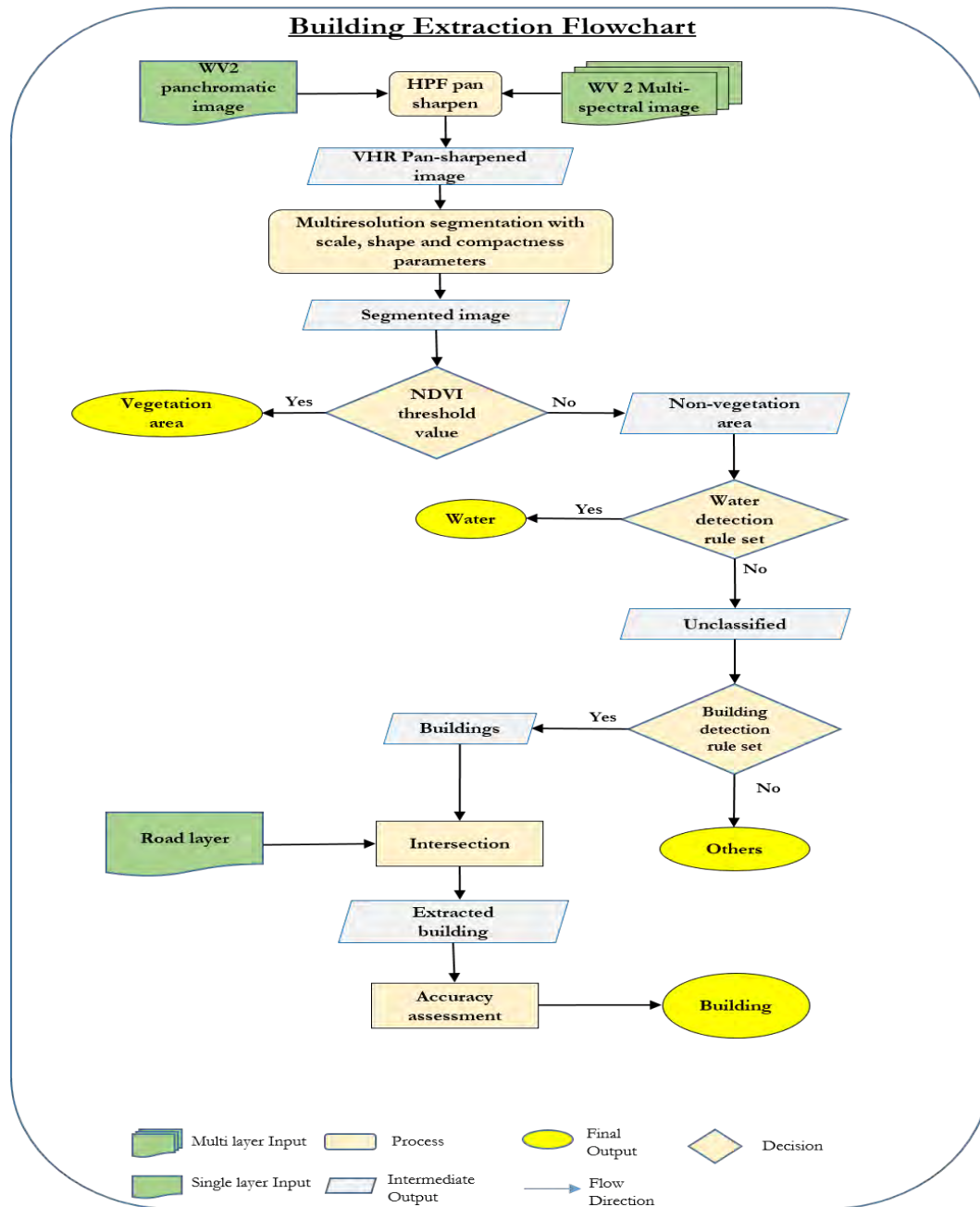


Figure 6: A detail methodological flow chart for building extraction process from WorldView 2.

Image segmentation process

The multi-resolution segmentation process starts with an iterative process of local optimization based on homogeneity of the created segments. The measure of homogeneity depends on two components - spectral and spatial component. The spectral homogeneity called as “*shape*”, is defined by the spectral reflectance of the pixels within the segment. A lower value indicates the higher influence of color on the segmentation process. Since the color of building roof can play a very important role in detecting the building from the image, the value for *shape* was set to 0.2. Spatial homogeneity is based on two attributes – *scale* and *compactness*. Different *scale* parameters were tried including 10, 20, 30, 40, and 50 for segmentation, and finally, 30 was fixed by the visual interpretation of the segmentation results. Figure 7 shows the effects of different scale parameters on the same image of the study area.

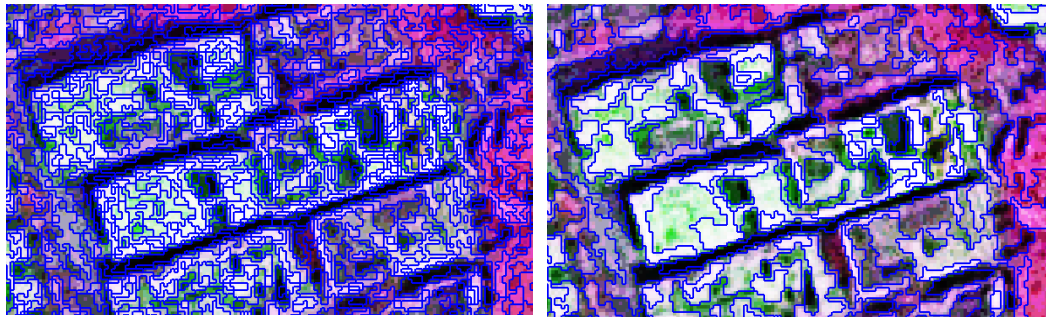


Figure 7: Segmented images (buildings) with various scale (left image 10, right image 30), shape and compactness parameters are 0.2 and 0.8 for both images respectively.

In addition, the *compactness* is defined by a value which indicates the closeness of objects to each other. A higher value of compactness means objects are more compact. The characteristics of buildings of the study area are more blocked and hence the value was set to 0.8.

Rule-based classification and rule-set development

In this study, buildings are the main target to extract. Buildings are very complex in size and have different textural character due to different spectral reflectance. Therefore, a hierarchical classification process was followed to classify the image into vegetation and non-vegetation area, then again non-vegetation area into the water, buildings and others classes (the remaining unclassified area). In this study, various indices/rules such as NDVI, Normalized Difference Water Index (NDWI) (Gao, 1996), Green band ration (RatioG), image brightness value (level of spectral radiance e.g., 2^{16} bit = 65536 level), mean spectral reflectance value from green (MeanB3) band within the segmented area and value of relation to building (closeness to previously classified building) were used during the development of rules set (Table 3 and Table 4). Finally, by defining these rules and constraints, the desired features classes were classified.

Table **Error! No text of specified style in document.**: The indices used for defining the rule set of OBIA.

Name	Formula	Descriptions
Normalized Difference Vegetation Index (NDVI)	$\frac{NIR1 - Red}{NIR1 + Red}$	To distinguish the vegetation from other classes
Normalized Difference Water Index (NDWI)	$\frac{Green - NIR1}{Green + NIR1}$	To identify the water bodies from other classes
RatioG	$\frac{Green}{Blue + Green + Red + NIR1}$	To identify the building's roof

Table 4: The image characteristics, which were used to classify different target object.

Parent class	Finer class	Rules and Constraints
WV2 image	Vegetation	$0.23 < NDVI$
	Non-Vegetation	$NDVI \leq 0.23$
Non-Vegetation	Water	$0.1 \leq NDVI < 0.15$ AND $0.3 < NDWI < 0.4$ AND $325 < \text{brightness} < 350$ AND Number of pixel > 500
	Buildings	$0.18 < \text{RatioG} < 0.32$ AND $470 < \text{MeanB3} < 510$ AND Brightness > 440 $0.32 < \text{RatioG} < 0.36$ AND $470 < \text{MeanB3} < 510$ AND Brightness > 390 AND Relation to Buildings = 1 $0.42 < \text{RatioG} < 0.55$ AND $470 < \text{MeanB3} < 510$ AND $150 < \text{brightness} < 390$ AND Relation to Buildings > 0.5 $0.32 < \text{RatioG} < 0.68$ AND $470 < \text{MeanB3} < 510$ AND $150 < \text{brightness} < 460$ AND Relation to Buildings > 0.8 $0.1 < \text{RatioG} < 0.25$ AND $510 < \text{MeanB3} < 530$ AND Relation to Buildings > 0.2 AND Brightness > 650
	Others	Unclassified

Accuracy assessment of building extraction

The accuracy assessment of extracted buildings was performed by comparing classification results with reference data, which were collected from the visual interpretation of the study image using a random sampling method. Congalton (1991) suggested to have 75-100 samples for each class if the image covers a large area or the classified image has a large number of LULC categories, such as more than 12 classes. Hashemian et al. (2004) found that accuracy results were stable for the large study area if

the sample size was approximately 70 for each class. However, this study area covers a very large area with 136 sq.km and the image was classified into four classes (i.e., buildings, water, vegetation, and others), so the reference sample size was fixed at 400 in total and 100 for each class. The accuracy of the building extraction by OBIA was evaluated in terms of error matrices from overall, producer's and user's accuracies (Congalton, 1991), and kappa coefficient (Cohen, 1960).

Result and Discussion

The standard value of accuracy is 85 % and nowadays this value is used widely in thematic mapping through image classification (Congalton & Green, 2009; Foody, 2008). The classification result is shown in table 5, where the overall classification accuracy is 77.75%. The average producer's accuracy for the classification was 81.31% and average user's accuracy was 77.75%. Vegetation has highest accuracy value in both producer's and user's accuracy with 100% and 96 % respectively. This means OBIA has a high potential to extract the vegetation area from VHR image with NDVI indices and segmentation with a certain scale. The next highest accuracy was water with 92.98% though the user's accuracy shows very poor of 53%. As mentioned earlier, there was some confusion between water and other urban features such as buildings and roads, which reflected on this matrix. Out of 100 samples 47 number of samples (11 samples in buildings and 36 samples in others) we misclassified as others category. The reason behind that is the materials of building roofs. Every building has a water tank on top of the roof, which sometimes overflows and fills with water. In addition, the buildings, which besides another tall building may affect with shadow. The shadow and water reflect very low same as water and caused confusion between water and buildings.

Table 5: Classification results for the OBIA of Dhaka City.

		Reference data					
Classification data	Class Name	Buildings	Others	Vegetation	Water	Total	User Accuracy (%)
	Buildings	85	15			100	85
	Others	19	77		4	100	77
	Vegetation		4	96		100	96
	Water	11	36		53	100	53
	Total	115	132	96	57	400	
	Producer Accuracy (%)	73.91	58.33	100.00	92.98	Overall Accuracy 77.75 % Kappa Coefficient 0.76	

The producer's accuracy achieved for buildings was 73.91% and user's accuracy was 85%. The value of the producer's accuracy metric is relatively low due to some reasons. Firstly, the spectral reflectances of building's roofs were misclassified with roads and sometimes with water bodies because the building's roofs are made of concrete and the brightness were very low. The various parameters which were used for buildings detection such as brightness, mean band 3 value, green band ratio did not perform well

enough as the reflectance characteristics of the buildings were very close to other urban features such as parking areas, bare ground, roads etc.

Secondly, Dhaka city has a practice of roof gardening which increased the challenge of building's roof identification as they were categorized as vegetation area. Figure 8 shows examples of roof gardening from the city.

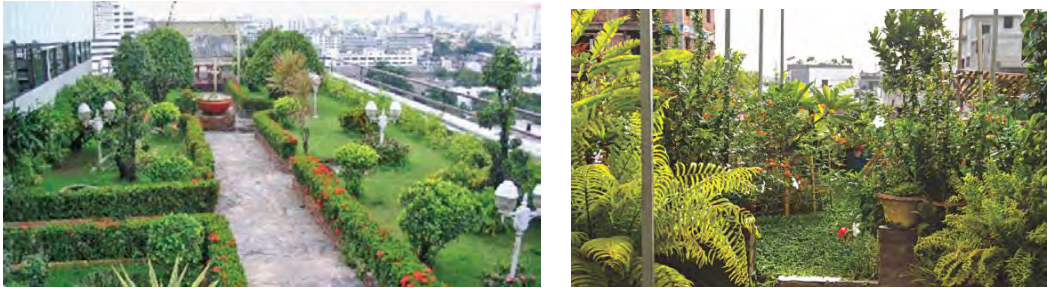


Figure 8: Some nature of roof gardening on top of the building's roof in Dhaka City. Source: left image (Karim, 2017), right image (Jahan, 2016).

Furthermore, the accuracy of building detection depends on the parameters of multi-resolution segmentation during the building detection process as well. These parameters such as scale, shape, compactness were set in trial and error method through visual interpretation of the result and applied over the entire study area at once. Sometimes the buildings were over-segmented or under-segmented during the segmentation process (figure 9). The rule worked very well on buildings of some part of study area but it got worse on another part by either over-segmenting or under-segmenting the objects. This error is called segmentation error. This error decreases the accuracy of building detection.

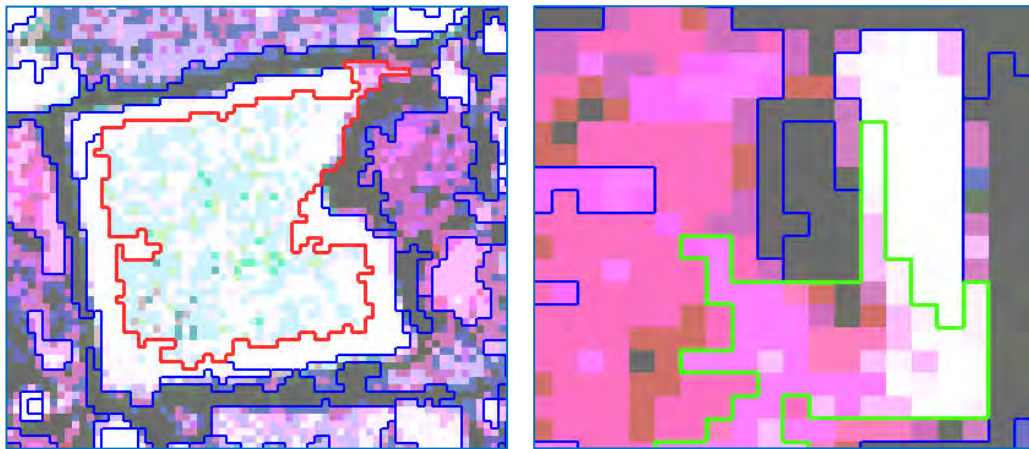


Figure 9: Visualization of over-segmented and under-segmented error of building detection. Left image: red line corresponding to over-segmentation result, whereas the whole white color represents the building. Right image: green line corresponding to under segmentation result, whereas some portion of the building (white color) was merged with other urban features (purple color).

Finally, the geometrical shape of the building was not as perfect as the real object. The rule set was design based on spectral and spatial characteristics such as a number of pixels and neighborhood pixels of the objects from the image. The rule set performed on entire study area at once and may have an error for detecting building in a perfect shape. These geometrical shape of the buildings caused the error for calculation of building area.

The main target for this OBIA was building's roof identification, whereas the remaining classes were categorized as "others" class. The producer's accuracy for this class was very poor with 58.33%, which indicates the complexity of study area. Some of them were misclassified as roads, buildings, and water because of similarity in their spectral reflections. As a consequence, it was a challenging task to separate them from buildings. Therefore, the ancillary data road layer was used to separate them from buildings and marked as others category.

The overall accuracy with 77.75% and kappa coefficient with 0.76 indicate the satisfactory result for a complex city like Dhaka city. Sometimes various communities produce maps with low accuracy to fulfill the specific demand or fit for purpose. This low accuracy may be accepted in remote sensing considering the complexity of the study area (Foody, 2008).

Conclusion

VHR satellite image is very helpful to detect the urban features such as buildings, roads, and other impervious areas. Previously, medium to the low-resolution image was used only to extract urban land cover or impervious areas. However, the various small object such as buildings, trees, roadside small objects etc. are being started to extract when the VHR images are available. Various VHR images such as WorldView2/3, Ikonos, QuickBird etc. have a different number of bands with different wavelengths focusing on different objects on the ground. In addition, all the objects in the urban area do not have same spectral reflectance and same spatial extent. Moreover, they vary from different urban areas and various methods were developed to extract different complex objects of urban areas. OBIA method is one of them and was selected to extract the complex buildings from the WorldView2 image for Dhaka city. A multi-resolution segmentation process was performed and a set of rules were used to classify the image into four urban land cover classes such as vegetation, water, buildings and other areas as the main target was the building detection. Though the urban scene was very complex and various confusion was found between buildings with roads, another road layer (vector) was used as ancillary data to reduce the misclassification. Though the buildings were not geometrically regular shaped, the accuracy was found 77.75% with the kappa coefficient of 0.76 for the study area.

References

- Ahmed, S. J., Nahiduzzaman, K. M., & Bramley, G. (2014). From a town to a megacity: 400 years of growth. In A. Dewan & R. Corner (Eds.), *Dhaka Megacity: Geospatial Perspectives on Urbanisation, Environment and Health* (p. 423). Dordrecht Heidelberg: Springer New York.

- Ahmed, Sharif Uddin. (1986). *Dacca: a study in urban history and development*. The University of Michigan, USA: Curzon Press.
- Baatz, M., & Schäpe, A. (2000). Multiresolution segmentation: An optimization approach for high quality multi-scale image segmentation. In J. Strobl, T. Blaschke, & G. Griesebner (Eds.), *Angewandte Geographische Informations- Verarbeitung XII*. 12–23. Karlsruhe, Germany: Wichmann Verlag.
- Bangladesh Bureau of Statistis, (BBS). (2011a). *Population & Housing Census-2011, National volume 3: Urban Area Report*. Bangladesh Bureau of Statistics, Ministry of Planning, Dhaka.
- Bangladesh Bureau of Statistis, (BBS). (2011b). *Population and housing census 2011:National Report, Volume-1, Analytical Report*. Bangladesh Bureau of Statistics, Ministry of Planning, Dhaka.
- Blaschke, T. (2010). Object based image analysis for remote sensing. *ISPRS Journal of Photogrammetry and Remote Sensing*, 65(1), 2–16. <https://doi.org/10.1016/j.isprsjprs.2009.06.004>
- Blaschke, Thomas, & Strobl, J. (2001). What' s wrong with pixels ? Some recent developments interfacing remote sensing and GIS. *GeoBIT/GIS*, 6(1), 12–17.
- Chen, G., Weng, Q., Hay, G. J., & He, Y. (2018). Geographic object-based image analysis (GEOBIA): Eemerging trends and future opportunities. *GIScience & Remote Sensing*, 55(1), 1–24. <https://doi.org/10.1080/15481603.2018.1426092>
- Chowdhury, A., & Faruqui, S. (2009). Physical growth of Dhaka city. In S U Ahmed (Ed.), *Dhaka: past present future* (2nd ed., pp. 56–76). Dhaka: The Asiatic Society of Bangladesh.
- Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20(1), 37–46. <https://doi.org/10.1177/001316446002000104>
- Congalton, R. G. (1991). A review of assessing the accuracy of classifications of remotely sensed data. *Remote Sensing of Environment*, 37(1), 35–46. [https://doi.org/10.1016/0034-4257\(91\)90048-B](https://doi.org/10.1016/0034-4257(91)90048-B)
- Congalton, R., & Green, K. (2009). Thematic accuracy. In R. Congalton & K. Green (Eds.), *Assessing the accuracy of remotely sensed data: principles and practices* (2nd ed., p. 56). Boca Raton: CRC Press, Taylor & Francis Group.
- Fauvel, M., & Benediktsson, J. (2008). Spectral and spatial classification of hyperspectral data using svms and morphological profile. *IEEE Transactions on Geoscience and Remote Sensing*, 46(11), 3804–3814. <https://doi.org/10.1109/TGRS.2008.922034>
- Foody, G. (2008). Harshness in image classification accuracy assessment. *International Journal of Remote Sensing*, 29(11), 3137–3158. <https://doi.org/10.1080/01431160701442120>
- Freire, S., & Santos, T. (2012). Extraction of buildings in heterogeneous urban areas: Testing the value of increased spectral information of WorldView-2 imagery. *Computational Modelling of Objects Represented in Images III: Fundamentals, Methods and Applications*, 2, 175. Retrieved from https://books.google.at/books?hl=de&lr=lang_de%7Clang_en%7Clang_fr%7Clang_it%7Clang_es&id=Z5ph3owFbMEC&oi=fnd&pg=PA175&dq=worldview-2+vegetation&ots=Zqfc4w9fKn&sig=RD_RgFcw7cZWazea596Ur6C-NMg
- Gao, B. C. (1996). NDWI - A normalized difference water index for remote sensing of vegetation liquid water from space. *Remote Sensing of Environment*, 58(3), 257–266. [https://doi.org/10.1016/S0034-4257\(96\)00067-3](https://doi.org/10.1016/S0034-4257(96)00067-3)

- Hamedianfar, A., & Shafri, H. Z. M. (2015). Detailed intra-urban mapping through transferable OBIA rule sets using WorldView-2 very-high-resolution satellite images. *International Journal of Remote Sensing*, 36(13), 3380–3396. <https://doi.org/10.1080/01431161.2015.1060645>
- Hamedianfar, A., Shafri, H. Z. M., Mansor, S., & Ahmad, N. (2014). Improving detailed rule-based feature extraction of urban areas from WorldView-2 image and lidar data. *International Journal of Remote Sensing*, 35(5), 1876–1899. <https://doi.org/10.1080/01431161.2013.879350>
- Hashemian, M. S., Abakar, A. A., & Fatemi, S. B. (2004). Study of sampling methods for accuracy assessment of classified remotely sensed data. *20th International Society for Photogrammetry and Remote Sensing Congress*, 12–23.
- Hay, G. J., & Castilla, G. (2006). Object-based image analysis: strengths, weaknesses, opportunities and threats (SWOT). *International Archives of Photogrammetry Remote Sensing and Spatial Information Sciences*, 36, 4. https://doi.org/10.1007/978-3-540-77058-9_4
- Hermosilla, T., Ruiz, L. A., Recio, J. A., & Estornell, J. (2011). Evaluation of automatic building detection approaches combining high resolution images and LiDAR data. *Remote Sensing*, 3(6), 1188–1210. <https://doi.org/10.3390/rs3061188>
- Herold, M., Gardner, M. E., & Roberts, D. a. (2003). Spectral resolution requirements for mapping urban areas. *IEEE Transactions on Geoscience and Remote Sensing*, 41(9), 1907–1919. <https://doi.org/10.1109/TGRS.2003.815238>
- Huang, X., & Zhang, L. (2012). Morphological building/shadow index for building extraction from high-resolution imagery over urban areas. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 5(1), 161–172. <https://doi.org/10.1109/JSTARS.2011.2168195>
- Huyck, C. K., Adams, B. J., Cho, S., Chung, H.-C., & Eguchi, R. T. (2005). Towards rapid citywide damage mapping using neighborhood edge dissimilarities in very high-resolution optical satellite imagery—application to the 2003 Bam,Iran, earthquake. *Earthquake Spectra*, 21(1), 255–266. <https://doi.org/https://doi.org/10.1193/1.2101907>
- Johnson, B., Bragais, M., Endo, I., Magcale-Macandog, D., & Macandog, P. (2015). Image segmentation parameter optimization considering within- and between-segment heterogeneity at multiple scale levels: test case for mapping residential areas using landsat imagery. *ISPRS International Journal of Geo-Information*, 4(4), 2292–2305. <https://doi.org/10.3390/ijgi4042292>
- Katartzis, A., & Sahli, H. (2008). A stochastic framework for the identification of building rooftops using a single remote sensing image. *IEEE Transactions on Geoscience and Remote Sensing*, 46(1), 259–271. <https://doi.org/10.1109/TGRS.2007.904953>
- Kim, T., & Muller, J.-P. (1999). Development of a graph-based approach for building detection. *Image and Vision Computing*, 17(1), 3–14. [https://doi.org/10.1016/S0262-8856\(98\)00092-4](https://doi.org/10.1016/S0262-8856(98)00092-4)
- Koc-San, D., & Turker, M. (2014). Support vector machines classification for finding building patches from IKONOS imagery: the effect of additional bands. *Journal of Applied Remote Sensing*, 8(1), 083694. <https://doi.org/10.1117/1.JRS.8.083694>
- Lein, J. K. (2012). Object-Based Analysis. In *Environmental sensing: analytical techniques for earth observation* (pp. 259–276). New York: Springer New York. <https://doi.org/10.1007/978-1-4614-0143-8>

- Li, E., Femiani, J., Xu, S., Zhang, X., & Wonka, P. (2015). Robust rooftop extraction from visible band images using higher order CRF. *IEEE Transactions on Geoscience and Remote Sensing*, 53(8), 4483–4495. <https://doi.org/10.1109/TGRS.2015.2400462>
- Li, H., Jing, L., Tang, Y., Liu, Q., Ding, H., Sun, Z., & Chen, Y. (2015). Assessment of pan-sharpening methods applied to WorldView-2 image fusion. *International Geoscience and Remote Sensing Symposium (IGARSS)*, 2015-Novem, 3302–3305. <https://doi.org/10.1109/IGARSS.2015.7326524>
- Li, S., Tang, H., Huang, X., Mao, T., & Niu, X. (2017). Automated detection of buildings from heterogeneous vhr satellite images for rapid response to natural disasters. *Remote Sensing*, 9(11), 1177. <https://doi.org/10.3390/rs9111177>
- Ma, L., Li, M., Ma, X., Cheng, L., Du, P., & Liu, Y. (2017). A review of supervised object-based land-cover image classification. *ISPRS Journal of Photogrammetry and Remote Sensing*, 130, 277–293. <https://doi.org/10.1016/j.isprsjprs.2017.06.001>
- Miura, H., Midorikawa, S., & Soh, H. (2012). Building damage detection of the 2010 haiti earthquake based on texture analysis of high-resolution satellite images. In *15th world conference on earthquake engineering*. lisbon, portugal.
- Munoz, X., Freixenet, J., Cufi, X., & Martí, J. (2003). Strategies for image segmentation combining region and boundary information. *Pattern Recognition Letters*, 24(1–3), 375–392. [https://doi.org/10.1016/S0167-8655\(02\)00262-3](https://doi.org/10.1016/S0167-8655(02)00262-3)
- Ok, A. O. (2013). Automated detection of buildings from single VHR multispectral images using shadow information and graph cuts. *ISPRS Journal of Photogrammetry and Remote Sensing*, 86, 21–40. <https://doi.org/10.1016/j.isprsjprs.2013.09.004>
- Pesaresi, M., & Benediktsson, J. A. (2001). A new approach for the morphological segmentation of high-resolution satellite imagery. *IEEE Transactions on Geoscience and Remote Sensing*, 39(2), 309–320. <https://doi.org/10.1109/36.905239>
- Salah, M., Trinder, J., & Shaker, A. (2009). Evaluation of the self-organizing map classifier for building detection from lidar data and multispectral aerial images. *Journal of Spatial Science*, 54(2), 15–34. <https://doi.org/10.1080/14498596.2009.9635176>
- Shackelford, A. K., & Davis, C. H. (2003). A combined fuzzy pixel-based and object-based approach for classification of high-resolution multispectral data over urban areas. *IEEE Transactions on Geoscience and Remote Sensing*, 41(10 PART I), 2354–2363. <https://doi.org/10.1109/TGRS.2003.815972>
- Sirmacek, B., & Unsalan, C. (2009). Urban-area and building detection using SIFT keypoints and graph theory. *IEEE Transactions on Geoscience and Remote Sensing*, 47(4), 1156–1167. <https://doi.org/10.1109/TGRS.2008.2008440>
- Tian, J., & Chen, D. M. (2007). Optimization in multi-scale segmentation of high-resolution satellite images for artificial feature recognition. *International Journal of Remote Sensing*, 28(20), 4625–4644. <https://doi.org/10.1080/01431160701241746>
- Troya-Galvis, A., Gancarski, P., Passat, N., & Berti-Equille, L. (2015). Unsupervised quantification of under- and over-segmentation for object-based remote sensing image analysis. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 8(5), 1936–1945. <https://doi.org/10.1109/JSTARS.2015.2424457>
- Ural, S., Hussain, E., & Shan, J. (2011). Building population mapping with aerial imagery and GIS data. *International Journal of Applied Earth Observation and Geoinformation*, 13(6), 841–852. <https://doi.org/10.1016/j.jag.2011.06.004>

- Wei, Y., Zhao, Z., & Song, J. (2004). Urban building extraction from high-resolution satellite panchromatic image using clustering and edge detection. In *IEEE International Geoscience and Remote Sensing Symposium* (Vol. 7, pp. 2008–2010). Honolulu, HI, USA. <https://doi.org/10.1109/IGARSS.2004.1370742>
- Zaman, A. M. (2017, August 7). Dhaka and her rivers: A beautiful relationship gone sour | The Daily Star. Retrieved from <http://www.thedailystar.net/opinion/environment/dhaka-and-her-rivers-1444537>
- Zhang, R., & Zhu, D. (2011). Study of land cover classification based on knowledge rules using high-resolution remote sensing images. *Expert Systems with Applications*, 38(4), 3647–3652. <https://doi.org/10.1016/j.eswa.2010.09.019>
- Zhao, W., Du, S., Wang, Q., & Emery, W. J. (2017). Contextually guided very-high-resolution imagery classification with semantic segments. *ISPRS Journal of Photogrammetry and Remote Sensing*, 132, 48–60. <https://doi.org/10.1016/j.isprsjprs.2017.08.011>
- Ziaei, Z., Pradhan, B., & Mansor, S. Bin. (2014). A rule-based parameter aided with object-based classification approach for extraction of building and roads from WorldView-2 images. *Geocarto International*, 29(5), 554–569. <https://doi.org/10.1080/10106049.2013.819039>

The Scope of Integrating Auxiliary Conservations Areas in the Regional Planning System: Experiences from China, India and the Philippines

Tasfin Aziz*

Abstract: Maintaining ecological balance is a challenge in the process of biodiversity conservation. The national Protected Area (PA) system often faces the edge effect, uneven representation, habitat fragmentation and lack of compliance with the regional priorities. Areas used for species' regular or seasonal movement, landscape connectivity, and additional layer of protection to the existing PAs are equally important for the conservation. There is no consensus on a common concept to address these areas like ecological corridor and buffer zone. In the spatial planning perspective, Auxiliary Conservation Area (ACA) approach addresses them as a part of the area-oriented approach. This paper critically reviews three cases from China, India, and the Philippines to evaluate the possibility of integrating ACA in the regional planning system.

Key words: Regional Landuse Planning, Biodiversity Conservation, Auxiliary Conservation Area

Introduction

Biodiversity is extremely complex, dynamic and varied feature of the Earth. The act of conservation can change depending on the biodiversity richness, geographic and management contexts. A critical review of different experiences of diversified regions and geographic attributes generate new knowledge on effective biodiversity management. This paper examined three country's contexts and their systems to manage biodiversity and Protected Areas (PAs) with a focus at the regional level. Each of these countries has rich biodiversity, different climate regions and geographic attributes. Most importantly all three countries are showing changes in ensuring balanced biodiversity conservation in the future. The review aimed at understanding the context of each countries, their existing laws and regulations, conservation approaches and ideology, administrative structures for biodiversity and PAs management, presence of decentralised management system, regional planning practices and the way of addressing ACAs in the conservation process at the regional level.

The paper is structured as review of different case studies. Thus, a literature review is undertaken in the next section to build the conceptual framework followed by exploration of three cases in terms of strategy and goals, legal frameworks, institutional frameworks and regional planning approaches. The next section summarizes the lessons learnt to conclude the key findings and the broader issues to consider in future research.

* Tasfin Aziz is a Lecture in the Department of Architecture, BRAC University. Correspondence address: tasfin.aziz@bracu.ac.bd

Literature review

Biodiversity conservation is confronted with two major problems: how to define and measure biodiversity; and how to optimize the in-situ conservation of biodiversity (Witting and Loeschcke, 1995). One way to define is establishing Protected Areas (PAs) as specific 'geographic spaces, recognized, dedicated and managed through legal or other efficient means to achieve the long-term conservation of nature with associated ecosystem services and cultural values' (Dudley, 2008). However, no habitat or location of certain species can be constraint through a clear boundary; there can always be overlaps and continuation to the surrounding areas making transition to different character. These areas are often left out from protection, yet are significant for efficient functioning of PAs.

These areas include ecologically important buffer zones and ecological corridors with similar characters. Tisdell (2013) coined them as Auxiliary Conservation Areas (ACAs) to address all the ecologically sensitive areas besides PAs and ecological Hotspots. He further explained that ACA is a place where human impact is massive; a buffer zone between conservation areas and domesticated land can help to defend conservation initiatives. The fragmentation of habitat is an over increasing problem that can only be addressed by setting up migration corridors between PAs. Hence, ACAs cover spatial distribution of ecological corridors and buffer zones as an impact area.

Two approaches are followed for biodiversity conservation and PA management: Area or Conservation-oriented approach and process or sustainable development-oriented approach (Du *et al.*, 2015). Of the two, this research is aligned with the first approach as it is focused on the spatial dimensions of conservation considering biodiversity elements. The shifting paradigm in these disciplines over the years tried to narrow down the focus to micro levels giving high priority to the nature, species variety and habitats. Magamck and Saunier (1995) further suggested that biodiversity conservation at the regional level deals with the integrated analysis and conservation of natural resources under four major considerations: conservation is a development activity; neighbours are important; a broadened development agenda and system thinking, based on the outline of the Convention on Biological Diversity (CBD), 1993.

Therefore, the System Thinking is especially significant for the integrated PAs management in the new regional planning paradigm. Regional planning tools need to have in-built indicators to accommodate environmental elements.

Methodology

The critical review was undertaken as a qualitative study on biodiversity conservation system and the possibility to integrate ACAs in the regional planning. Thus, the research adopted case study not as a methodological choice rather as a choice to study object. A 'case' is a specific, bounded and functioning system providing answers to questions like 'How?' or 'Why?' about a contemporary set of events, over which the investigator has little or no control (Thomas, 1998). Case studies add value in refining theory, suggesting complexities for further investigation, and help to establish the limits of generalizations (Stake, 1994) which was helpful for conducting this research based on secondary data.

Figure 1: Locations of the Asian countries



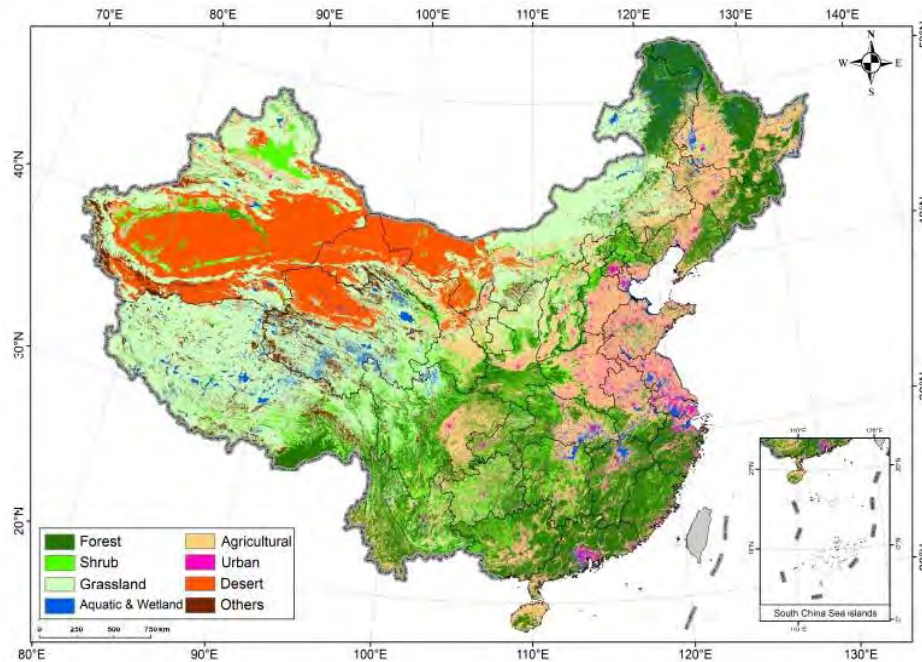
Source: Adopted from Google map

Learnings across three Asian countries

China is one of the twelfth countries with richest biodiversity in the world. The country also has wide range of biological features, from mountain chains and deserts to grasslands and forests ranging from boreal to tropical forests (Ministry of Environmental Protection, 2014) (see Figure 2). Fifty-eight out of the 81 World Wildlife Fund (WWF) recognized eco-regions in East Asia are located in China along with 26 biosphere reserves (covering 63,776 sq.km), 30 ramsar sites (covering 29,359 sq.km), and nine world heritage sites (covering 29,471 sq.km) (MacKinnon and Yan, 2008). By 2013, China established 2,697 nature reserves, 2,855 forest parks, 225 national-level scenic spots, 737 province-level scenic spots, 179 national-level protected sites of agricultural wild plants and 468 wetland parks covering almost 16.8 percent of the country's land area (MEP, 2010). Along with eco-regions, 35 priority areas of biodiversity conservation have been identified (see Figure 3) taking into consideration endemism, special

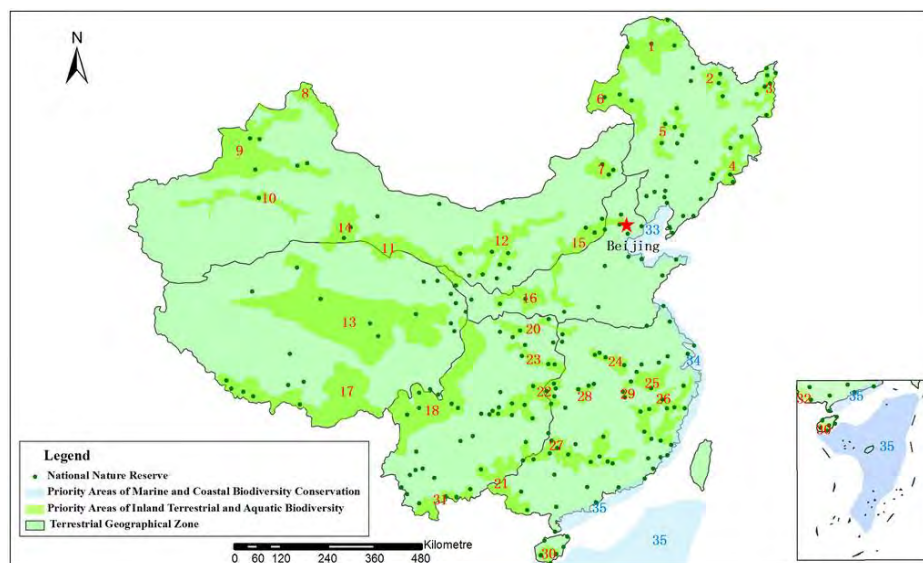
ecological functions of various ecosystem types, regional representativeness. Ensuring protection of these areas are the key to future biodiversity conservation in China (Wu et al., 2014).

Figure 2: Land cover map of China



Source: Ministry of Environmental Protection, 2014

Figure 3: Locations of priority areas for biodiversity conservation in China



Source: (Cao, Peng and Liu, 2015)

Strategy and goals

Biodiversity Conservation Strategy in China has been viewed through an ideological perspective to ensure the well-beings of the present and future generations along with their socio-economic development. The China National Biodiversity Strategy and Action Plan (NBSAP), 2011-2030 set the goal to achieve the conservation and sustainable use of biodiversity (MEP, 2010). The goal is guided by the scientific development principles and the principle of coordination between socio-economic development and biodiversity conservation. Developing or strengthening institutions and mechanisms for biodiversity conservation; strengthening capacities for ecosystem management and protecting biological and genetic resources; increasing public awareness and participation; and promoting ecologically friendly development and harmony between human beings and nature are considered as integrals in the plan. The Chinese government set three tiers of strategic goals. The short and medium-term goals focus on making effort to control biodiversity decline and loss while the long-term goal aims to effectively protect biodiversity by 2030 (ibid).

Legal framework

However, these action plans are not bounded by any comprehensive legal or regulatory frameworks. All the biodiversity conservation initiatives are executed based on the China Biodiversity Conservation Action Plan (CBCAP), 1994 following the National Biodiversity Strategy and Action Plan (NBSAP), 2010. Different laws and regulations are issued by departments at the national and the regional levels following the national plan. The revised NBSAP, 2011-2030 was updated in conjunction with the implementation of the National Plan for Major Function Oriented Zone (MFOZ) in 2010. The State Council of China, the supreme policy-making authority, approved a series of plans for promoting actions in biodiversity conservation. The regional level authorities and agencies take initiatives aligning with those plans.

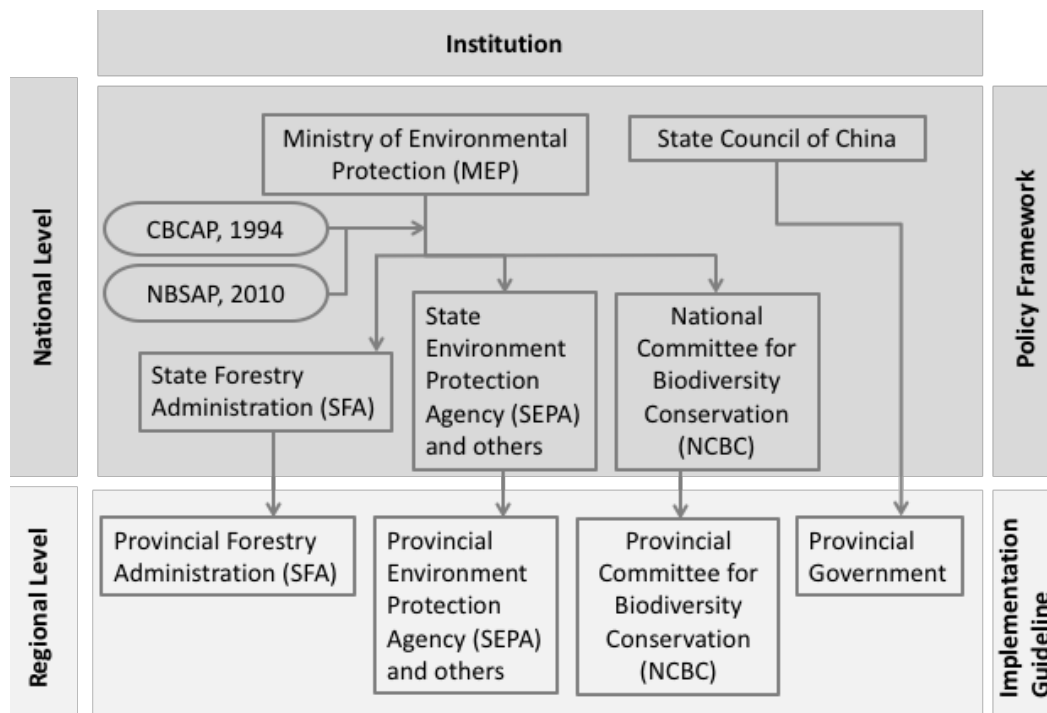
Institutional framework

The Ministry of Environmental Protection (MEP), as the lead coordination authority, jointly updated the NBSAP, 2011- 2030 with more than 20 ministries and departments. Most of China's nature reserves are managed by the State Forestry Administration (SFA) under the MEP. The State Environment Protection Agency (SEPA) establishes these areas in coordination with the Ministry of Construction, Ministry of Water Conservation, Ministry of Agriculture or State Oceanic Administration. National Committee for Biodiversity Conservation (NCBC) was established in 2011 to coordinate biodiversity conservation actions at the national level. The Inter-ministerial Joint Conference for Protection of Biological Resources and the National Coordinating Group for Implementation of the Convention on Biological Diversity work under the guidance of the committee (see Figure 4).

Most provincial governments reinforce institutions related to biodiversity such as departments of the environment, agriculture, forestry and marine management, and established inter-departmental coordinating mechanisms (NBSAP, 2010). A few sites are

managed by multiple agencies. Many of the larger nature reserves have been classified as national nature reserves, as opposed to being managed by provinces or counties. Xie and Li (2004) pointed out that the proportion of PA managed at the national level is too high (67 per cent), thus more should be managed by provinces. The current conservation system's reliance on national level often results into poor management.

Figure 4: Institutional Framework around biodiversity conservation in China



Regional planning

The State Council of China launched the National Plan for Major Function Oriented Zone (MFOZ) in 2010 following principles of zoning. Thus, the country's lands were divided into four major functional zones: a) land for priority development, b) land for key development, c) land for limited development and d) and land prohibited for development (Fan *et al.*, 2012). The government aimed to promote a coordinated regional development and shape an orderly spatial structure by applying the regulation of territorial function. The 35 key ecological function zones within the eight ecological regions are included in the 'land prohibited for development' zones of the MFOZ. Consequently, some areas, for example areas for habitat permeability and control, forest ecological functional areas are incorporated with the biodiversity conservation process besides the Protected Areas (PAs).

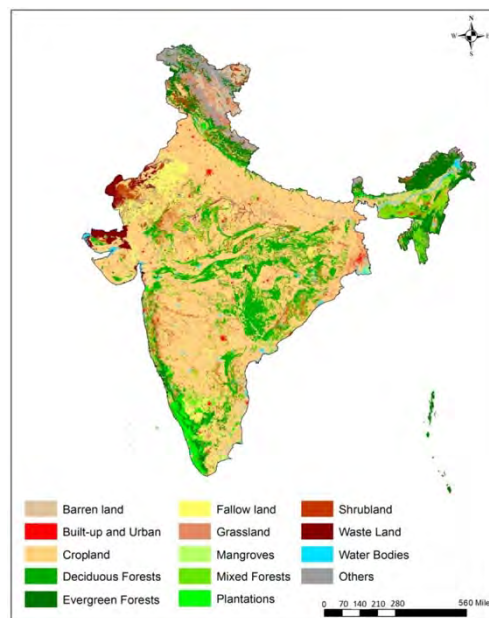
Although the Plan of the MFOZ can be seen as supporting of protecting auxiliary conservation areas, one of the criticisms of the plan is that it has been conceived as a spatial planning prepared at the highest level without the support from lower levels (Fan

et al., 2012). Provincial governments are responsible for formulating different criterions for their provincial MFOZ planning in view of the local contexts. Thus, horizontal coordination among agencies is an important aspect for the success of MFOZs which is again dependent on fiscal assistance from the state government. Moreover, declaring as development prohibited zone often face resistance in the context of the country's intrinsic demand for industrial development with greater GDP turnover. The Chinese past experience on spatial regulation illustrates that decentralizing can become messy while unifying can be depressing for people (Fan *et al.*, 2012). Such deficiencies raise concerns about the protection of ACAs.

India

India is the home of about seven to eight percent of all recorded species of plants and animals worldwide (MoEF, 2014). It is situated at the tri-junction of the Afrotropical, Indo-Malayan and Palaearctic realms, all of which support rich biodiversity with various land covers (see Figure 5). Being one of the 17 identified mega-diverse countries; India has 5 biomes and 10 biogeographic zones. Four of the 35 globally identified biodiversity hotspots: the Himalayas, the Indo-Burma region, the Western Ghats-Sri Lanka and Sundaland represent India's ecological richness (Conservation International, 2013). The diverse physical features and climatic conditions have resulted in a variety of ecosystems such as forests, grasslands, wetlands, desert, coastal and marine ecosystems. Till 2014 there were 690 PAs consisting of 102 National Parks, 527 Wildlife Sanctuaries, 572 Conservation Reserves and 4 Community Reserves covering 166,851 sq.km or 5.07% of the country's geographical area (MoEF, 2014).

Figure 5: Land cover map of India

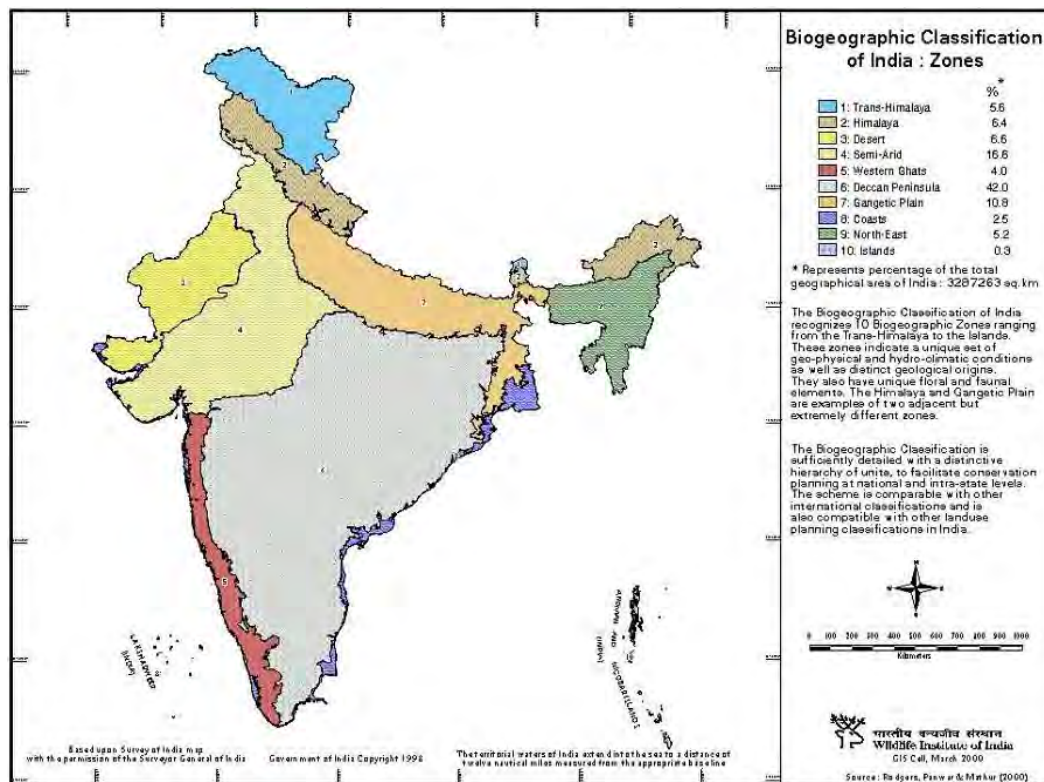


Source: (Roy *et al.*, 2015)

Strategy and goals

India's national protected area system is based on conservation planning framework. A 'Biogeographical Classification of India' was developed in the mid 1980's by the Wildlife Institute of India, adopted and widely implemented by the Ministry of Environment and Forest (MoEF). The concept is viewed as two tier consecutive divide: Biogeographic Zone (BZ) and Biogeographic Province (BP) (see Figure 6). The zoning is based on criteria like altitude, moisture, topography, rainfall and temperature to represent biodiversity in the landscape level (Rodgers, Panwar and Mathur, 2000). The MoEF initiated the National Biosphere Reserve Programme in 1986 ensuring long-term conservation and sustainable use of the country's representative and diverse biological diversity. As a consequence, nine biosphere reserves have been established. The country's biodiversity conservation practice usually refers to the PAs management focused on national parks, wildlife sanctuaries, conservation reserve and community reserve. The applicability of the ecosystem approach for establishing/managing PAs in the regional context is well understood in India.

Figure 6: Biogeographic zones of India



Source: Wildlife Institute of India, 2007

Legal framework

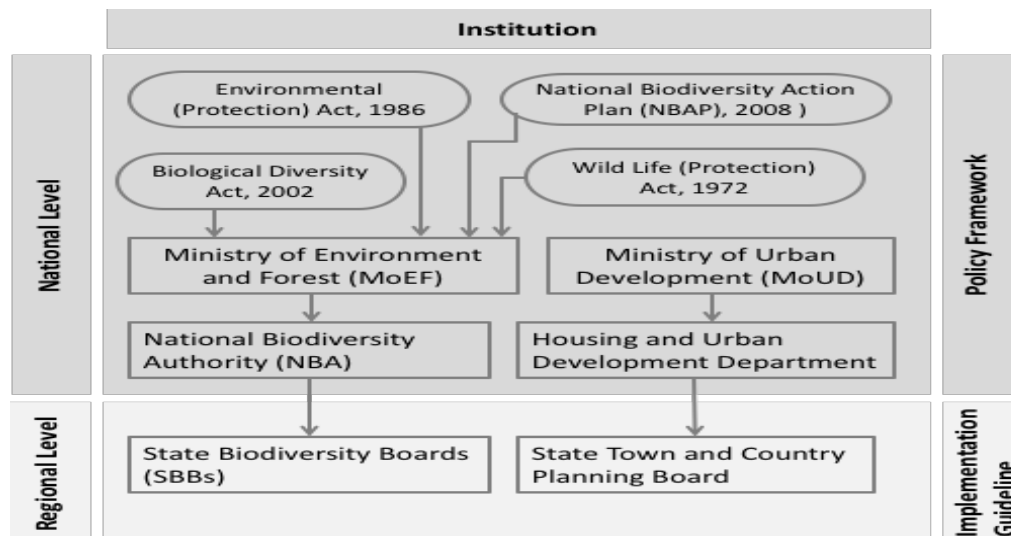
India is also one of the first countries to have a proactive legislation. As a signatory to various international conventions and treaties related to environmental protection, the country has strong national policies, legislation, programmes and plans. In the initial stage, National parks and sanctuaries were set up under the Wild Life (Protection) Act of 1972 (Singh, 1997). The country enacted a comprehensive Biological Diversity Act in 2002 to implement the provisions of Convention on Biological Diversity (CBD), 1993. It helped to formulate the Biological Diversity Rules and preparation of the National Biodiversity Action Plan (NBAP), 2008 (Dhillon, 2014). In addition, the National Wildlife Action Plan, 2002-2016 was prepared.

One of the most significant recent legislative steps has been setting up of the National Green Tribunal (NGT) which became functional in 2010 with the NGT Act. The NGT is a dedicated statutory environmental court with the mandate of dealing civil cases related to environment including biodiversity. In addition, the Supreme Court and the High Court have directed to set up a Green Bench in the Supreme Court of India in 2013 (MoEF, 2014). Thus, the legal provision on biodiversity protection is continuously strengthening in India.

Institutional arrangements

The Biological Diversity Act in the country is implemented through a three-tier structure: National Biodiversity Authority (NBA) at the national level, State Biodiversity Boards (SBBs) at the state/provisional level, and Biodiversity Management Committees (BMCs) at the local level. The Act also stipulates preparation of Peoples Biodiversity Registers (PBRs) by the BMCs involving local people and with guidance's from SBBs and NBA. About 33 SBBs have been established in 28 States and BMCs have been set up in 23 States so far (see Figure 7).

Figure 7: Institutional framework around biodiversity conservation in India



Regional planning

All the 29 states in India have a state level Urban and Regional Planning authority and acts to operationalize them. The act enables the Board to include environmental considerations while preparing metropolitan area plans and district plans (Dutt *et al.*, 2007). As a decentralized entity of the government, every state has their own way of addressing PAs within their planning jurisdiction. Each state is also responsible for setting up a Development Planning Committee, one of whose responsibilities include maintaining a database of natural resources to inform planning (Swiderska *et al.*, 2008). However, the state administrative boundaries are not necessarily aligned with the boundaries of 10 Biogeographic Zones (BZs) and 26 Biogeographic Provinces (BPs) in India. Each state follows the criteria of classification set by zones while incorporating environmental concerns in spatial planning.

In 2000, the MoEF instructed all state governments to identify species-based, ecosystem-based and geomorphological features-based ecologically fragile areas in their respective states based on some common criteria. Some of the PAs were too small to safeguard because of the landscape-dependent population in the country. The areas were exposed to risks of habitat fragmentation in the absence of 'functional corridors' to ensure permeability for movement of wild animals. Recognizing the threats, the Wildlife Conservation Strategy 2002 identified the 10 km adjacent to the boundaries of National Parks and Wildlife Sanctuaries to be notified as eco-fragile zones (MoEF, 2014). The decision was opposed by several state governments due to the presence of human population and development pressure in the close proximity. Therefore, in 2006 MoEF issued guideline to regulate activities around the national parks and wildlife sanctuaries to reduce negative impact of development and human activities.

The Philippines

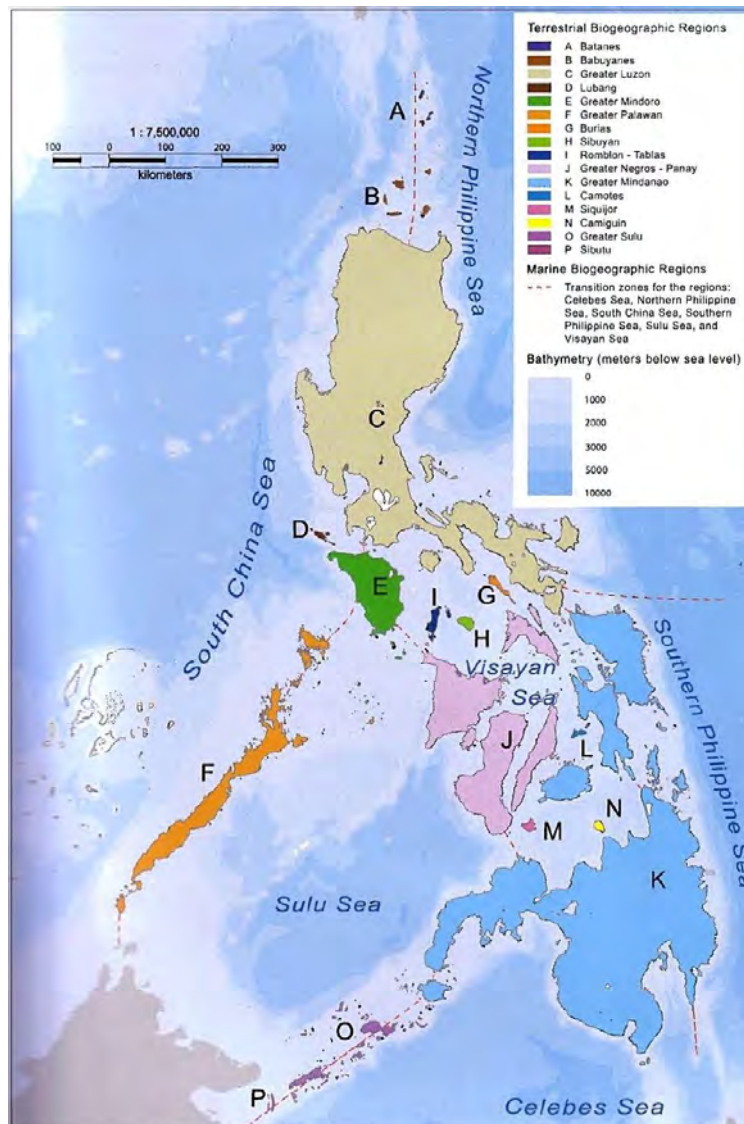
The Philippines, a country of more than 7,000 islands is the second-smallest of the 17 mega-diversity countries in the world. The varied geological histories of the different parts of the archipelago, with different climates and topography, contribute to the exceptionally diverse biota in the country. Each biogeographically distinct set of islands is home to unique community of species, plants and animals, with larger islands holding more unique species than most countries (CEPF, 2001). The country has unique terrestrial and marine plant and animal species. It has the greatest concentration of terrestrial mammalian diversity in the world (DENR-PAWB, 2012). The country is considered as one of the biodiversity hotspot among the 35 biodiversity hotspots in the world (Conservation International, 2013).

Strategy and goals

The Philippines adopted target 11 of Aichi Targets as the National Vision for PAs. The target aimed at conserving at least 17 percent of terrestrial and inland water, and 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services by 2020. The process of conserving emphasized on considering effective, equitable management and ecological representativeness. It also

suggested to connect PAs and other effective area-based conservation measures integrated into the wider landscapes and seascapes (DENR-PAWB, 2012). Moreover, institutionalizing biodiversity corridors has been rigorously mentioned in the Philippine National Biodiversity Strategy and Action (NBSAP), 2014-2025. Understanding the diversity, the country has been divided into 16 terrestrial and six marine Biogeographic Regions (BRs) under the Philippine Biodiversity Conservation Priority-setting Program, 2002 (see Figure 8). The diversity of small BRs in such a compact area makes the Philippines ecologically unique (CEPF, 2001).

Figure 8: Biogeographic zones of the Philippines.



Source: (Ong, Afuang and Ambal, 2002)

Legal framework

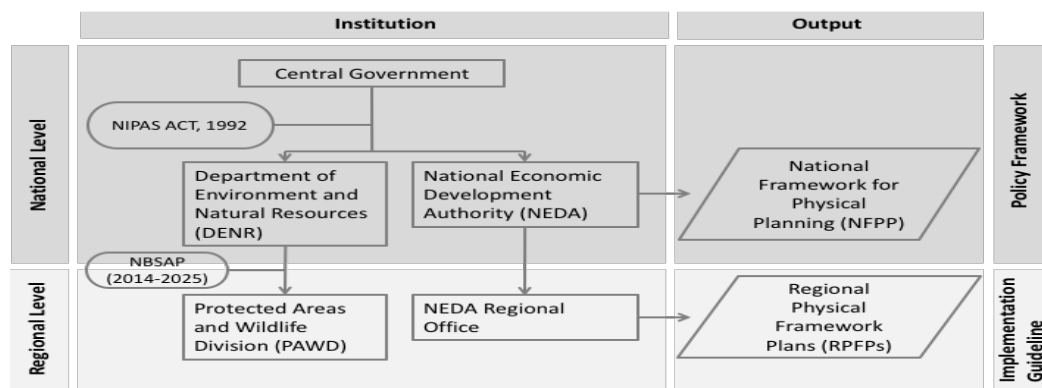
The country has National Integrated Protected Area System (NIPAS) established by the republic enacted in 1992. This act aimed at the overall biodiversity management in the country with the objective to secure the perpetual existence of all native plants and animals through the establishment of integrated PAs for the present and future generations. The NIPAS act covers all types of PAs, whether terrestrial, coastal or marine that are biologically important, habitats of rare and endangered species of plants and animals. The act specifically mentions the possibility of the inclusion of additional areas in the system and establish peripheral buffer zones when necessary only if the additional areas pose outstanding physical features, anthropological significance and biological diversity to protect them from activities that will directly and indirectly harm.

Institutional framework

The Department of Environment and Natural Resources (DENR) is the primary implementing agency and administrator of the NIPAS in the Philippines. They are also responsible for preparing strategy and providing guidelines for the preparation of site-specific management plans. They are assigned with the authority to promote the adoption and implementation of innovative management techniques including, if necessary, the concept of zoning, buffer zone management for multiple use and protection, habitat conservation and rehabilitation, diversity management, community organization, socio-economic and scientific researches, site-specific policy development, pest management, and fire control. DENR also provide guidelines for the protection of indigenous cultural communities, other tenured migrant communities and sites and for close coordination between and among local agencies of the Government as well as private sector.

Protected Areas and Wildlife Division (PAWD) at the regional offices of the DENR work under the supervision of a Regional Technical Director. A Protected Area Management Board is also created for each of the established PA which include representatives from the municipal government, local community and government and non-government organizations involved in the PA management (see Figure 9).

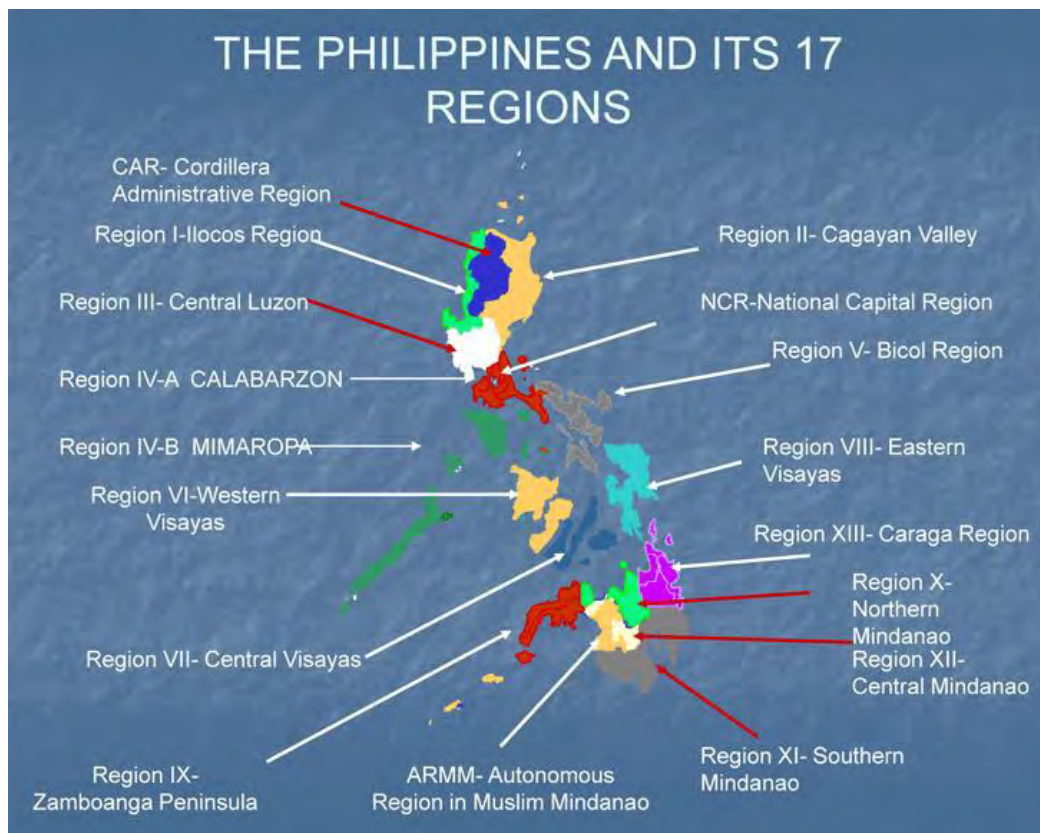
Figure 9: Institutional framework around biodiversity conservation in the Philippines



Regional planning

Apart from the NIPAS administration, Philippines has National Framework for Physical Planning (NFPP) as a spatial planning system established through National Economic Development Authority (NEDA). Similar types of plans are available in the regional, provincial and city/municipal levels. Fifteen out of 17 regions (see Figure 10) have their own Regional Physical Framework Plans (RFPPs) in parallel to the national plans. The NFPP, 2001-2030 lays out policies and initiatives related to the distribution, utilization, management, and development of land and material resources while the regional level plans include spatial planning and socio-economic development planning for a period of 30 years. The RFPPs address PAs with special values to reduce and control the incidence of human intrusion and exploitation activities. They analyses existing land uses of base year and proposed land-use protection until the end of the framework validity period. They accommodate NIPAS and Non-NIPAS areas within the Biogeographic Regions (BRs) in the land use framework. NEDA's regional offices coordinate with the PAWD.

Figure 10: Regional Administrative Division in the Philippines



Source: (MLIT, 2017)

Key learnings

All the three country cases recognize and address ACAs, i.e. ecological corridors, buffer zones, ecologically fragile or sensitive areas, in their biodiversity conservation planning, specifically at the regional levels. The regional authorities aligning with the national plans and legal frameworks prepare spatial and development plans integrating these ACAs in addition to the established PAs. The format of these plans varies within these countries: China prepares Major Function Oriented Zone (MFOZ) both at the national and provincial (regional) level; 29 states in India independently prepare Urban and Regional Plans at the regional levels; and the Philippines prepare National Framework for Physical Plans at the national level. The findings illustrate that to maintain PAs effectively, ACAs are significant in order to minimize the risks of edge effect arising from either development demand or dependency of landscape-dependent population. The regional planning creates the flexibility, through the provisions of having development-optimised, development-prioritised, development-restricted and development-prohibited areas as in China, there can be possibilities to address context specific demands and opportunities for conservations.

The comparative study among these three cases also illustrate two streams of institutions usually get involved; firstly, national and regional level agencies or department address biodiversity conservations; and secondly, spatial planning authorities, especially at the regional levels who either are subordinating entity of the national organization or autonomous organizations following national plans and policy frameworks. Since in some contexts, these organizations have different agendas and mode of operations, coordination between these two streams has the utmost significance. The cases of China and the Philippines suggest that if the organizations ensuring biodiversity conservation planning have more decision-making power, the coordination works better. In the absence of such organization, for example in the case of India, the legal frameworks become important to address public litigations arising from confrontations of development demand and ecological preservations.

Conclusions

Auxiliary Conservation Areas (ACAs) are generally overlooked in biodiversity conservation efforts, whereas Protected Areas (PAs) have an established process of safeguarding. A critical study was undertaken of three Asian countries who have very unique and widely diverse ecological elements and attributes which encouraged them to address both PAs and ACAs. ACAs help to withstand against the confrontation of urbanization or development demand and areas need to be protected. ACAs act as membrane to keep a balance between nature reserve and human habitation. Regional planning system has the opportunity to embrace the ACAs and integrate into the landuse planning. However, the plans need to be bounded by the legal frameworks in order to avoid being challenged by development demand and priorities. Non-binding planning system might have the risk of being compromised.

Regional planning has the provision to focus on the micro levels; prioritizing the nature, species variety and habitats. It is difficult to comply with the intangible nature of

ecological shift without having decentralized biodiversity management system. Because centralized systems are failing to address the regional priorities. Nevertheless, the integration of environmental elements into the regional planning, necessitates it to move beyond the principles of zoning towards incorporating local spatial, socio-economic contexts. The focus is not only on the present but also to the predicted future through the comprehensive regional landuse planning. Further research is needed to comprehend such planning mechanism that can synchronize between spatial planning and biodiversity management.

Acknowledgement

This paper has been revised and improved by following suggestions from Dr. Huraera Jabeen, Associate Professor of the Department of Architecture, BRAC University Dhaka.

Bibliography

- Cao, M., Peng, L. and Liu, S. (2015) 'Analysis of the Network of Protected Areas in China Based on a Geographic Perspective: Current Status, Issues and Integration', *Sustainability*, 7, pp. 15617–15631.
- CEPF (2001) *The philippines hotspot, The Critical Ecosystem Partnership Fund*. Available at: <https://www.cepf.net/our-work/biodiversity-hotspots/philippines>.
- Conservation International (2013) *Hotspots: Targeted investment in nature's most important places*. Available at: <https://www.conservation.org/how/pages/hotspots.aspx> (Accessed: 20 June 2005).
- DENR-PAWB (2012) *Action Plan for Implementing the Convention on Biological Diversity's Programme of Work on Protected Areas*. Protected Areas and Wildlife Bureau, Department of Environment and Natural Resources, the Philippines.
- Dhillion, S. (2014) *Technology Transfer in India: CBD, Institutions, Actors, Typologies and Perceptions*. Lysaker: FNI.
- Du, W. *et al.* (2015) 'Models and Approaches for Integrating Protected Areas with Their Surroundings: A Review of the Literature', *Sustainability*, 7, pp. 8151–8177. doi: 10.3390/su7078151.
- Dudley, N. (2008) *Guidelines for Applying Protected Area Management Categories*. Gland: IUCN.
- Dutt, A. K. *et al.* (2007) *City, Society, and Planning*. New Delhi: Concept Publishers Co.
- Fan, J. *et al.* (2012) 'Major Function Oriented Zone: New method of spatial regulation for reshaping regional development pattern in China', *Chinese Geographical Science*, 22(2), pp. 196–209.
- MacKinnon, J. R. and Yan, X. (2008) *Regional Action Plan for the Protected Areas of East Asia 2006-2010*. Gland: IUCN.
- Magamck, R. A. and Saunier, R. E. (1995) *Conservation of Biodiversity and the New Regional Planning*. Gland: IUCN.
- MEP (2010) *China National Biodiversity Conservation Strategy and Action Plan (2011-2030)*. Ministry of Environmental Protection.
- Ministry of Environmental Protection (2014) *China's Fifth National Report on the Implementation of the Convention on Biological Diversity*.

- MLIT (2017) *An Overview of Spatial Policy in Asian and European Countries*. Available at: http://www.mlit.go.jp/kokudokeikaku/international/spw/general/philippines/index_e.html.
- MoEF (2014) *India's Fifth National Report to the Convention on Biological Diversity*. Ministry of Environment and Forests, Government of India.
- Ong, P., Afuang, L. and Ambal, R. G. (2002) *Philippine biodiversity conservation priorities: A second iteration of the National Biodiversity Strategy and Action Plan*. Quezon City: Department of Environment and Natural Resources, Conservation International, University of the Philippines Center for Integrative and Development Studies, and Foundation for the Philippine Environment.
- Rodgers, W. A., Panwar, H. S. and Mathur, V. B. (2000) *Wildlife Protected Area Network in India: A review*. Wildlife Institute of India.
- Roy, P. S. *et al.* (2015) 'Development of Decadal (1985–1995–2005) Land Use and Land Cover Database for India', *Remote Sensing*, 7(3), pp. 2401–2430. doi: 10.3390/rs70302401.
- Singh, S. (1997) *Biodiversity Conservation through Ecodevelopment Planning and Implementation: Lessons from India*. United Nations University (Japan), Third World Academy of Sciences.
- Stake, R. (1994) 'Case studies', in Denzin, N. K. and Lincoln, Y. S. (eds) *Handbook of Qualitative Research*, pp. 236–247.
- Swiderska, K. *et al.* (2008) *The Governance of Nature and the Nature of Governance: Policy that Works for Biodiversity and Livelihoods*. 08.
- Thomas, A. (1998) 'Challenging cases', in Thomas, A., Chataway, J., and Wuyts, M. (eds) *Finding Out Fast: Investigative Skills for Policy and Development*. London: Sage Publications in association with the Open University, pp. 307–332.
- Tisdell, C. A. (2013) *Handbook of Tourism Economics: Analysis, New Applications, and Case Studies*. Singapore: World Scientific.
- Wildlife Institute of India (2007) *Biogeographic Zone of India*. Available at: <http://www.wii.gov.in/>.
- Witting, L. and Loeschke, V. (1995) 'The optimization of biodiversity conservation', *Biological Conservation*, 71(2), pp. 205–207.
- Wu, X. *et al.* (2014) 'Impacts of climate change on ecosystem in Priority Areas of Biodiversity Conservation in China', *Chinese Science Bulletin*, 59(34), pp. 4668–4680.
- Xie, Y. and Li, L. S. (2004) 'GAP Analysis on Nature Reserve System', in Xie Yan, W. S. and Schei, P. (eds) *China's Protected Areas*. Beijing: Tsinghua University Press.

A Discourse on Incoherence between Industrialization leads Environmental Degradation and Conservation Sundarbans

Afsana Nasreen*

Ummeh Saika**

Mohammad Nayeem Aziz Ansari***

Abstract: The Sundarbans is the world largest mangrove forest, considered as one of the natural wonders of the world, which has declared a UNESCO World Heritage Site. Despite objections from the UNESCO's World Heritage Committee and the International Union for the Conservation of Nature, Bangladesh has approved a huge number of industrial projects in this area, including the massive Rampal coal-fired power plant. It is well argued that the accelerating industrialization of the Sundarbans threatens not only this unique ecosystem – which hosts Bengal tigers, Ganges river dolphins and other endangered species – but also poses serious risks to the human rights of the 6.5 million people. The concern now days come into different fronts whether we should pursue development that respects human rights and protects the environment, or we need to follow industrial projects in disregard of their environmental costs, and end up with neither a healthy environment nor a healthy economy. The government of Bangladesh enacted several Environmental Laws; however, environmental laws apparently seem to be unsuccessful in restricting the establishment of industry throughout the country including the nearby areas in the Sundarbans. Keeping this view in mind and based on review of different literature this study presents the discourse on the incoherence between the status of present industrialization in the Sundarbans area and how effectively the environmental laws are actually implementation in ground in protect the Sundarbans from the environmental degradation occurring due to massive industrialization.

Introduction

Quite a long ago on 22 November, 1989, considering the importance of the Sundarbans, in the last two lines in his poem 'For the Sundarbans', the British poet Ted Hughes, a Nobel laureate, wrote "Bangladesh take care- of the Sundarbans". After 30 years later, we, the people of all walks in this country, are equally echoing the same words in order to save the Sundarbans from the severe environmental degradation. It is now much evident that on the edge of the Sundarbans, the number of heavily polluting factories like cement, leather, petrochemicals, as well as thermal power plants have been established that threatens the mangrove ecosystem. Considering the conservational value of the Sundarbans, in 1997 United Nations Educational, Scientific and Cultural Organization (UNESCO) has declared 1397 km² forest area of the Sundarbans as the World Heritage

* PhD Researcher, Department of Tourism Science, Graduate School of Urban Environmental Sciences, Tokyo Metropolitan University, Japan, Email: afsanasreen@gmail.com

** Associate Professor, Department of Geography and Environment, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh, Email: usaikau@gmail.com

*** Professor, Department of Geography and Environment, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh, Email: ansari@juniv.edu

site (WCMC, 2001). Besides, south-west part of this forest has also declared as Ramsar site- the world's most important wetlands (Islam, 2011). As we know that, the Sundarbans is the largest mangrove forest in the world locating between India–Bangladesh borders. The Bangladesh part comprises around 599,330 ha; which contains about 62% (Rahman et al., 1979) and the rest of the area about 426,300 ha falls in West Bengal province of India (Sanyal, 1983). The government of Bangladesh enacted several Environmental Laws i.e. Bangladesh Environment Conservation Act 1995, Environment Conservation Rules 1997, Environment Court Act 2010, and so on. However, environmental laws apparently seem to be unsuccessful in restricting the establishment of industry throughout the country including the nearby areas in the Sundarbans. Whereas it has specified in Bangladesh Environment Conservation Act 1995 which is amended in 2010 that no industrial activity is allowed to set up within 10 kilometers of the Sundarbans mangrove forest, which is designated as an Ecologically Critical Area (ECA) (Roy, 2018). But going against its own policy, the government over the last few years permitted setting up of 190 industrial and commercial units known as severe units in the ECA and in total approved more than 320 industrial project in the Sundarbans' periphery. Within the 10 kilometers radius there are several cement factories, a petrochemical refinery, and many gas bottling plants with scores more being built, among them a massive USD 21.5 million leather processing plant and the contentious Rampal thermal power plant (Sarkar, 2018) which, according to experts, poses a serious threat to the biodiversity of the world's largest mangrove forest. However, environmentalists fear that the Rampal coal-fired power plant will cause serious damage to the forest once it goes into operation which is strategically located 14 kilometers north-east from the existing Mongla sea port (Mookerjea and Misra, 2017:3). The plant is facing intense hostility in Bangladesh, both from the grassroots and civil society groups because it would not only endanger for the livelihoods of locals but also adversely affect to the ecosystem of the Sundarbans. It cannot be ignored that the contribution of industry for the development of Bangladesh is enormous, but unplanned industrialization causes great harm for environment, destroys the balance of ecology and the result is obstruction of sustainable development. Unplanned and reckless industrialization only creates opportunity for a fraction of the country while it causes harm for the whole country and in extreme cases it becomes a global concern (Khanam and Shahnewaj, 2017). It is a common scenario in Bangladesh that the authority cannot address the problems before they take place and policy makers usually get conscious about a matter when it becomes bad to worse which is utterly not a good sign for conserving the nature. The concern now days come into different fronts whether we should pursue development that respects human rights and protects the environment, or we need to follow industrial projects in disregard of their environmental costs, and end up with neither a healthy environment nor a healthy economy. The accelerating industrialization of the Sundarbans threatens not only this unique ecosystem – which hosts Bengal tigers, Ganges river dolphins and other endangered species – but also poses serious risks to the human rights of the 6.5 million people whose lives, health, housing, food and cultural activities depend directly on a safe, healthy and sustainable Sundarbans forest

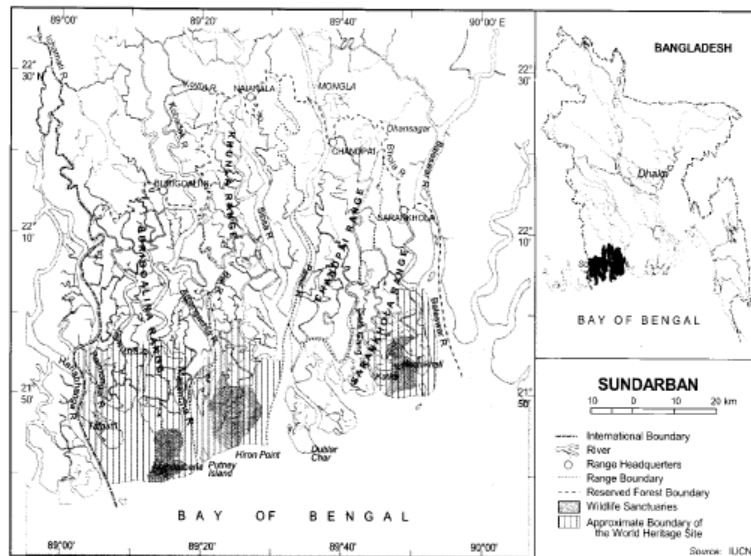
Objectives and Methodology

The aim of this paper is to review the status of present industrialization in the Sundarbans area and to review how effectively the environmental laws are actually implementation in ground in protect the Sundarbans from the environmental degradation occurring for industrialization. The paper therefore, at first discuss the geographical distribution of different industries in the Sundarbans and its adjacent areas including the Rampal Thermal Power Plant issues- a new conflict in public domain considering the Sundarbans' environmental sustainability. Secondly, the papers draws some of the scenarios of environmental degradation that are taking place in the forest area due to massive industrialization. Finally, it describes the politics in space in order to show the what incoherence exists between the establishment of industries in Sundarbans and in implementing of environmental laws in the ground

This paper employed 'discourse analysis' (Potter and Hepburn, 2007) and logical presentation of 'thick description' (Strauss and Corbin, 1998). According to Bavelas et al. (2000), discourse analysis systematically studies the naturally occurring (not hypothetical) communication in the broadest sense, at the level of meaning (rather than as physical acts or features). Discourse study used in this paper as a framework for analysis where many different forms of text and opinions have been selected for analysis. The methods therefore, used in this research was to identify, to select and to appraise the existing published and unpublished literatures systematically, and then to summarize and compare the review's conclusions with a discussion of the strength of these conclusions. Besides the using of thick description mainly aimed to provide a large conclusion from small, but very dense textured facts to support broad assertions (Greetz, 1973).

The Sundarbans and its Impact Zone

The Sundarbans Mangrove Forest of Bangladesh is bounded on the south by the Bay of Bengal, to the west they are contiguous with the Indian Sundarbans and on the east and north they are separated from cultivated land by a complex of small rivers and streams (IRMP, 1998; Siddiqi, 2001). Within Bangladesh, the forests are spread across 17 sub-districts within the five districts of Khulna, Satkhira, Bagerhat, Pirojpur and Borguna (Samarakoon, 2004; ADB, 1998; Islam, 2011).



Map 1: Sundarban Mangrove forest with three ecological zones. Source: Muhibbullah et al., 2007

The Sundarbans Reserved Forest is divided into four zones:

- The Marine Zone, including the marine area of the extreme south of the forest;
- The Protection Zone, including three wildlife sanctuaries where all types of resource collection are illegal;
- The Production Zone, which is subject to sustainable harvest; and
- A Buffer or Impact Zone, which is a belt approximately 20 km wide on the periphery of the reserved forest and from the periphery of the reserved forest 10 km is Ecologically Critical Area (ECA).

The site is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of ongoing ecological processes. The area is known for its wide range of fauna, including 260 bird species, the Bengal tiger and other threatened species such as the estuarine crocodile and the Indian python. The Sundarbans provides sustainable livelihoods for millions of people in the vicinity of the site and acts as a shelter belt to protect the people from storms, cyclones, tidal surges, sea water seepage and intrusion. The area provides livelihood in certain seasons for large numbers of people living in small villages surrounding the property, working variously as wood-cutters, fisherman, honey gatherers, leaves and grass gatherers.

Exorbitance of Industrial Factories in ECA of Sundarbans

The rapid industrialization growth both small and large enterprises has had its impact on the environment; this has now become a major concern to the ecological balance of Sundarbans. Bare land around the Sundarbans is being sold continuously as plots for heavy industries. According to experts, it will pose a serious threat to the

biodiversity of the Sundarbans in the long run. The government itself gave permission for setting up 190 industrial units within 10 km of ecologically critical area (ECA) of the Sundarbans. Due to have labor intensity, low labor wages, bare land, easy excess river basin, get-at-able transportation, accessible raw materials and importance in generating employment opportunities for the less well-off members of the surrounding upazila communities, industrialists have been encouraged and given assistance by the government. However, it is found that small enterprises tended to be the worst polluters because they gave the least attention to environmental issues as part of their operations. Such factories will eventually destroy the forest.

Table 1: List of Industrial Units in ECA, Sundarbans.

Type of Industry	Number of Industry	Category of Industry according to the pollution level*	Pollution Level
Cement Factory	6	Red	High
LPG	7	Green	Low
LPG Gas Cylinder	1	Green	Low
Oil Refinery	3	Red	High
Ship Building	2	Red	High
Saw Mill	15	Orange	Medium
Betel Nut Processing	8	Orange	Medium
Rice Mill	73	Orange	Medium
Fish Farm and Hatchery	19	Orange	Medium
Saline Water Refinery	7	Red	High
Brick Kilns	3	Orange	Medium
Others	46	--	Low to Medium

Source: The Daily Star (April 6, 2018).

Under the ECA and ECR (Environment Conservation Rules), for the purpose of issuance of Environmental Clearance Certificate, the industrial units and projects have been classified under four categories: Green, Orange A, Orange B and Red. These categories are based on the location and its impact on the environment. Department of Environment (DoE) prepared a list in September 2016, where pointed that out of the 190 industrial units 154 units are running and 36 are now closed. In 154 factories, 24 were placed under Red category for their high pollution, 56 under Orange-B category for lesser pollution and the rests were placed under Orange-A for ordinary pollution (NEWAGE, 2017). The industrial units fall under “the red category”, meaning those are extremely harmful to the fragile biodiversity of the Sundarbans, since they are discharging toxic substances (industrial smog and discharging liquid wastes and saline water) in the ECA. The Red category pollutants included an under construction coal-fired power plant. The other pollutants are LPG bottling plants and gas cylinder, oil refinery, lubricant blending factory, industrial complex, shipyards and the factories for manufacturing cement, bitumen and cigarette, hatcheries, saline water refinery and welding factory, rice husking

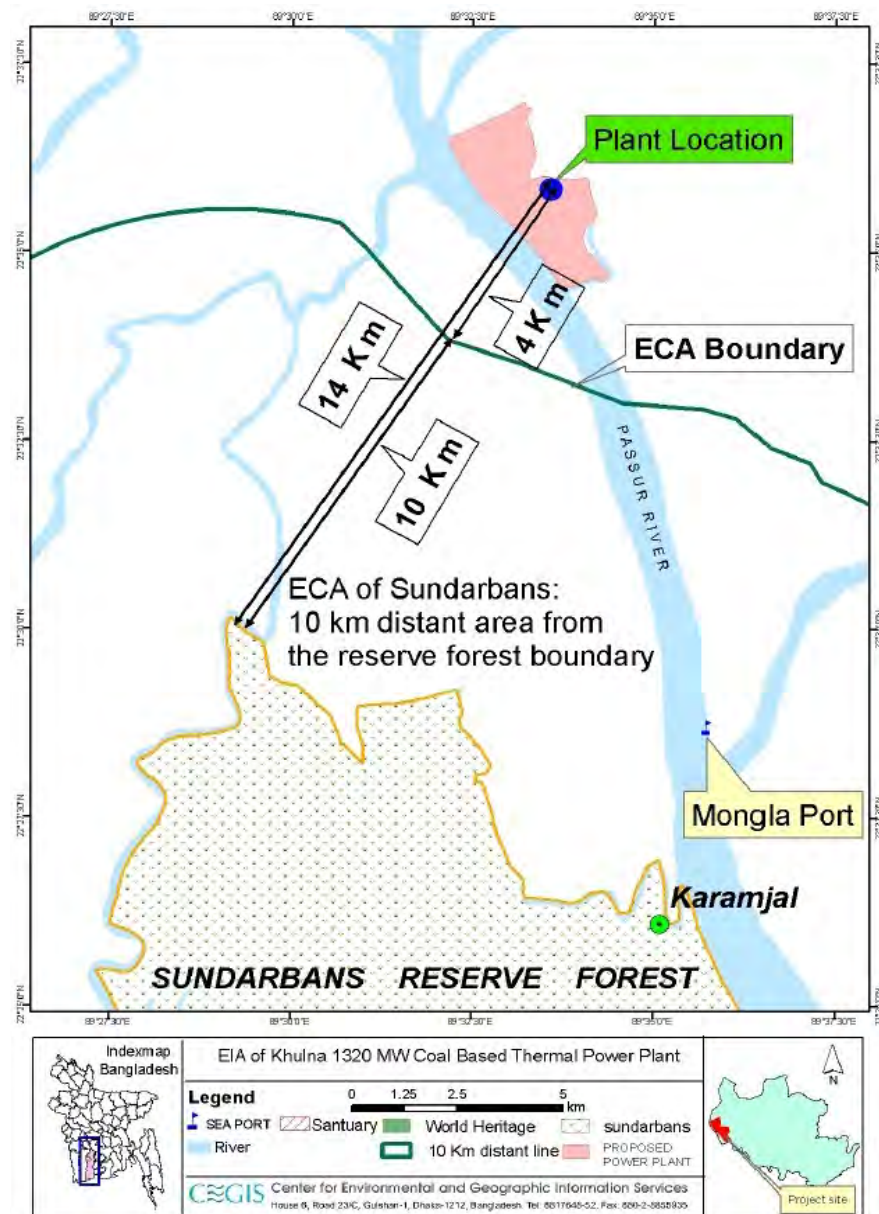
and saw mills, and brick kilns (The Daily Star, April 6, 2018). Most of the heavy and harmful industries are located in the Mongla industrial and Mongla port areas (Map 2).



Source: Modified after The Daily Star, 2018.

Map 2: Distribution of different Industries near Sundarbans.

Another new issue to Sundarbans' sustainability is linked to establishment of Rampal Thermal Power Plant. The Rampal Coal-Fired Power Plant was signed between the governments of Bangladesh and India on 1 November 2010 to "enhance the traditional ties of friendship between the two countries through the development of cooperation for mutual benefit of both the countries" (Report of the Fact Finding Mission to Rampal, Bangladesh, 2015). This 1,320 MW power plant project is being implemented by the Bangladesh-India Friendship Power Company (Pvt.) Ltd as a joint venture of Bangladesh Power Development Board (BPDP) and Indian National Thermal Power Corporation (INTPC) (Mookerjee and Misra, 2017:2). The power plant is being built in the Rampal Upazila of Bagerhat District; the Sea is 115km away from Rampal Upazila and the proposed project area is 5 km away from the Mongla Sea Port and 4 km away from the buffer zone of the Sundarbans (Map 3).



Map 3: The Rampal Power Plant.

According to a 2016 report by the Institute for Energy Economics and Financial Analysis, the Rampal power station will produce electricity that will cost 32% more than the average electricity costs in Bangladesh, despite multiple subsidies from Bangladesh and India. Moreover, basic precondition states that such projects must be outside a 25-kilometre radius of the outer periphery of an ecologically sensitive area. Furthermore, transportation of coal to fuel the plant through the river flow path that cuts through the Sundarbans adds a greater dimension of risk.

Impacts of Industrialization in Sundarbans: Some issues

The increasing number of heavily polluting factories producing petrochemicals, cement, and leather on the edge of the Sundarbans, as well as new thermal power plants, threatens the mangrove ecosystem. In a recent research has found that the rampant industrialization in Sundarbans is causing irreparable damage, with oil levels in water bodies rising six-fold and temperature by over four degrees, pushing wildlife to the edge and reducing the fish population by half (IANS, 2018). The reason behind increasing water temperature is the salinity and chemicals dissolved from industrial discharge and huge vessels plying. Activists have fear towards the LPG plant, which is within 11 kilometers of the forest, causes irreparable damage to its wildlife and biodiversity. Siddique (2018) in his research noted that ships carrying toxic fuels to and from the plant seriously pollute rivers as they run through the forest. Some of the carriers have broken down, leaked fuel, and capsized in the Sundarbans Rivers over the years that contaminating the whole ecosystem. The Sela River runs through a sanctuary for the endangered Irrawaddy and Ganges river dolphin along the northern edge of the Sundarbans East Wildlife Sanctuary, was in the global spotlight since December 9, 2014, when a wrecked tanker released near about 94,000 gallons of heavy fuel into the river. In May 3, 2015, a capsized cargo vessel leaked 200 tones potash fertilizer into the Bhola River, which is southeast part of the earlier oil spill. Although the authorities have turned more vigilant after these disasters, the potential of more such incidents cannot be ruled out yet (Sarkar, 2018).

Strategically located in south-western Bangladesh, the success of Mongla is due to the frenetic industrialization in its hinterland. Within a radius of 10 kilometers there are several cement factories, a petrochemical refinery, and many gas bottling plants – with scores more being built, among them a massive USD 21.5 million leather processing plant. This humming industrial hub, however, carries with it an environmental cost that may be high enough to endanger the economy of the entire region. Situated as it is on the edge of the Sundarbans – a world heritage site and a biodiversity hotspot – the risk of pollution to its unique ecosystem is quite high, environmentalists fear (The Third Pole, 2018). The oil attached on the leaf surface can block up stomata and affect photosynthesis, respiration, and water metabolism of mangrove plants (Peng, 2000). Reported Organic pesticides and high concentration level of heavy metals such as Zn, Cd, Cr, Pb, Cu have been reported in mangrove sediment (Rahman et al., 2009).

In recent years, the Rampal Coal-Fired Power Plant is one of the crucial controversial projects that has divided the country into two different society. Local and international experts and environmentalists have raised their concern that the power plant activities could change the critical water balance in the Sundarbans region, pollute the surrounding water and air, and increase the risk of oil and coal spills (Banu, 2016). According to experts, all of these could have an impact on the Sundarbans mangrove forest, and threaten the well-being of the local residents and wildlife who call that area home. On the other side, some arguments come in to public front that the government claims that the power project will help mitigate the perennial power crisis to an extent and add impetus to the local economy (Riaz, 2016). The construction of the Rampal power plant has been part of an ambitious government plan to enhance power generation to 20,000 MW by 2021. The government argues, the project will lessen the financial dependency of the

local people on the mangrove forest by opening the opportunity of alternative employment and also it has been observed that the local people who had been involved in illegal tree-felling and other illicit activities in the Sundarbans to earn a living, would get job opportunities in the plant.

Despite the valuable criticism of experts and environmentalists, advice of UNESCO, the Bangladesh government is continuing to back the construction of the power plant in Rampal. The Bangladesh government has decided to bring coal inside the Sundarbans through the Mongla seaport. Indian National Thermal Power Company and Bangladesh Power Development Board are the two signatories of the project. The proposed power plant will burn around 4.75 million tons of coal annually when more or less 0.71million tons ashes and around 0.5 million tonnes sludge and liquid waste may be produced (CEGIS 2013). It would also emit a good amount of carbon dioxide (CO₂)-key factor for global warming - some other toxic gases and airborne particles, according to Union of Concerned Scientists, a USA-based group. The ground water and water of the Poshur River may be polluted by the huge amount of waste produced due to burning of the coal. Whereas the existence of strict laws to protect the environment and the wildlife, the government has recently decided to declare a part of the Poshur and Andharmanik rivers sanctuaries for dolphins (Sarkar, 2012). The government officials have down played the threats and insisted that the emissions of carbon, Sulphur, fly ashes and other types of air pollution will be “kept at a minimum level to avoid any adverse impact on the environment” and also they assured that the Bangladesh-India Friendship Power Company Limited (BIFPCL) would import high quality coal, erect a 275 metre high chimney, use state-of-art technology and undertake other steps to ensure that the plant’s impact on the nearby Sundarbans remains at a negligible level (Riaz, 2016).

The government’s major point of ignoring the environmental cost is geopolitics. There has an important geopolitical dimension to the Rampal development. Mookerjea and Misra (2017) demonstrated a strong point regarding the establishment of power plant in Bangladesh part of Sundarbans and pointed out some interesting facts - India-Bangladesh relations have seen major improvements under Hasina’s rule. Various commentators argue that the Rampal plant is meant to be a demonstration of India’s firm backing of the current ruling party. Banu (2016) illustrated that the contract for the power plant is non-transparent and unequal and many alleged that the Indian government will be more benefited than Bangladesh. It looks like the Bangladeshi Government is not looking after its people’s interest. The project is objected by people from different corners of both India and Bangladesh, but ignoring all criticism government has been continuing its construction work.

Incoherence in between industrialization and Conservation of Sundarbans

The environmental laws and policies call for a precautionary approach to minimize impact from other sectors like industry, transportation, urbanization, flood control etc. Law and policy documents generally refer to the principles that govern the action directed towards given ends. They provide a basis for plans, prescriptions and framework to maintain the dynamic growth of the sectors. During 1990 some NGO’s were working to addressing the issues of environment, besides that some precursors of this process such

as Bangladesh Environmental Lawyers Association and Bangladesh Poribesh Andolon with their judicial and extrajudicial activism and by the actions and remedies provided by the judiciary being able to set a standard of Environmental Law in Bangladesh (Islam, 2018). However, in various sectors concordance have been absent between existing law and practice.

Considering the Sundarbans; Bangladesh declared the 10 kilometers periphery of the mangrove forest as the ECA in 1999 and as per the Bangladesh Environment Conservation Act 1995 amendment in 2010, no one is allowed to set up any factory in the ECA. But Bangladesh's environment ministry had issued permission to set up 186 industrial projects in the Sundarbans region before the ECA designation came into effect. Among them, 140 industries were given permission in Khulna, Bagerhat, and Satkhira with final clearance from the department. Whereas the 21 industrial units of Mongla Export Processing Zone, 21 industrial units of Mongla Port Industrial Area, and five other industrial units near the port area also received permission (Prothom Alo, 2017). But in the ground the reality is different. The popular daily newspaper *The Daily Star* reported (June, 2018) that in the mid-way of 2017 the Department of Environment's environmental clearance committee held off on giving the license to Navana's Liquefied Petroleum Gas (LPG) bottling plant in Mongla, since the plant was within the designated Ecologically Critical Area around the Sundarbans. But interestingly half a year later, their opinions changed, and Navana's plant got a freshly minted license and so did at least 11 other LPG bottling plants. They got certificate as green industries- industries that are not harmful for the environment – putting them in the same category as solar plants and bio-fertilizer factories. In this way, the government has recently taken initiatives to promote industrial development and expansion, specifically in the southwest region, allowing establishment of several industries by re-classifying them to “Green” from “Red” (Siddique, 2018). Rights activist Sultana Kamal raised voice against this issue after such changes and noticed that these 24 red category units will not have to show any Environmental Impact Assessment (EIA). At its 39th session in July 2015, the World Heritage Committee issued a decision concerning the Sundarbans World Heritage site, which, among other things, formally requested that the government provide additional information on the potential impacts from the operation of the Rampal plant to the property, and the proposed mitigation measures to minimize the impacts. The Committee's multiple requests indicate that there is insufficient information for it to be adequately ascertain the project's potential threats. They also claimed that the government has taken little or no action to meet many of these requests. In particular, it has not accessed the impacts of dredging on the Sundarbans or assessed the indirect and cumulative impacts on the Sundarbans from the coal plant projects and other developments in the vicinity. Other concerning developments since the Committee's July 2015 decision include:

- Rapid movement towards beginning construction of the Rampal plant;
- Progress towards developing the Orion Khulna coal plant across the river from the Rampal plant;
- Dredging of the Pashur River to create landfill at both sites;

- A third major shipping accident in the Sundarbans over the span of one year; and
- A fact-finding mission documented irregularities in the environmental impact assessment process as well as multiple human rights violations associated with the Rampal plant.

Moreover, despite receiving objections from UNESCO's World Heritage Committee and the IUCN, Bangladesh has approved more than 320 industrial projects in the area (The Independent, 2018). This has become a cause for concern for the environmentalists who fear such large-scale industrialization in Sundarbans, will have a severely adverse effects on the biodiversity and ecosystem of the largest mangrove forest in the world.

It is well argued now a days that establishment of Rampal Power Plant encouraging other Industries in the area. Since the government decided to set the Bangladesh India Maitree Super Thermal power plant at Rampal near the Sundarbans, industrialists rushed to the Mongla area to buy agricultural land and homesteads to make industrial plots. Industrialists purchased around 150 plots to set up different kind of industries on the bank of the Passur River in the Mongla area (Roy, 2018). UNESCO (2017) asked Bangladesh to initiate a Strategic Environmental Assessment (SEA) in the southwest region of the country including the Sundarbans. But that suggestion is yet to be carried out by the government, which is making strength to coal plants to power its growth.

In September 2015, South Asians for Human Rights (SAHR), a non-governmental organization that “seeks to contribute to the realization of South Asian peoples’ right to participatory democracy, good governance and justice for stopping the irregularities in the environmental review process for the project, including essential elements of legitimate environmental decision-making. For example, the report noted obstacles preventing local communities and advocacy groups from accessing and adequately reviewing the draft EIA:

The [draft EIA], written in English, is 676 pages long and was not disseminated among any citizens’ groups. It was available only online and the time for sending people’s views on the report was limited to two weeks that too, during the Eid holidays when all the offices were closed for 3-5 days. It appears that people’s access to the report was deliberately restricted by the government.

The report further documented a lack of meaningful public participation throughout the EIA process:

The EIA states that different groups of people, including farmers, fishermen, development workers, activists etc., were consulted. Locals claim however, that opinions reflected in the EIA were misleading, partisan and unrepresentative of people’s true sentiments. Informants alleged that most of the people who were invited to discussions for the EIA were affiliated with the ruling party, and as such, they did not represent the people’s concerns about the environment, loss of livelihoods etc. ... Within a week from the event, the EIA was finalized, without incorporating any of the changes suggested by the stakeholders.

These procedural irregularities call into question the legitimacy of the environmental review process and its conclusions. The NEWAGE (August 25, 2017) reported

“Environmentalists accused that the government is playing ‘leading role’ in polluting the Sundarbans by giving certified to establish factories and other installations” and they said that the absence of boundary of the ECA around the Sundarbans paved the way to allow the environment department to provide environmental clearance and further renew those. The government took more than 16 years to finalize the map demarcating the boundaries of ECA (NEWAGE, 2017). The owners of the factories, other installations gained environmental clearance and renewal certificates from the Department of Environment (DoE) over the period by taking advantages of the loopholes in the government orders.

Conclusion

The Sundarbans Mangroves are not only degraded in the buffer areas of reserve forest, they also have been reduced from the inner parts of forests. The coastal wetlands of Sundarbans dominated by mangroves are potentially threatened by degradations in a multiple way of risk factors. This is a great challenge to the forest department and coastal zone management authorities of Bangladesh to achieve the desired conservation objectives for the sea face of Sundarbans wetlands in an even more sustainable manner against the upcoming threats with predicted sea level rise in the region. Identification of potential threats of the coastal wetland is possible by the preparation of mangrove degradation checklists. The Management Development committee (MDC) can provide thus a perspective for management opportunities and challenges to restore the coastal wetlands dominated by mangroves in the Sundarbans. There is still scant research on the effect of industrialization in the Sundarbans in Bangladesh. It is, therefore, reasonable to expect that industrial pollution will start impacting the biodiversity of the Sundarbans in a way that could be irreversible in the near future.

References

- ADB. 1998. Report and Recommendation of the President to the Board of Directors on a Proposed Loan and Technical Assistance Grant to the People's Republic of Bangladesh for Sundarbans Biodiversity Conservation Project. Manila.
- Banu, N. 2016. Rampal Power Plant Vs Sundarbans. Bangla Sydney.
- Bavelas, J. B., Kenwood, C., and Phillips, B. 2000. Discourse Analysis. In M. Knapp, & J. Dary (Eds.), Handbook of Interpersonal communication (3rd ed., pp. 102-109), Newbury Park, CA: Sage.
- CEGIS. 2013. Final Report on Environmental Impact Assessment of 2x (500-660) MW Coal Based Thermal Power Plant to be Constructed at the Location of Khulna. Center for Environmental and Geographic Information Services, Ministry of Water Resources, Bangladesh pp. 500.
- Geertz, C. 1973. The interpretation of cultures: selected essays. New York: Basic Books.
- IANS.<http://www.sify.com/finance/industries-irreparably-damaging-sundarbans-fish-down-by-half-news-finance-sf1oG6dcidefj.html> retrieved on May 27, 2018.
- IRMP. 1998. Integrated Resource Development of the Sundarbans Reserve Forest, Bangladesh. FAO/UNDP Project BGD/84/0561
- Islam, M.S. 2011. Biodiversity and livelihoods: A case study in Sundarbans Reserve Forest, World Heritage and Ramsar Site (Bangladesh). A Master thesis submitted of the

- requirements for the degree of Master of Science (M.Sc.) in Management of Protected Areas at the University of Klagenfurt, Austria.
- Islam, R. 2018. Environmental Law in Bangladesh, LAW HELP BD. <https://lawhelpbd.com/international-law/environmental-law/environmental-law-bangladesh/> retrieved on 21.05.2018
- Khanam, M., and Shahnewaj. The Daily Star. 2017 <https://www.thedailystar.net/law-our-rights/environment-and-industrialisation-1507165> retrieved on December 19, 2017
- Mookerjea, S. and Misra, M. 2017. Coal Power and the Sundarbans in *Bangladesh: Subaltern Resistance and Convergent Crises. Against Colonization and Rural Dispossession: Local Resistance in South/East Asia-Pacific and Africa*. (Ed) Dip Kapoor, Zed Books. Chapter-X. PP.3
- Muhibbullah, M., Chowdhury, M.A.T., and Sarwar, I. 2007. Floristic Condition and Species Distribution in Sundarban Mangrove Forest Community, Bangladesh. *Journal of Biological Sciences*, 7: 384-388.
- NEWAGE. 2017. <http://www.newagebd.net/article/22683/hc-asks-govt-why-new-industries-in-10km-of-sunderbans-wont-be-declared-illegal> on 25, 2017
- Peng L. 2000. Environmental ecology and economic utilization of mangroves in China. China higher education press, Beijing, China.
- Prothom Alo <https://en.prothomalo.com/bangladesh/news/153543/186-industrial-projects-around-Sundarbans> retrieved on July 12, 2017
- Potter, J. and Hepburn, A. 2007. Discursive psychology: Mind and reality in practice. In A. Weatherall, B. Watson and C. Gallois (eds), *Language, Discourse and Social Psychology* (pp. 160–181). London: Palgrave.
- Rahman, N., Billah, M.M., and Chaudhury, M.U. 1979. Preparation of an up to date map of Sundarban forests and estimation of forest areas of the same by using Landsat imageries. Second Bangladesh National Seminar on Remote Sensing (9–15 December), Dhaka.
- Rahman, M. M., Chongling, Y., Islam, K. S., and Haoliang, L. 2009. A Brief review on pollution and ecotoxicologic effect on Sundarbans mangrove ecosystem in Bangladesh. *IJE E* 1:369-382.
- Riaz, S. 2016. Rampal Power Plant: The Death Sentence for Sundarban. https://www.academia.edu/37811672/Rampal_Power_Plant_The_Death_Sentence_for_Sundarban_--
- Roy, P. 2018. Bangladesh allows nearly 200 polluting factories near Sundarbans. DownToEarth. <https://www.downtoearth.org.in/news/forests/bangladesh-allows-nearly-200-polluting-factories-near-sundarbans-60358> retrieved on 30.04.2018
- Samarakoon, J. 2004. Issues of Livelihood, Sustainable Development, and Governance: Bay of Bengal. *AMBIO: A Journal of the Human Environment*, 33(1), 34–44. doi:10.1579/0044-7447-33.1.34
- Sanyal P. 1983. Mangrove tiger land: the Sundarbans of India. *Tiger paper*. 1983; 10(3):1–4.
- Sarkar, P.K. 2012. Fighting for the survival of the Sundarbans. Bangladesh: Climate Home News. <https://www.climatechangenews.com/2012/02/23/fighting-for-the-survival-of-the-sundarbans/> retrieved on 23.02.2012
- Sarkar, S. <https://www.thethirdpole.net/en/2018/03/16/rapid-industrialisation-poses-pollution-risk-to-the-sundarbans/> retrieved on March 16, 2018

- Siddiqi, N. A. 2001. *Mangrove Forestry in Bangladesh*. Chittagong: Institute of Forestry & Environmental Science, University of Chittagong.
- Siddique, A. 2018 Development in Southwest Bangladesh: Bane for Sundarbans? Bengal delta. <https://bengaldelta.net/industrial-development-in-the-southwest-bane-for-the-sundarbans/> retrieved on 08.09.2018
- Strauss, A., and Corbin, J. 1998. *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.
- The Daily Star. 2018. License to harm Sundarbans: Govt allows 190 industrial units within 10km of the forest; 24 of them extremely harmful, Published on April 6, 2018. <https://www.thedailystar.net/frontpage/licence-harm-sundarbans-1558918>
- The Independent <http://www.theindependentbd.com/post/160343> retrieved on August 1, 2018
- Siddique, A. 2018. Greens: Amendment favours LPG factories, endangers the Sundarbans, published in The Daily Star, 8 April, 2018.
- The Third Pole. 2018. Rapid Industrialization Poses Pollution Risk to the Sundarbans. <https://www.thethirdpole.net/en/2018/03/16/rapid-industrialisation-poses-pollution-risk-to-the-sundarbans/> retrieved on March 3, 2018.
- UNESCO. The Daily Star. 2017. UNESCO Withdraws Objection to Rampal Power Plant near Sundarbans. <https://www.thedailystar.net/environment/unesco-withdraws-objection-rampal-power-plant-construction-near-sundarbans-bangladesh-1429213> retrieved on July 6, 2017.
- WCMC 2001. Protected areas program: World Heritage Sites. UNEP World Conservation Monitoring Centre, Cambridge, United Kingdom. <http://www.unep-wcmc.org/sites/wh/sundarb.html>.

River Training Program and Hydro Morphological Dynamics: A Case Study of Bangabandhu Bridge at Jamuna River

Sahinur Rahman*
Mohammad Sujoun Lasker**
Md. Nurul Islam***

Abstract: Bangladesh is a riverine country with hundreds of rivers overlaying its landscape. Bangladesh is physically divided by several rivers, which need to be bridged over in order to develop the country's infrastructure. One of these, the Bangabandhu Bridge which cross the Jamuna river. The River Training Works (RTW) has to ensure that the river remains flowing underneath the bridge. This was accomplished by constructing a pair of banana-shaped guide bunds, a pair of hard points, flood embankments and by closure of river branches. This study investigated the relation between bank line shifting and channel change with latent impact of water level and discharge in Jamuna river Bangladesh. Landsat TM satellite images (resolution 30 meter) for the year 1975, 1985, 1995, 2005 and 2015 are used to delineate the bank line shifting and channel migration. The hydrological data water level and observed discharge data collected from the Bangladesh Water Development Board (BWDB) to flow regime analysis. Geographic Information System (GIS) and Remote Sensing (RS) techniques are used to analyze the spatial and temporal changes of the bank line and channel shifting. The exploratory statistical data analysis techniques are used to trend analysis of the hydrological parameters. The cross-sectional width has been measured of the four cross-sections of the study site. The results reveal that during monsoon the water level and discharge is very high and low in post monsoon season. In contrast of the study reach, there is a sharp distinguish observed among the cross sections. The minimum channel width was 4.19 km in 1975 at the cross section 3 and maximum width was 15.53 km in 2005 at the cross section 1. Hydrological phenomenon is one of the main causes for the increment of the flow in the Jamuna river which bring changes in bed erosion and deposition. The variation of the channel width is mainly causes of channel change and bank line shifting are influenced by complex set of hydrological and geomorphological phenomenon discharge, erosion, accretion, flood and earthquake etc.

Key Words: River Training Work, Erosion, Accretion, Bank line Shifting, Water level, Discharge,

Introduction

River dynamics play the most energetic role in the socio-economic sphere of the country. River bank erosion and its protective measures are very important for sustainable river management. Protective measures may vary as per river characteristics, social attitudes, knowledge and practices of executing agencies. The pattern and intensity of riverbank erosion largely depends on the hydro-morphological characteristics of the river (Rahman

* Research Consultant at Center for Environmental and Geographic Information Services (CEGIS). Gulshan-1, Dhaka.

** Master of Engineering, Space Technology Application, Beihang University, Beijing, China.

*** Professor, Dept. of Geography & Environment, Jahangirnagar University.

et al., 2012). River Training Works (RTW) is required to protect project infrastructure against erosion by the river. Bangladesh is predominantly a low-lying riverine country situated in the South Asian Subcontinent. There are almost 700 rivers including convergence of Ganges (Padma), Brahmaputra (Jamuna), and Meghna and their tributaries were run through country (Banglapedia, 2012). The physical characteristics, geographical position, climatic condition, and auto-cyclic fluvial courses have produced numbers of big multi-channel river following through country with separate channel width of up to 5 km in which scour generated around 50 m depth (Best *et al.*, 2007). The channel width becoming large and depth is reducing over the year due to unfavorable geographical location and river flow control by the countries upstream reaches, that's leading to unexpected erosion deposition processes along the river. Thus, bank erosion and channel shifting of alluvial rivers are under serious problem in social, economic, and environmental aspect (Zhang *et al.*, 2011). The Jamuna is one of the largest rivers in the world ranking fifth in terms of discharge and eleventh in terms of drainage area (Thorne *et al.*, 1993). The annual hydrograph of the river is characterized by low flows in winter, between January and March, and high flows in summer, between July and September. The summer high flow season occurs due to a combination of snowmelt runoff from the Himalayas and monsoon rainfall in India and Bangladesh. The average annual flood is 70,000 m³s⁻¹ while the average low flow is 4,250 m³s⁻¹, which yields a ratio of high to low flow that is greater than 16. The Jamuna River is the downstream reach of the Brahmaputra River in Bangladesh. It is braided in nature and its channels are very dynamic. During the last few decades, the Jamuna River has increased its braiding intensity and width. The rate and fluctuation of water flow as well as sediment transport, which are very high, result in erosion/deposition, channel shifting and bar (char) development (CEGIS, 2010). Bed materials and bank materials of the river have very little resistance against erosive forces generated by the flow.

The planform changing process includes changes in width, braiding intensity and extent of annual bank erosion. At present the length-averaged width of the river is more than 12 km (Sarker *et al.*, 2011). The cost of the riverbank protection along the Jamuna River is very high. The Bangladesh Water Development Board (BWDB) has been trying to protect the riverbank with its limited resources in order to decrease the sorrow of the people and diminish national losses. Rapid channel development and channel shifting make the protection work difficult. Since the early 1970s, bank protection works in the Jamuna River have been practiced. The Sirajganj town protection works of the 1970s is probably the first major intervention for protecting the river Jamuna. Several bank protection works were constructed during the last one and half decades. Different types of bank protection works were tried with different construction materials to obtain an economic but sustained solution for the Jamuna River.

Since 2000, Remote Sensing (RS) and Geographical Information System (GIS) technologies are widely used tools to study of physical environment dynamics through longitudinal monitoring (Andrea *et al.*, 2001; Stabel and Loffler, 2004; Twumasi and Merem, 2006; Islam, 2006). Jamuna river is highly dynamic and constantly changing the bank line of the channel, which ultimately affects all aspect of the adjacent floodplains. The Bangabandhu Bridge, one of the largest in South Asia, was completed across the

Jamuna River in 1998, connecting Sirajganj with Bhuapur on the river's east bank and thus it requires river training of the large river. A research was carried out by Islam *et al.*, (2017) to find out the impacts of Bangabandhu Jamuna Multi-purpose Bridge on the dynamics of bar morphology of Jamuna River, which is a great endeavor of river training program and assesses to the mid channel bar dynamics using the satellite image analysis. This study gives an overview how a bar develops and changes due to obstacles of natural flow of the river. A river training program attempts to control of river bank erosion to stable the physical structures of the channel banks and natural flow will pass under the bridge without any hurdle. In this context, it is very important to investigate the effects of hydraulic parameters in the Jamuna river and how erosion and accretion cause changes on the bank line and effects of dynamics of channel width.

Aim and Objectives

The aim of this research is to monitor the variation of hydrological and morphological characteristics of the Jamuna river due to river training program. To meet the aim of this research several specific objectives are given below:

- i. to investigate the river training program of the study area;
- ii. to explore the hydrological characteristics of the Jamuna river; and
- iii. to examine morphological characteristics of the study site.

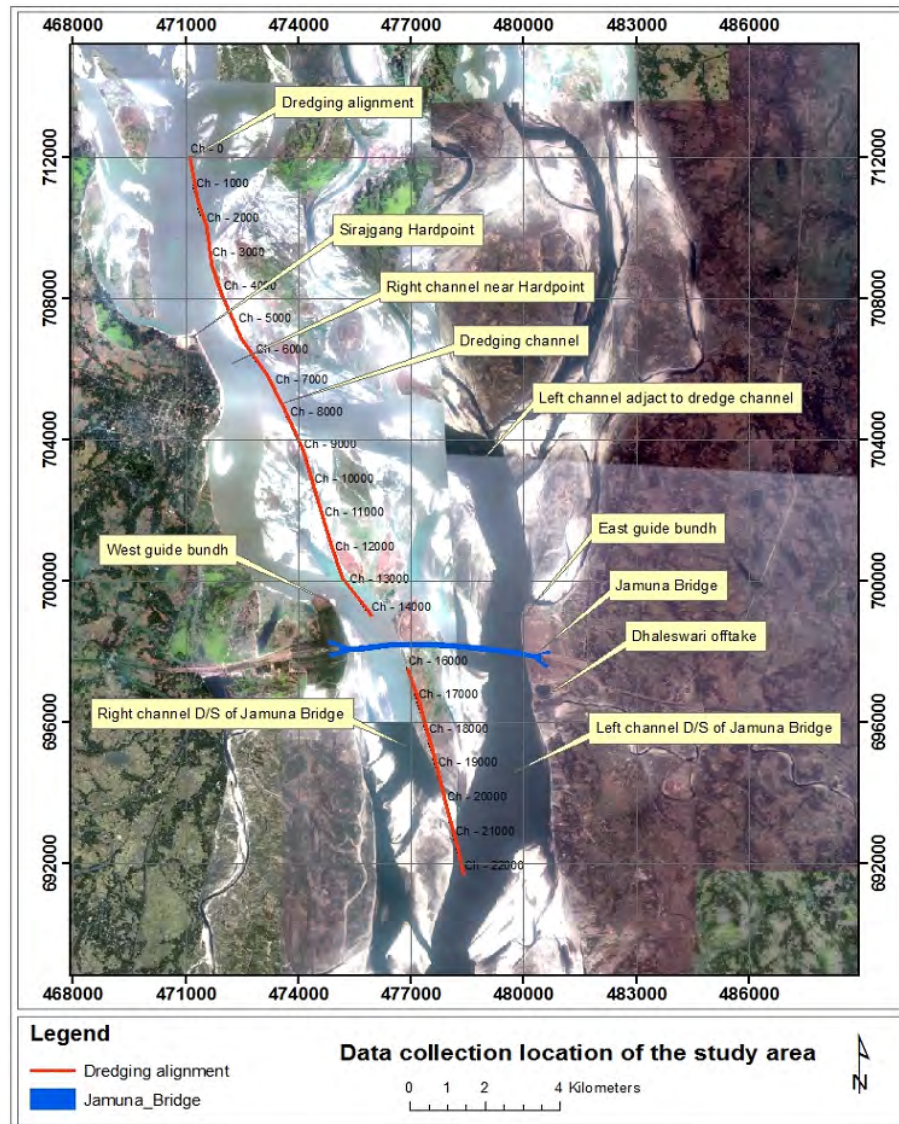
Study Area

The Jamuna, one of the largest river in Bangladesh, originates at the source of a glacier in the Kailas Range of the Himalayas, south of the Gunkyd Lake in southwestern Tibet. The river rises at an elevation of about 5300 m (Goswami, 1998) and then flows 1100 km eastward across the Tibetan Plateau as the Tsangpo River, before turning south to cross the east- west trending ranges of the Himalayas. The total catchment area is 570,000 km² of which only 7% lies in Bangladesh. The maximum flow recorded in the river at Bahadurabad is 100,000 cumec in 1988. The low flow recorded is 2,860 m³ in 1971, the average flood and low flow are 68000 and 4600 m³, respectively (Sarker *et al.*, 2003). The average width of the river is about 12.5 km (CEGIS, 2010). Bank materials of the river reaches are mainly unconsolidated, fine non-cohesive and uniformly graded (Thorne et, al. 1993). Total length of the Bangabandhu Bridge is 4.8 km. River Training Works starts in 1993 and the bridge open in 1998. River Training length- 3.2 km in both side and the hard point is 1.7 km.

Data Source and Methodology

Landsat imagery is used in this study as main data source. The spatial resolution of Landsat imagery is sufficient for river morphological analysis particularly identify and monitor the dynamics of river systems, migration of the bank line, movement of river channels and eroded and deposited riverbanks (Priestnall and Aplin, 2006). Time series of (1975, 1985, 1995, 2005 and 2015) Landsat TM images with 30 meter resolution has been used to detect the bar dynamics and channel change of the Jamuna river and its adjacent areas. All of these satellite images are collected from USGS Earth Explorer.com.

Flow regime of the Jamuna river is investigated by various recorded hydrological parameter data such as water level data from 1998 to 2018 and discharge data from 2000 to 2014. All the collected information and data from various sources is analyzed by different method with the help of different GIS and RS software. Statistical analysis average, mean, maximum, minimum, range etc. have been calculated and various types of representation such as data table, line graphs, column diagrams etc. have been produced. Finally dynamics of river systems, migration of the bank and river channel pattern are mapping and analysis.



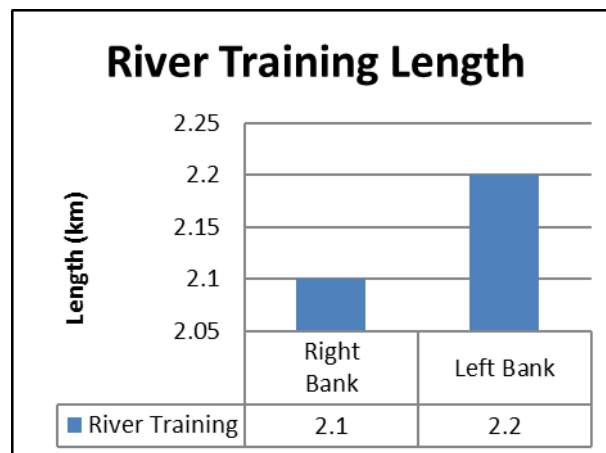
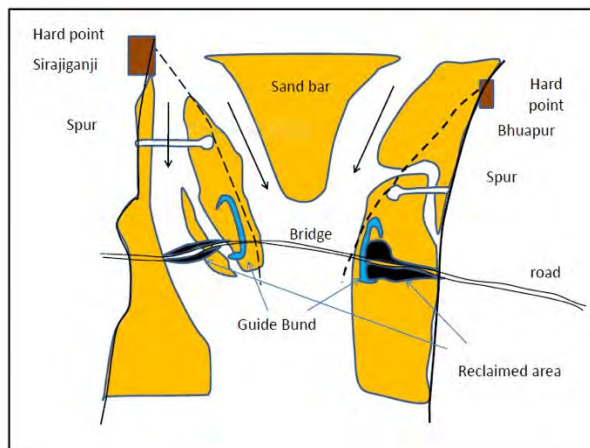
Source: Google earth image, compile by author

Figure 1: Location of the study area

Results and Discussion

Investigate the river training program

The construction of the river training works started in the year of 1993. Land acquisition for the river training program is more than 7000 acres. Total Directly and indirectly affected household was 16500 in a population of 100000. Forced relocate household was 4500 and Total resettled households 1231 (612 households in the West resettlement site and 619 households in the East resettlement site).



Source: author, 2016

Figure 2: River training work in Jamuna river

The hard point is 2.5 km with revetment at Sirajgonj. In planform the guide bunds look like banana shaped structures. Their function is two-fold they protect the bridge abutments against current attack. The river narrowed to about 5 km in between the guide bunds.

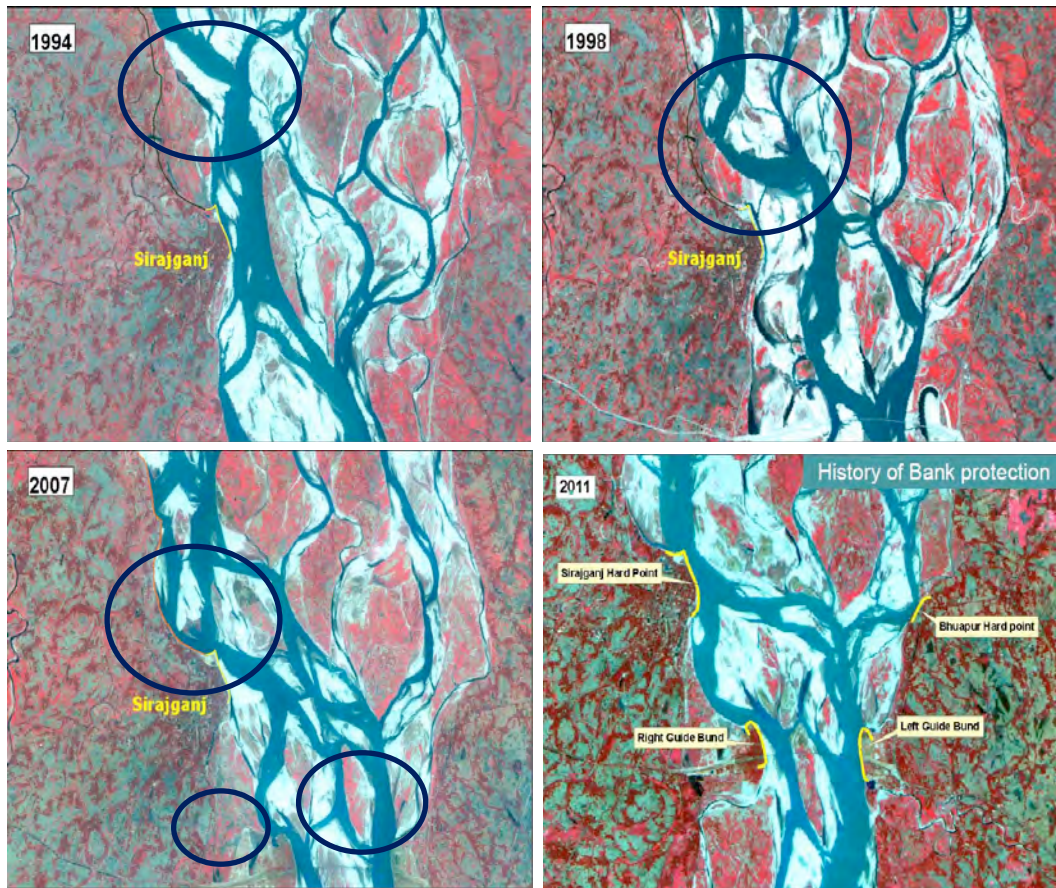


Figure 3: Historical bank protection of Jamuna river

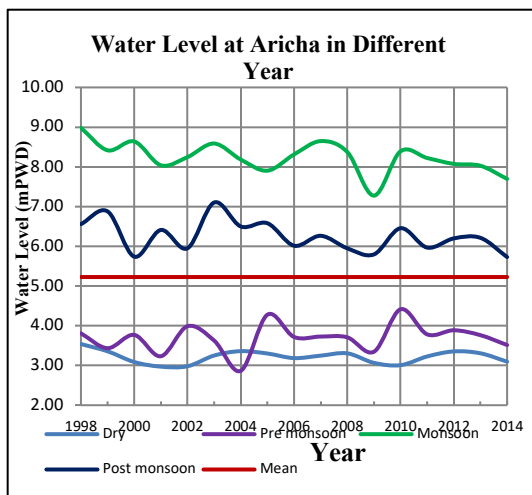
Water Level data analysis

The Jamuna and the Padma are the rivers with peculiar characteristics i.e. heavy water flows in the monsoon but less in the dry season (winter). The Jamuna has a lot of islands which are inundated in the monsoon in normal water level. Due to the heavy water flow in the monsoon and flood, the locations of the Jamuna river channel are always changing. The same phenomenon is also observed for the Padma (Islam, 2010). This research focused on the hydrological parameters (water level and discharge) which are related with the dimension of river, spatial and temporal shifting of the bank lines and the changes of associated bars due to geomorphic processes (erosion and accretion). Water level and observed discharge are analyzed by the time series of statistical data from 1998 to 2014. Data are collected from the Bangladesh Water Development Board (BWDB). Water level and discharge data at two stations, Aricha and Sirajgonj in Jamuna river has been analyzed yearly.

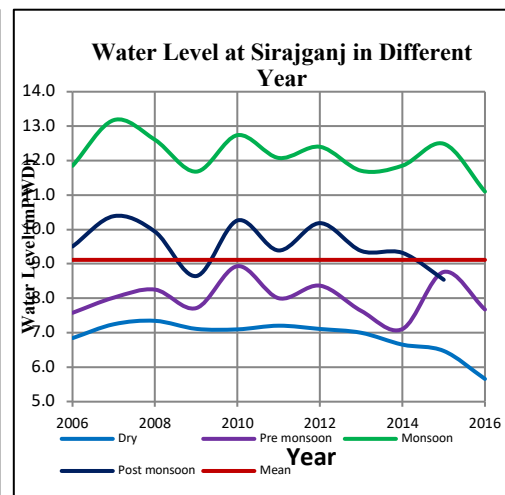
Maximum water level was found 14.92 mPWD all over the year that observed in 2007 and minimum water level was found 6.19 mPWD that observed in 2014 at Sirajgonj

gauging station. Mean water level of Sirajgonj gauging station was 9.28 mPWD. Monthly average highest water peak was 13.70 mPWD among all over the year it was occurred in august 2007 and monthly average lowest water peak was 6.20 mPWD all over the year that observed in February 2014.

At Aricha gauging station monthly average highest water level peak was found 9.86 mPWD in august 1998 that means monsoon season and the monthly average lowest water level was 2.32 mPWD in February 2010 that means dry season. Mean water level of Aricha gauging station was 5.31 mPWD. Maximum water level was 10.76 mPWD among all over the year it was occurred in 1998 and minimum water level was 2.08 mPWD all over the year that observed in 2010.



Source: BWDB, 2016



Source: BWDB, 2016

Figure 4: Water level at aricha in different season

Figure 5: Water level at Sirajgonj in different season

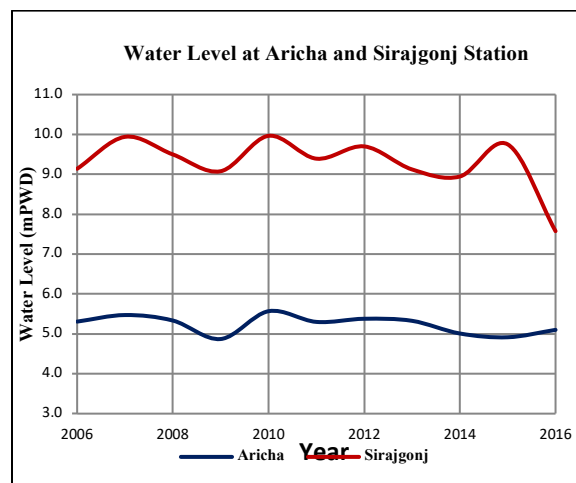
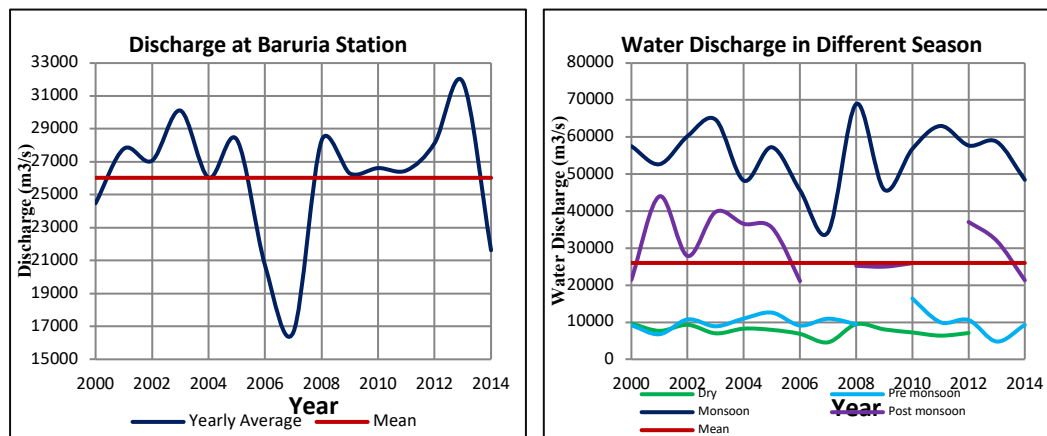


Figure 6: Comparison of average water level between aricha and Sirajgonj Gauging Station from 1998 to 2016.

Dynamics of the Water Discharge

Discharge has been analyzed monthly, yearly and season wise from 2000 to 2014. The average of all year discharge data of Baruria transit exposes that discharge gradually increases in the month of July, August and September. Maximum water discharge was found in monsoon season and lowest water discharge was found in dry season. The maximum water discharge was 68946.63 m³/s in 2008 all over the year in monsoon season and the minimum water discharge was 4597.12 m³/s in 2007 in dry season. The yearly average highest discharge was 32853.09 m³/s in 2013 and the minimum yearly discharge was 16631.05 m³/s in 2007. The yearly average discharge was in 26028.67 m³/s in 2000 to 2014.



Source: BWDB, 2016

Figure 8: Average Water Discharge at Baruria Gauging Station (2000-2014).

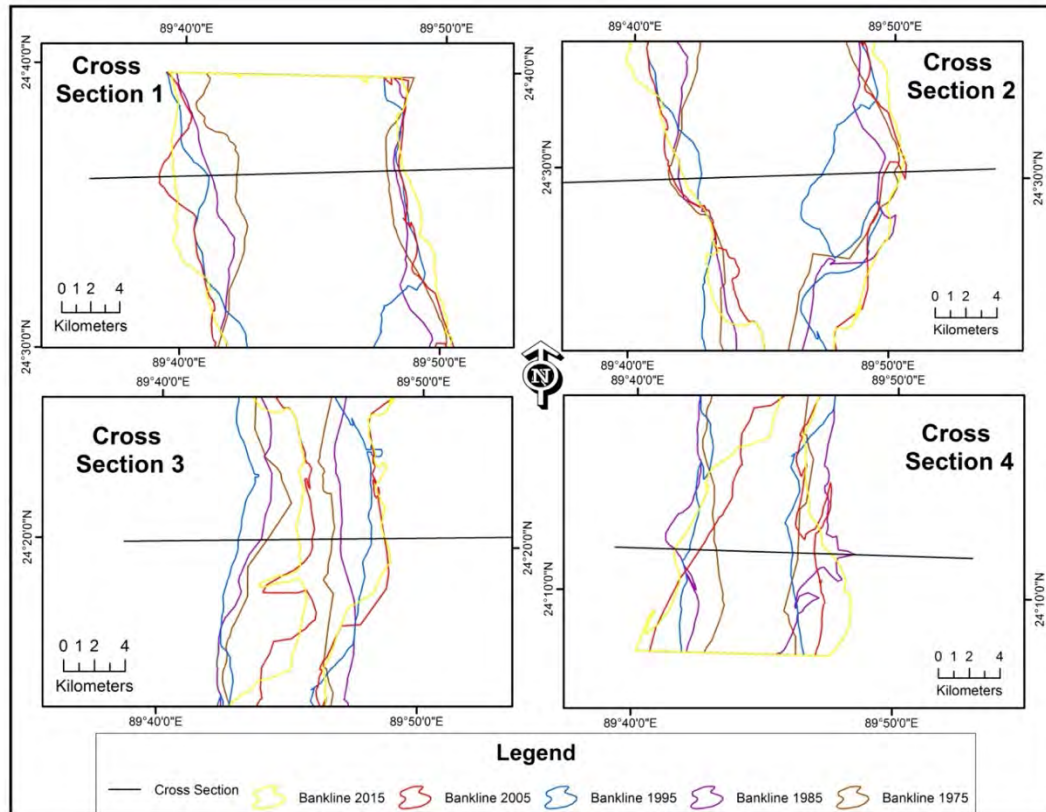
Figure 7: Yearly average water discharge at Baruria with mean discharge in (2000-2014).

Bank line Shifting

Practice of bank protection structures along the Jamuna River started in Bangladesh from the 1970s. Most of the erosion protection works along the Jamuna River are groynes/spurs and revetment works. In the 1970s and '80s, different local scale initiatives were taken by the BWDB to protect Sirajganj town. In the early 1990s, a China Bangladesh Joint Expert Team (CBJET, 1991) also addressed the possibility of training the

Jamuna. The major large bank protection structures were constructed in the 1990s included the Kamarjani permeable groynes, guide bunds for the Bangabandhu Bridge, Sirajganj town protection revetment, hard points of Sariakandi and Mathurapara, Kalitola groyne, Bahadurabad revetment, and Bhuapur revetment. River width changes because of the changing nature of hydro morphology of a river. In the hydrological variation as like as water level, discharge and tides, there was a massive change found in the river morphology. Observation of satellite image for 1975, 1985, 1995, 2005, 2015 years are usually used compare the bank line shifting from Padma multipurpose bridge project area at the different reaches. To easy the measurement of bank line shifting the study area are

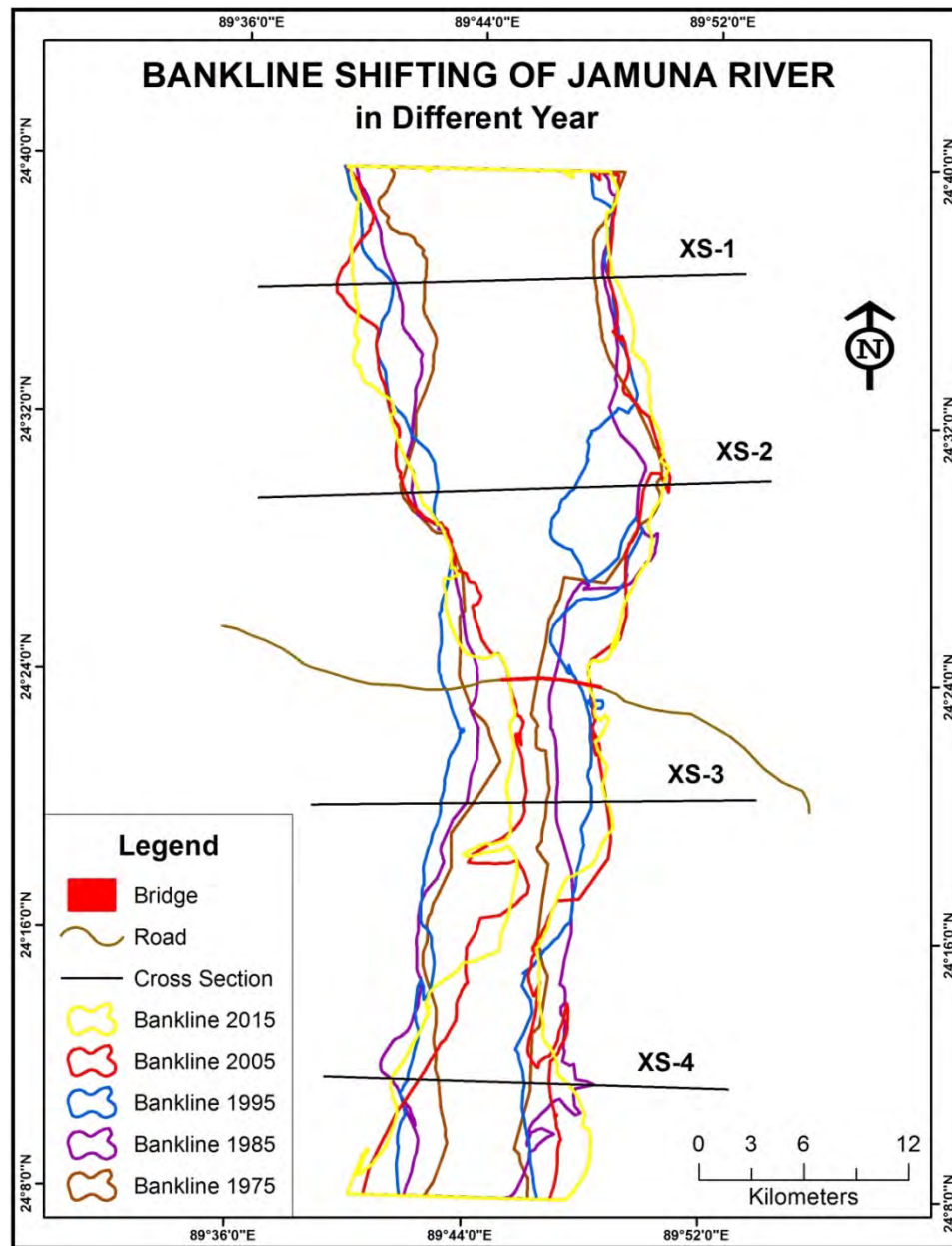
divided into five cross section. Those are XS-1, XS-2, XS-3, and XS-4. All those cross section are located at different absolute and relative location.



Source: USGS, Compile by author, 2016

Figure 9: Bank line of the Jamuna river in different cross section

The shifting of the Jamuna river shows that the mitting point of the rivers has been changed into different direction into different cross section. The main channel shifted one place to another place day by day. The channel of the Jamuna river undergoes changes in response to hydrological and morphological variation. In the study reach the cross section 2 was the highest shifted area and lowest shifted area was cross section 3. The minimum channel width was 4.19 km in 1975 at the cross section 3 and maximum width was 15.53 km in 2005 at the cross section 1. There was a huge change found in the bank line shifting in the jamuna river.

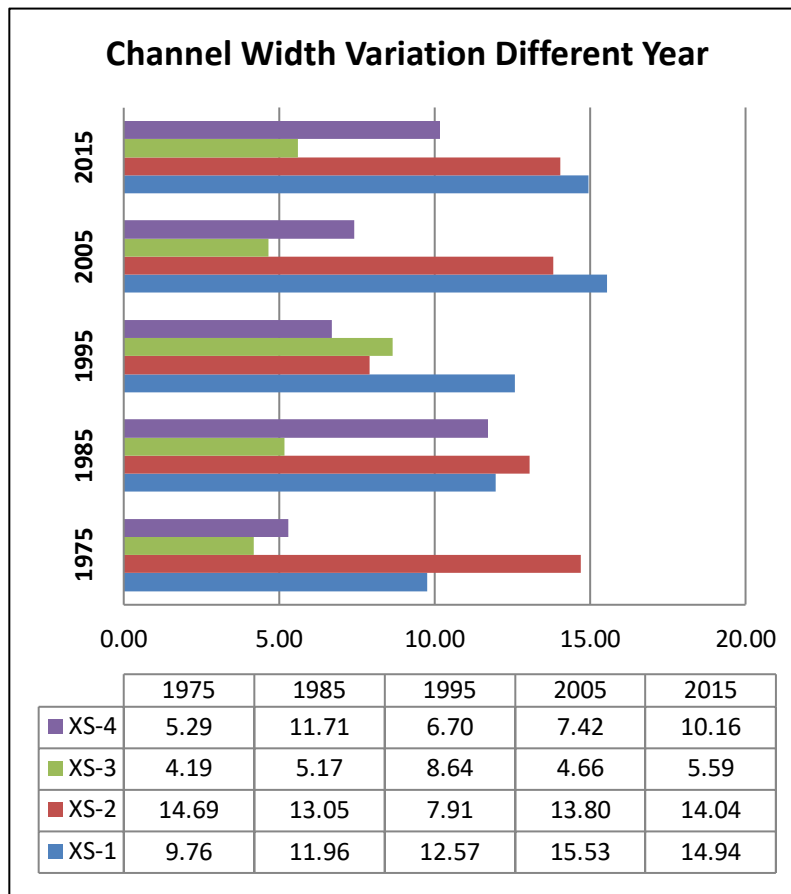


Source: USGS, Compile by author, 2016

Figure 10: Bank line shifting of the Jamuna river in different cross section

Jamuna is a braided river. Channels are always changes in this river. There are various causes are responsible for this change. The bank line of different years has drawn from satellite images. The natural channel pattern varies over a larger range of time and space scales. The analysis of the bank line shifting from different cross section exposes that the Jamuna river continuously changes its plan form through shifting of the channel. Continuous shifting of the thalweg from one position to another has been occurred within

banklines. It also indicates the erosion and accretion level at different cross section. Braided rivers are characterized rapid rates of erosion and deposition and frequent channel and braid belt avulsion (Bridge, 1985). Due to the erosion and deposition in the channel the Jamuna river is considered as a Ana branching and braided pattern. Study reach of the Jamuna river is changed along the cross section in different time period. Again it can also say that river channel has changed in a particular time period at different cross section. Due to natural processes bank erosion, down cutting and bank accretion the Jamuna river has changed and then changed the river channel pattern and the bank line in different cross section (figure 11).



Source: USGS, Compile by author, 2016

Figure 11: Channel width variation in different cross section

Conclusion

From the data analysis and result discussion, it can conclude that hydrological phenomenon is one of the main causes for the increment of the flow in the Jamuna river which bring changes in bed erosion and deposition. Higher bed erosion is caused by the higher amount of flow and deposition of eroded materials at downstream is also caused by these phenomena and also the climate change. Rainfall intensity and irregular flooding

scenario represents the enhancement of the flow, which may cause increment in velocity at certain locations. Maximum velocity causes threat to bank protective structures. The rate of annual riverbank erosion has been decreasing in the Jamuna River since the early 1990s. The rivers of Bangladesh are morphologically dynamic, so shifting of bank line and channel of the Padma and the Jamuna is quite normal phenomenon. The shifting of river channel of the Jamuna is faster than the Padma that is seen in this study since 1975 to 2015 using RS and GIS.

River training works for a dynamic river like the Jamuna required a flexible attitude from all parties involved. A detailed study needs to be carried out to assess the impact of the structures in reducing the erosion rate and influencing the overall morphology of the Jamuna River. The performance or stability of the different types of structures constructed with different materials should be evaluated along with vigorous investigation in connection with the local morphology of the river.

References

- Andrea, S.L., Douglas, E.J., Norman, R.H., and Grant, M.C. 2001. Stream Change Analysis using Remote Sensing and Geographic Information Systems (GIS). *J. Range Manage.* 54: A22-A50.
- Banglapedia. National Encyclopedia. The People Republic of Bangladesh; 2012. Available: <http://en.banglapedia.org/index.php?title=River> (Accessed 05 January 2016).
- Best, J.L., Ashworth, P.J., Sarker, M.H., and Roden, J.E. The Brahmaputra-Jamuna River Bangladesh. In *Large rivers: Geomorphology and management*. Wiley & Sons Ltd, Chichester. 2007;395430. Available: <http://onlinelibrary.wiley.com/doi/10.1002/9780470723722.ch19/summary>.
- Bridge, J.S. 1985. Pale channel patterns inferred from alluvial deposits: a critical evaluation. *Journal of Sedimentary Petrology*. 55: 579–589.
- CEGIS, 2010; Padma Multipurpose Bridge Design Project River Training Works Updated Scheme Design Report, Bangladesh Bridge Authority, under Padma Multipurpose Bridge Design Project, developed by MOUNSELL and AECOM.
- China-Bangladesh Joint Expert Team (CBJET), 1991. Study report on flood control and River training on the Brahmaputra River in Bangladesh, vol.1 and 2. Government of Bangladesh and Government of China, Dhaka and Beijing.
- Goswami, D.C., 1998; Fluvial Regime and Flood Hydrology of the Brahmaputra River, Assam, *Memoir Geological Society of India*, No. 41, 53-75. Sarker et al, 2003
- Islam, M.T. 2009a. Quantification of Eroded and Deposited Riverbanks and Monitoring River's Channel Using RS and GIS. *IEEE CNF*, the 17th International Conference on Geoinformatics, Fairfax, Virginia, USA.
- Islam, M.T. 2010. River Channel Migration: A Remote Sensing and GIS Analysis. *ESA Living Planet Symposium*. 052-D4, 1-6.
- Islam, R., Islam, M.N. & Islam, M.N. 2017. Impacts of Bangabandhu Jamuna Multi-purpose Bridge on the dynamics of bar morphology at the Jamuna River in Bangladesh, *Model. Earth Syst. Environ.* 3: 903. <https://doi.org/10.1007/s40808-017-0342-8>
- Priestnall, G. and Aplin, P. 2006. Spatial and temporal remote sensing requirements for river monitoring. *International Journal of Remote Sensing*, vol.25. No.11, pp. 2111-2120.

- Rahman, M.M., Arifur, R. M. and Munsur, R. M. 2012. Effectiveness of River Training Structures in Bangladesh, ICSE6 Paris - August 27-31, 2012.
- Sarker, M. H., Haque, I., Alam, M, Koudstaal, R. 2003. Rivers, Chars and Chars dwellers in Bangladesh. *International Journal of River Basin Management*, 161-80.
- Sarker, M. H., Akter, J and Ferdaous, M.R., 2011; River bank protection measures in the Brahmaputra-Jamuna River: Bangladesh Experience. Conference Paper · May 2011.
- Stabel, M.E and Löffler, E. 2004. Optimized Mapping of Flood Extent and Floodplain Structures by Radar Echo-Methods. Lacoste, H. (ed), Published: CDROM, Frascati, Italy.
- Thorne, C.R., Russel, A.P.G. and Alam, M.K., 1993; Planform Pattern and Channel Evaluation of the Brahmaputra River, Bangladesh, in 'Braided Rivers' IL. Best and C.S. Bristow (eds), Geological Society of London Special Publication No. 75, ISBN 0-903317-93-1, pp.257-276.
- Twumasi, Y.A. and Merem, E.C. 2006. GIS and Remote Sensing Applications in the Assessment of Change within a Coastal Environment in the Niger Delta Region of Nigeria. *International Journal of Environmental Research and Public Health*. 3(1): 98-106.
- Zhang H, Nakagawa H, Baba Y, Kawaike K, Rahman MM, Uddin MN. Hydraulic and morphological consequences of bank protection measures along the Jamuna River, Bangladesh. *Annals of Disas. Prev. Res. Inst. Kyoto Univ.* 2011; 54 B: 477-496. Available: <https://www.researchgate.net/publication/266353225>

Effectiveness of the Committee Systems at Union Parishad in Bangladesh

Dr. Muhammad Sayadur Rahman*

Abstract: Union Parishad (UP) is the oldest and the lowest unit of rural local government in Bangladesh which provides the local fundamental services to the rural people of Bangladesh. According to the UP act 2009, 13 Standing Committees (SCs) have been ensured in the UP to support the Parishad in ensuring transparency, accountability, and people's participation in planning and implementing for ensuring better governance and service. In order to assist UP in carrying out its functions properly, a provision of 13 standing committees has been made. However, the major complained against the committee systems of UP is, these committees are not effective and have failed to ensure accountability of the governing process of the Ups. With this contextual background, it is imperative to examine the effectiveness of UP standing Committees in performing its functions empirically. Therefore, this study intends to explore the functions and the effectiveness of the committee systems in UP with empirical evidence.

Introduction

Union Parishad (UP) is the oldest and the lowest unit of rural local government in Bangladesh which provides the local fundamental services to the rural people of Bangladesh. To ensure good governance at local level, it is the only institution we have (Siddiqui and Ahmed, 2016). Article 59 of the constitution of the People's Republic of Bangladesh says UP has a vital role of maintaining law and order, preparing and implementing plans relating to public services and economic development (GOB, 1996). Union Parishad has some fundamental functions to perform like education, health, family planning, social welfare and disaster management, and agriculture, fisheries and livestock. It also works on micro infrastructure; consolidate implementation of safety net programs and promotion of local economy (GOB, 2005). In order to assist UP in carrying out its functions properly, a provision of 13 standing committees has been made (Rahman, 2008). According to UP act 2009, 13 Standing Committees (SCs) in the UP to support the Parishad in ensuring transparency, accountability, and people's participation in planning and implementing for ensuring better governance and service. Thus, it is imperative to examine the effectiveness of UP standing Committees in performing its functions. Therefore, this paper intends to study the effectiveness of the committee system of Union Parishad with empirical evidence. The fundamental aim of this study is to clarify the effective working of different UP standing committees in the development activities of union parishad. In order to meet the objectives of the study, the following research questions have been set to address for finding out the effective functioning of standing committees of union parishad. Do the standing committees function effectively? Do the members participate in activation of the committees? What are the obstacles possibly faced by the members of standing committees in discharging their duties? And

* Associate Professor, Department of Public Administration, Jahangirnagar University, Savar, Dhaka-1342

how can we overcome the obstacles in order to ensure effective functioning of the committees?

Methodology of the Study

There are different methods exist in social research methodology like qualitative, quantitative and mixed approach (both qualitative and quantitative). Qualitative methods are mainly used to examine and understand the opinions of the respondents on social problems which make generalization about the problem. The study has been conducted based on qualitative approach following survey method. Data have been collected from field with a semi structured questionnaire forming each open ended and close ended questionnaire. Data have been collected from two main sources; primary and secondary sources. The Study has been conducted at Bagadana Union under Sonagazi upazila. Sonagazi is an upazila under Feni district of Bangladesh. This study has used purposive method of sampling. In this sampling technique the researcher purposely choose subjects who, in their opinion, are thought to be relevant to the research topic (Sarantakos, 1993). 50 respondents were selected as sample for this research. The respondents are representative in nature. The study covers three kinds of respondents. The first category is from members of the standing committees, Representatives both elected and government officials and mass people those who are living around Bagadana union.

The Formation of Union Parishad in Bangladesh

Union Parishad is the smallest and nearest institution of local government in Bangladesh. It is the oldest unit under local government emerged with the name Chawkidary Panchayat in 1870 as watchman. A local body 'Union Panchayat' emerged with more respectable role under the influence of Lord Ripon's famous Resolution of Local Self-government in 1882. The Chawkidary Panchayat and Union Panchayat were combined with a new name 'Union Board' under 'The Bengal Village Self- government Act 1919' (Ahmed, 2012). From 1960 to 1962 it was in the name of union council consisted of 10 members (Siddiqui, 2005). After the liberation war of Bangladesh, the government dismissed the Basic Democracy and introduced Union Panchayat in place of union council (Wahhab, 1980). According the local government ordinance 1976, a lot of changes were made in the structure and composition of Union Parishad (Khan, 2011). At the present time, UP is the lowest tier of local government and very popular to the general people. The UP is thus currently made up of 13 members. Among the 13 members, 1 Chairman, 9 general members – 1 from each of the 9 wards, and 3 women members elected to reserved seats each covering 3 wards (Talukdar, 2009). The main functions of UP are Maintenance of law and order and assistance to administration for this purpose, adoption and implementation of development schemes in the fields of local economy and society, Performing administrative and establishment functions and Providing public welfare services (UP act 2009, 47-1).

Standing Committees of Union Parishad and Its Roles and Functions

Among different problems that modern states are confronted with, is to identify the way(s) of ensuring a balance between the executive and the legislature. However, finding

the best way of ensuring the balance between these two important organs of modern democratic states is quite difficult. That is why; maximum use of standing committees (SCs) has emerged as one of the important ways of strengthening democratic institutions without weakening the executive. Members of SCs can not only formulate perfect decisions for an organization but also play an oversight role in the functioning of an organization. Members of the SCs could also encourage members of organizations to build up more specialized knowledge of policy areas, provide a means of keeping them busy and feeling useful, and enable them to actively participate in the governing process of an organization (Panday, 2018). Standing Committees have a high potential of ensuring transparency and accountability of Union Parishads, involving cross section of people in decision making process, reducing the dominance of one-man show of UP Chairmen, ensuring proper utilization of Annual Development Programme and Block Grants, and encouraging female members to perform important responsibilities at the local; the actual scenario is not that much encouraging (Rahman, 2008). However, these committees are not active in about 90% of the Parishads because the elected chairmen and other members are not properly aware and interested about its functions and jurisdictions (The Daily Star, October 27, 2014). The reasons behind the sluggish performance of Standing Committees may be attributed to a number of factors: lack of initiatives of UP members; lack of pressure from the common people; lack of political pressure; lack of skills required for planning and implementing development Programmes at the local level; no specific terms of references of Standing Committees; unwillingness on the part of UP Chairman to delegate authority and even non-existence of Standing Committees, or existence only on paper. All of above discussion made the researcher interested to conduct a research in this area of SCs of UP.

The committees are universal phenomenon of local government in different parts of the world. They exist in some form or other in all forms of local government. A committee is a body to which some tasks have been referred or committed (Muttalib and Khan, 1982). The roles of standing committees in Union Parishad are crucial, important and significant to improve the service delivery at grassroots level. Basically Union Parishad is a service delivery organization though its efficiency is completely unknown to the general people. Apart from all the roles of Union Parishad, making standing committees more effective and stronger should be one of the paramount criteria today to promote transparency and accountability to people. It will also assist UP to make them more participatory and democratic in management and decision making process (Ullah and Rahman, 2018).

But the scenario of Union Parishad is not very friendly on the question of effectiveness of standing committees. When it concerns the effectiveness of SCs of the Ups, it is found from the previous literature that in most cases, these committees have been formed but do not function properly. These committees have failed to ensure accountability of the governing process of the UPs which is their main activities (Panday, 2018). Most of the Union Parishads made it for official purpose, but practically their implication is not seen anywhere. The reasons behind the sluggish performance of Standing Committees may be attributed to a number of factors such as lack of initiatives of UP members, lack of pressure from the common people, lack of political pressure, lack of skills required for planning and implementing development Programmes at the local level, no specific terms

of references of Standing Committees, unwillingness on the part of UP Chairman to delegate authority and even non- existence of Standing Committees or existence only on paper (Rahman, 2008). Above discussion literary reveals that SCs of UP are simply dysfunctional and workless. So, it's urgent to examine how effectively SCs works practically.

Taking into account the gravity of SCs, the government of Bangladesh has incorporated the provision of the formation of SCs or committees in all local government bodies. These SCs work as a watchdog organization over different activities of their respective bodies. For instance, there are 13 SCs in the Union Parishad (UP) while the number of committees is 17 in the Upazila Parishad (UZP). In addition to these, the law has delegated both the bodies the authority to form additional SCs or committees in accordance with the provision of their respective law. Structurally, SCs of the UP are more organized as they have well-defined terms of references (ToRs) while UZP lacks it. Moreover, there are provisions for incorporation of general people as co-opted members in SCs and committees of UP and UZP respectively (Panday, 2018). Standing Committee is led by an elected councilor and requires 5 to 7 members. Each committee can co-opt citizens but such members will not have voting rights. Each SC has to meet every two months, but emergency meetings can be arranged any time. According to the section 38 of Union Parishad Act 2009, UP can formulate standing committees for each of these areas; Finance and establishment, Education and Mass education, Health, family planning and epidemic control, Audit and accounts, Agriculture and other development works, Social welfare and community centers, Cottage industries and cooperatives, Law and order, Welfare of women and children, Fisheries and livestock, Conservation of environment and tree plantation, Union public works, Rural water supply and sanitation. The roles and functions of standing committees are follows:

- Monitoring the activities of service providers and giving feedback to the general people based on their needs and demand.
- Give planning support to the service delivery provider and monitor the implementing process.
- Provide regular reports to the UP about the activities of the committee, decisions and monitoring with two month intervals.

Data Analysis and Major Findings: Socio-economic Status of the Respondents

This section explains the differences of opinions of the respondents because of their socio-economic background on the several factors that determine the effective functioning of standing committees of Union Parishad in Bangladesh. Though there might be many other factors that related to socio economic characteristics like age, gender, education, occupation and income that make the differences on the opinion when answering the questions in data collection period. Demographic information provides data regarding research participants and is necessary for the determination of whether the individual in a particular study are a representative sample of the target population for the generalization purpose (Salkind, 2010). The following table represents the respondent's

categories on the basis of socio economic backgrounds or demographic status of the respondents in this study.

Table 1: Demographic Status of the respondents

Variables	Number	Percent
Age		
25-35	6	12%
36-45	28	56%
46-55	12	24%
56+	4	8%
Total	50	100%
Gender		
Male	38	76%
Female	12	24%
Total	50	100%
Education		
Bellow SSC	20	40%
SSC	8	16%
HSC	6	12%
Honors	14	28%
MS	2	4%
total	50	100%
Occupation		
Farmer	6	12%
Business	28	56%
Job holder	8	16%
Teacher	4	8%
Others	4	8%
total	50	100%
Income		
Bellow 300000	20	40%
300001-600000	14	28%
600001-900000	6	12%
900001+	6	12%
Don't Want to Say	4	8%
Total	50	100%

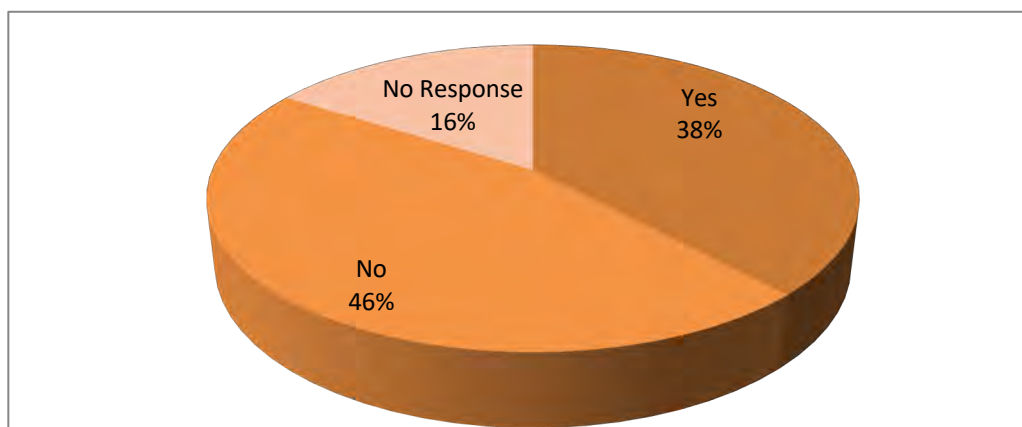
Source: Field Survey 2018

The presented data on the table shows that most of the respondents of this study were in the age category of 36-45 years. The number of respondents of this category is 28 (56%). It means that most of the members and chairmen of UP are in between 36 to 45 years. Above table also indicates that 38 (76%) respondents were male of this study and rest of the amount of respondents was female 12 (24%). Stated data on the table also disclosed

the educational background of the respondents. Most of the respondents were not highly educated, 20 (40%) respondents out of 50 were in the category of below SSC. It is observed that most of the local representative are businessmen. Most of the respondents of this study were businessmen. The table shows that 28 (56%) respondents were in this category of occupation. Income is another important demographic variable of this study where most of the respondents like 20 (40%) respondents were in the category of below 300000tk.

Functions and Performance of SC: Regular Meeting

Meeting is the formal issue of standing committee of union parishad. According to the act of 2009 of union parishad, the members of committees of UP have to arrange meeting in every month. The respondents were asked, do the members arrange meeting in a regular basis? The field responses are categorized below in the figure.



Source: Field Survey 2018

Figure 1: Respondent's Opinions on Regular meeting of SC

The presented data on the figure basically shows that the opinions of the respondents about the regular meeting of standing committees of union parishad. The respondents were questioned that do the members meet in a monthly basis? Most of the respondents were in the category of No. 46% of the total respondents said the members of the committees are not meeting in a regular basis (Monthly). 19 (38%) respondents were in the category of Yes that members of the standing committees are generally meeting in a regular manner. 8 (16%) respondents had no response to this specific asking. So finally, it is found that the meeting of the standing committees is not a regular phenomenon of Union parishad.

Discussion Issue

In the meeting session, the members of the committees discuss about the different agendas of local people, local development and local issues in order to improve the standard of living of local people. On that note, respondents were asked what are the discussing issues of standing committees during the session of monthly meeting. The answers of this question are categorized below.

Table 2: Respondent's Views on Discussion Issue

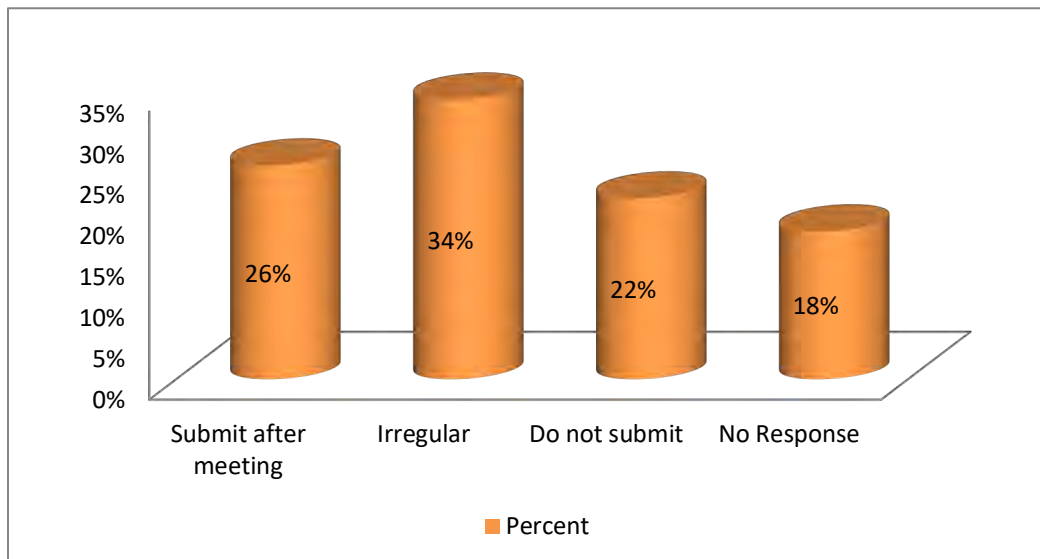
Categories	Number	Percent
Development projects	16	32%
Local issues	8	16%
Only meeting	19	38%
Nothing discussed	4	8%
No Response	3	6%
Total	50	100%

Source: Field Survey 2018

The above table is about the discussing agenda of standing committees of union parishad during the monthly meeting session. Most of the respondents said that they have no agenda; they just meet to each other and do gossiping. 19 (38%) respondents were in this category. 16 (32%) respondents said they talk about the development projects of local area. 8 (16%) respondents said only about local issues, they discuss during meeting session of standing committees. 8% respondents said that said they discuss nothing during meeting session. 6% were in the category of No Response. Basically the standing committees are nothing discuss in the meeting rather just meeting and gossiping.

Submitting Meeting Report

Every standing committee has to submit their meeting report to the respective UNO and DC after meeting of every month according to the manual of 2009 of UP. Because of that the respondents were asked that do the chairman of standing committees of UP submit their report to UNO and DC after meeting every month? The answers are categorized below.



Source: Field Survey 2018

Figur 2: Submitting Meeting Report

The presented data are about the submission of meeting report after meeting of every month by the chairman of different standing committees of UP. Most of the respondents were in the category of irregular. 17 (34%) respondents said that they submit their monthly meeting report irregularly. they are not regular in submitting their monthly report. 13 (26%) respondents said that they submit their monthly meeting report after meeting. 22% of the total respondents said they do not submit their monthly meeting report. and 9 respondents had no response about the meeting report submission. So, it is found that submitting meeting report is very uncommon phenomenon in union parishad.

Family Conflict Resolution & Women and Children Affairs in SC

Fundamentally the question was asked to the respondents is what is mainly the standing committee of Family Conflict Resolution & Women and Children Affairs (FCRWCA) doing to find out the effective working of this committee. The categories of the respondent's opinion are given bellow;

Table 3: Respondent's opinion on functions of FCRWCA

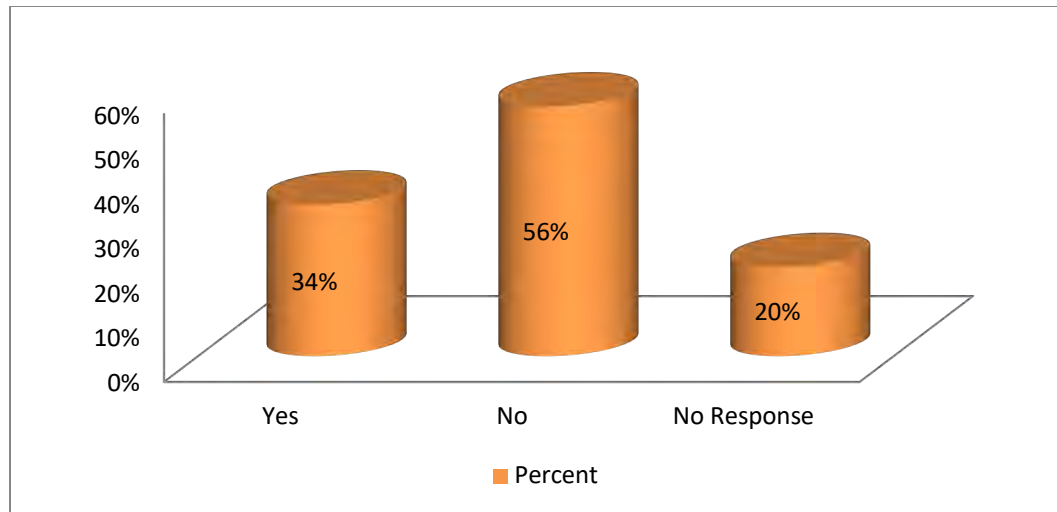
Categories	Number	Percent
Domestic Violence	12	24%
Reducing Child marriage	9	18%
Reducing Women and child abuse	13	26%
No Response	16	32%
Total	50	100%

Source: Field Survey 2018

The above table shows the data on respondent's opinion on the fundamental functions of FCRWCA. Most of the respondents had no response about the functions of FCRWCA. 16 (32%) respondents were in this category. 24% (12) respondents said it is working on basically to resolve the problem of domestic violence. 18% (9) respondents were in the category of reducing child marriage. 13 (26%) of total respondents were in the category of reducing women and child abuse. Finally it is found that this committee is basically works on domestic violence and reducing child and women abuse.

Standing Committee on Education

Members of the standing Committees activate Education Officer to improve the education system, logistic support, communication throughout the schools, determine the condition of different schools, activate the school management committees, improve the teachers quality, reduce the drop out children from school, increase the local contribution to the schools, develop the Infrastructure of the schools, Asses toilet facilities for male and female students and take necessary measures, determine the source and facilities of safe drinking water for students, improve the security conditions of the girl students and monitor the distribution of school books among students. Do the members of SC invigilate and maintain a cordial relationship with educational institution?



Source: Field Survey 2018

Figure 3: Respondent's opinion on Relation between SC and Educational institution

The above figure shows the statistics of respondent's opinions on relation between SC of education and educational institutions. Most of the respondents said that there is absence of a good relationship between the committee on education and educational institution. 56% (23) respondents said about that. 17 (34%) respondents were in the category of Yes that there is a maintained relation between SC and Educational institution. 10 respondents had no response on that specific question. so, above statistics indicates that there is no good relation between SC and educational institution which is very important for improving educational status of a region. There is another question the respondents were asked that what do they work on infrastructural problems of different institution? The respondents answer are given below

Table 4: Respondent's opinion on Functions of SC of Education in infrastructural problems of different institution (Multi Response)

Categories	Number	Percent
Logistic support	33	66%
Asses toilet facilities	16	32%
Sufficient Class room	25	50%
Sufficient teachers room	28	56%
Others facilities	14	28%
No response	3	6%

Source: Field Survey 2018

Above table with statistics is all about Respondent's opinion on Functions of SC of Education in infrastructural problems of different institution. Most of the respondents were in the category of logistic support for institution. 66% respondents were in this category. 16 (32%) of the total respondents said about assessing toilet facilities of

schools. 50% of the respondents said about sufficient class room. 56% (28) respondents said about sufficient teachers room. 6% (3) respondents had no response.

Agriculture, Fisheries and Livestock

Standing Committee members assess the Knowledge and technology known by the farmers of the locality, they also insist Block supervisors to assess the nature of supply of raw materials for agricultural production. Similarly they determine the flow and source of capital for agricultural production. Block supervisors also assess the nature of crop processing, management and facilitate the marketing strategy for the produced crops. Do they meet to the farmers in a regular basis?

Table 5: Respondent's opinions on SC meeting with farmers

Categories	Number	Percent
Yes	19	38%
No	27	54%
No Response	4	8%
Total	50	100%

Source: Field Survey 2018

The presented data on the table is all about Respondent's opinions on SC meeting with farmers. Most of the respondents were in the category of No that the standing committee on agriculture does not meet to the farmer in a regular basis. 54% (27) respondents were in this category. 19 (38%) respondents were in the category of Yes. 4(8%) had no response on that specific question. so it is found that the committee members of agriculture do not meet to the farmers on a regular manner. There is another question which was asked the respondents that "they provide raw materials to the farmers for agricultural activities"? The answer of this statement are given below regarding strongly agree, Agree, Disagree and Strongly Disagree

Table 6: Respondent's opinion on providing raw materials to the farmers

Category	Number	Percent
Strongly Agree	6	12%
Agree	7	14%
Disagree	5	10%
Strongly Disagree	32	64%
Total	50	100%

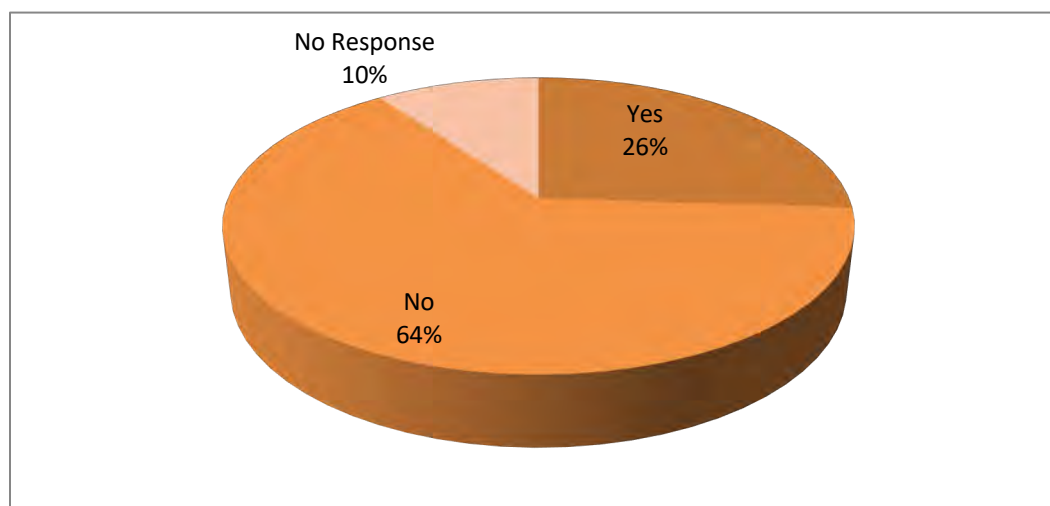
Source: Field Survey 2018

The above table shows the Respondent's opinion on providing raw materials to the farmers for agricultural activities. Most of the respondents said that the committee does not provide sufficient raw materials to the farmers for agricultural activities and they are not given strong support from the committee. 32 (64%) respondents were in this category. 12 % of the total respondents were in the category of strongly agreed and 14%

of the respondents were agreed to the statement. 5 (10%) are disagreed to the statement that they are no able to provide raw materials to the farmers in doing their tasks.

Public Health Issues

Members of the standing Committee activates health officers to get the regular status of EPI program, to know the sanitation behavior of the locality and source of safe drinking water. They also asses the Peoples Knowledge on ORS, determine the facilities and statusof MCH and also asses the Breast feeding behavior. The respondents were asked a question which is Does the committee of Health work according to the Mannual of 2009 of UP? The answer of the question is given bellow



Source: Field Survey 2018

Figure 4: Respondents views on Health committee

The above figure shows the data about the working of Health committee according to the rules stated in the Mannual of 2009. Most of the respondents said that the committee on health is not working according to the Mannual of 2009 of Union parishad. 32 (64%) of total respondents were in this category. 10% of the respondents had no response on this specific questions. It is finally found that the committee on health does not work according to the manual of 2009 of union parishad.

Importance of Standing Committee

There are two ways in which the SC can intervene to improve services at the local level. First, it can resolve on its own initiative the problem in service delivery identified through monitoring. Second, the SC can report the issue to UP monthly meeting and the UP chair can place the issue to either UZP level SC or UZP monthly meeting for appropriate action. Standing committee is important phenomenon in the development of local area. In order to find respondent's opinion a questions has been asked the respondents that How important the standing committees to improve the development of local area? The respondent's opinions are given bellow.

Table 7: Respondent's opinions on importance of SC

Categories	Number	Percent
High	33	66%
Moderate	9	18%
Low	5	10%
No response	2	4%
Total	50	100%

Source: Field survey 2018

Above table is about the importance of standing committee of union parishad in the development of local area. Most of the respondents said that the standing committee is highly important in the development of local area. 33 (66%) respondents were in this category. 9 (18%) respondents said that standing committee is moderately important in the development of local area of Bangladesh. 10 % of the respondents were in the category of low. and 2(4%) had no response on that specific question. Finally, standing committee is highly important for the local development.

Challenges of SC of UP

A question was asked to the respondents that what the challenges standing committee right now are facing in doing its task. The respondent's opinions are given bellow on the table;

Table 8: Respondent's opinions on Challenges of SC of up (Multi Response)

Challenges	Number	Percent
Chairman's Control	31	62%
Absence in the meeting	29	58%
Does not have autonomy	37	74%
Do not bother committee decision	11	22%
Not having accountability mechanism	23	46%
Political Biasness	25	50%

Source: Field Survey 2018

The above table discusses about the opinions of respondents on challenges of standing committees of UP in doing its task. Most of the respondents said about the autonomy of the committee. They said the committee does not have real autonomy to wok. 37(74%) respondents said about this. 31(62%) respondents said about chairman's control over the committee decision. 29 (58%) respondents said that the committee members are absent in the meeting session. 11(22%) respondents said the UP chairman does not bother the decision of the committees. 23 (46%) and 25 (50%) respondents were in the category of not having accountability mechanism and political biasness respectively.

Respondents Suggestions to overcome the existing challenges

In order to overcome all these challenges, the respondents were requested to give some suggestions; the suggestions from respondents are given bellow

Table 9: Respondents Suggestions (Multi Response)

Suggestions	Number	Percent
Reducing Chairman's Control	18	36%
Giving importance to the committee decision	22	44%
Free from political biasness	14	28%
Strong Accountability mechanism	25	50%
Monitoring the works of the Committees	27	54%

Source: Field Survey

Above mentioned data on the table shows the suggestion came from the respondents during field data collection to make standing committee effective in its activities. 18 (36%) respondents recommend to reduce chairman's control over the activities of SC of UP. 22(44%) of the respondents were talking about giving importance to the committee decision. 14 (28%) of the respondents said about making standing committee free from political biasness. 25 (50%) of the respondents said about strong accountability mechanism and 27(54%) were talking about monitoring system of UP.

Conclusion and Recommendation

The field study clearly reveals that strengthening the UP level SCs through SDLG project has resulted in quite promising results. In particular, the successes in preventing violence against women and children, lessening absenteeism of health and agricultural workers, protecting agricultural land from water logging and tidal water in coastal areas, and resolution of community level disputes have been encouraging not only for SCs themselves which were largely dysfunctional before, but also for other UPs which can take lessons from this innovative approach. However, the SCs also need to remain within the provisions described in the law and act through reporting to the respective UZP or government departments. Actions are needed to be taken by the government departments along with regular monitoring and review so that the same unwanted events are not repeated with regular flow of information from the SCs. At the upazila level, there are too many committees formed under ministry directives requiring too many meetings and with actions uncoordinated with the UP SCs. These committees may be minimized in number and coordinated more effectively with the UP SCs to create better results. Thus, we suggest the following recommendations to support local ownership, sustainability and institutionalization, and wider replication of the good practices.

- i. Encourage SCs to forward unresolved issues to upazila level. Greater interaction among SC members and upazila level officers should be promoted. It was found that in many cases SCs are unable to solve problems by themselves but not forward such issues to upazila level.

- ii. Urge sector projects to work with UP SCs. This step may make achieving the project's goal easier and will also support UP SC functioning.
- iii. Promote greater interaction among ministry committees at upazila and union levels and UP SCs. UP SCs can be a very useful source of information regarding service delivery of union level government staff.
- iv. Increase follow up monitoring activities by upazila level officers on previous interventions. This is required to ensure sustainability of solutions resulting from SC or upazila level officer interventions.
- v. Replicate the process of standing committee activation through training in other unions and introduce regular monitoring of government service providers. Initiatives by the SCs can enhance the community's trust and confidence in the UP body and the SCs' own sustainability.

Reference

- Ahmed, Tofail. (2012). *Decentralization and the Local State; Political Economy of Local Government in Bangladesh*. Dhaka: Agrangee Prakashani
- GOB (1996). Report of the local government commission for Strengthening of local government institution.
- GOB (2005). 'Unlocking the Potential, National Strategy for Accelerated Poverty Reduction', General Economic Division, Planning Commission.
- Khan, M. M. (2011). *Local Government in Bangladesh; Some Contemporary Issues and Practices*. Dhaka: AH Development Publishing House.
- Local Government (Union Parishad) Act 2009 (in Bangla), Bangladesh Code, *Ministry of Law*, Government of Bangladesh.
- Muttalib, M.A., and Khan, M.A.A. (1982). *The Theory of Local Government*. New Delhi: Sterling Publishers Ltd.
- Nur Ullah, M., and Rahman, M. S. (2018). *Local Government in Bangladesh: A Study of Zila Parishad*. London: Glimmer Publishing Ltd.
- OECD Working Paper, (2005). 'Fiscal Autonomy of Sub-Central Governments'.
- Okafor, J. (2010). 'Local government financial autonomy in Nigeria: The State Joint Local Government Account', *Commonwealth Journal of Local Governance*, 1(6): 125-131.
- Panday, P. K. (2018). 'Standing Committees for Effective Local Governance', *The Daily Sun*, March 14, 2018.
- Rahman, R. (2008). 'Scope and Performances of Standing Committees of Union Parishad; A case Study of Two Upazilas', *Institute of Governance Studies*.
- Siddiqui, K. (2005). *Local Government in Bangladesh*. Dhaka: University Press Limited.
- Siddiqui, K. & Ahmed, J. (2016). *Local Government in Bangladesh*. Dhaka: Academic Press and Publishers Library.
- Slack, E. (2017). 'How Much Local Fiscal Autonomy Do Cities Have? A Comparison of Eight Cities around the World', *Institute on municipal finance and governance*, 19(1): 2-10.
- Talukdar, M. R. I. (2009). *Rural Local Government in Bangladesh*. Dhaka: Osder Publications.
- Wahhab, M. A. (2002). *Decentralization in Bangladesh; Theory and Practice*. Dhaka: Osder Publications.

Changes in Pre and Post Aila Livelihood Vulnerability Level in Batiaghata, Khulna

Umme Salma Sonia*
Md. Manjur Morshed**
Jebunnessa***

Abstract: Over the years the coastal areas of Bangladesh have been immensely affected by disasters like Aila and Sidr which have not only created damages to assets and loss of lives but also have influenced the changes in daily livelihood pattern. Aila was one of the most devastating natural disasters for Bangladesh. Among the coastal regions, Batiaghtaupazila has been taken as the area of interest for the study to observe the changes in livelihood pattern between Pre- and Post-Aila stages. The objective of the study was to investigate the change of Pre- and Post-Aila livelihood vulnerability level of Batiaghata. The methodology that has been followed to identify the changes in the livelihood pattern was a composite index approach. Primary data has been collected through focus group discussion, key informant interview and questionnaire survey to analyze the present and past condition of upazila. In total 64 sample households were selected for the survey and a Livelihood Vulnerability Index has been developed consisting of seven major components. Additionally, the human development index has been used to standardize the components. After conducting the survey, it was found that the value of Livelihood Vulnerability Index was higher in Post-Aila stage than in Pre-Aila stage. The area has also low adaptive capacity in Post-Aila phase than Pre-Aila as a result of an increasing vulnerability in different sectors. Different types of steps can be taken to decrease vulnerability measures that helps in to building awareness and provisioning of alternative livelihoods should be introduced to the local people to decrease the vulnerability.

Key Words: Natural Disaster, Vulnerability, Changes, Developing Country, Bangladesh.

Introduction

Cyclone Aila caused significant damage to water sources, particularly in the severely affected Khulna District

Bangladesh is geographically located in a cyclone-prone area, and has a long history of being hit by cyclones. The coastal areas and off-shore islands of Bangladesh are low lying and very flat. The height above mean sea level of the coastal zone is less than 3m. Prompted by the deadly Bhola cyclone in 1970 soon after Bangladesh's independence, the new government launched a cyclone preparedness program, in 1972. After a cyclone in 1985, the government constructed multipurpose cyclone shelters across the coastal

* Department of Urban and Regional Planning, Khulna, University of Engineering & Technology, Khulna 9203, Bangladesh, e-mail: salma.kuet15@gmail.com (**corresponding author**)

** Department of Urban and Regional Planning, Khulna, University of Engineering & Technology, Khulna 9203, Bangladesh, e-mail: manjurmorshedkhan@gmail.com

*** Associate Professor, Associate Professor and Chairperson, Department of Public Administration, Jahangirnagar University, Savar, Dhaka, e-mail: asiranjar@yahoo.com

areas (sadik, et al., 2018). It is estimated that from 2000 to 2005 about 250 million assets were hampered by different natural disasters (Qaisrani, et al., 2018).

Cyclone 02B, later named as Aila hit the south-western coastline of Bangladesh on the early afternoon of May 25, 2009. Satkhira and Khulna districts of Bangladesh suffered the heaviest damage along with Bagerhat, Pirojpur, Barisal, Patuakhali, Bhola, Laksmipur, Noakhali, Feni, Chittagong and Cox's Bazar. Aila made landfall with sustained winds between 65 and 75 mph (74 mph is the lowest threshold for a Category one hurricane) (UNDP, 2010).

About 3.9 million people were affected because of this cyclone and it caused 190 deaths. The coastal defense structure and road communication system in the affected areas collapsed, as 237 km of embankment, 2233 km of roads, 175 bridges, and multiple culverts were seriously damaged or destroyed. Four upazilas (Dacope and Koyra under Khulna, and Shyamnagar and Assasuni under Satkhira district) were the worst affected by the cyclone Aila and following storm surge. 13 Unions out of 40 under these 4 upazilas have been flooded by the storm surge; 228 Villages were damaged. More than 500,000 people among 800,000 of these areas directly affected by the cyclone Aila and more than 297,000 people took shelter on the embankments, educational institutions, other buildings and cyclone shelters (Hasan, 2015).

Cyclone Aila has also caused a lot of difficulties for the people who live in the coastal areas. Moreover, the impact of a similar hazard is not same for all the areas or for different times. However, for the preparedness and protection against hazard also as for the mitigation of post-hazard emergency activities, it is necessary to know the demographic, socio-economic, public health and natural resources factors as well as regional vulnerable communities with variations (Hasan, 2015). To address the impact on livelihood vulnerability and related issues, a vulnerability assessment is needed. It will help to understand the complicated set of factors that contribute to the adaptive capability of the households. Vulnerability assessment describes a various set of ways used to systematically integrate and examine interactions between humans and their physical and social surroundings (Toufique&Yunus, 2013).

Methodology

Study area selection

The study concentrates on Batiaghataupazila of Khulna district as it was severely damaged by the cyclone. The total area of Batiaghataupazila is about 248.32 square km. The location is in between 22°34' and 22°46' north latitudes and in between 89°24' and 89°37' east longitudes. The north side of it is bounded by Kotwali and Sonadangathanas and Dumuriaupazila, and the south side is bounded by Dacope, Paikgacha and Rampalupazilas. It has also Fakirhat and Rupshaupazilas on the west and Dumuria and Paikgacha on the west (BBS, 2013). BatiaghataUpazila consists of 7 unions and 176 villages.

Sample size selection

For determining sample size the population of two villages (Boro Aria and Roypur) of Surkhali union of Batiaghataupazila has been used as this two villages were most affected by Aila throughout Batiaghataupazila.

According to Cochran Formula,

$$n_0 = \frac{z^2 pq}{e^2} = \frac{1.64^2 * 0.5 * 0.5}{0.10^2} = 68$$

$$\text{Sample size, } n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} = \frac{68}{1 + \frac{(68 - 1)}{926}} = 64$$

Here $z=1.64$ (90% confidence level)

$e=0.10$ (10% error)

$p=0.5=q$

And Total Households, $N=926$

LVI Components Selection

The Livelihood Vulnerability Index consists of seven main components and they are Socio-demographic Profile (SDP), Livelihood Strategies (LS), Social Network (SN), Health (H), Water (W), Food (F) and Natural Disaster (ND). Each of them is consisting of different indicators and sub-components. All of them played an important role to describe the whole situation of the study area. They were developed based on different literature reviews of papers and similar works and local area information (Hahn, et al., 2009). The table gives an explanation of how each sub-components was expressed, the survey question used to collect data and the original source of the components and survey questions.

Table 1: Major Components and Sub-Components of LVI

Major Components	Sub-components	Explanation of sub-components	Survey Questions	Source
Socio-Demographic Profile	Dependency ratio	Ratio of the population under 18 and over 60 years of age to the population between 19 and 59 years of age.	Could you please list the ages and sexes of every person who eats and sleeps in this house?	Hahn et al. (2009)
	Percent of female-headed households	Percentage of households where the Primary adult is female.	Are you the head of the household?	Hahn et al. (2009)
	Average education of the head of the household	Percentage of households where the heads of household report that they have attended zero years of formal schooling	Information collected from household roster on the level of education of each member, including the head of the household	Toufique and Yunus (2013)
Livelihood Strategies	Percent of households with family member working in a different community	Percentage of households that report at least 1 family member who works outside of the community for their primary work activity.	How many people in your family go to a different community to work?	Hahn et al. (2009)
	Percent of households dependent solely on agriculture as a source of income	Percentage of households that report only agriculture as a source of income	What is your Occupation? What are the occupations of your family members?	Hahn et al. (2009)
	Agricultural livelihood diversification index	The inverse of (the number of agricultural livelihood activities+1) reported by a household. For example, a household that cultivates rice, vegetables and has aquaculture in pond will have a livelihood diversification index = $1/(3 + 1) = 0.25$	What are the crops that you cultivate? How much land do you devote in each Crop and aquaculture?	Toufique and Yunus (2013)
Health	Average time to health facility (minutes)	Average time it takes the households to get to the nearest health facility.	How long does it take you to get to a health facility?	Hahn et al. (2009)
	Access to sanitary latrine	Percentage of households without a sanitary latrine	What is the type of latrine you use? The response “no latrine” is taken here	Toufique and Yunus (2013)
	Percent of households where a family member had to miss work or school due to illness	Percentage of households that report at least 1 family member who had to miss school or work due to illness.	Has anyone in your family been so sick that they had to miss work or school?	Hahn et al. (2009)

Table 2: Components of Livelihood Vulnerability Index

Social Network	Availability of Amenities	Inverse of the (total number of types of amenity available +1). For example, if the village has primary school and primary health care center, amenity= 1/ {1+ (1+1) =.33	Do you have primary school, high/junior school, primary health care, doctor's chamber, general hospital, bazar, fire services in your village?	Toufique and Yunus (2013)
	Household that did not receive assistance	Percentage of the household did not receive assistance from government agencies/NGOs/financial institutions	Did you receive any type of assistance after the natural disaster?	Toufique and Yunus (2013)
Food	Percent of households dependent on family farm for food	Percentage of households that get their food primarily from their personal farms.	Where does your family get most of its food?	Hahn et al. (2009)
	Percentage of household losing their agricultural land	Percentage of household that lose their agricultural lands	Do you lose any agricultural land?	Monirul Islam(2017)
Water	Unsafe source of drinking water	Whether the household has access to safe drinking water. Sources of water such as from pond, water-tank or river/canal etc. are considered unsafe	What is the source of your drinking water? Several choices are given which are classified as safe (tap, tube well, etc.) and unsafe (pond, river, etc.)	Toufique and Yunus (2013)
	Time to travel the source of safe drinking water	Self-explanatory	How much time do you need to reach the safe drinking water source from your home?	Toufique and Yunus (2013)
	Whether experienced scarcity of water	Self-explanatory	Is the water supply from the source you use adequate?	Toufique and Yunus (2013)
Natural Disaster	Percentage of households that did not receive a warning about the natural disasters	Percentage of households that did not receive a warning about the most severe flood or cyclone event in the past 20 years.	Did you receive a warning about the flood/cyclone before it happened?	Toufique and Yunus (2013)
	Value for damages of physical assets (land, equipment etc.)	Percentage of households that reported losses of physical assets of their household	Did you face any damage of physical assets?	Monirul Islam(2017)
	Percent of households with an injury or death as a result of the most severe natural disaster	Percentage of house -holds that reported either an injury to or death of one of their family members as a result of the most severe flood, drought, or cyclone in the past 20 years	Was anyone in your family injured in the flood/cyclone? Did anyone in your family die during the flood/ cyclone?	Hahn et al. (2009);

Source: Field Survey, 2018

Data Collection

Primary data were managed through collecting information from face to face interviews (FGD and Questionnaire) with local authorities and people. Secondary data were collected through manipulating and processing the primary data like scoring it, converting it in the same scale, etc.

Calculating LVI: Composite Index Approach

The livelihood vulnerability Index used balance weighted an average approach where every sub-indicator contributed indifferently to the LVI. Each main element was combined with different variety of sub-indicators. The LVI used the formula that was an easy method of contributing similar weights to every main component.

Since each of the sub-indicators was determined on a distinct scale, so it had been initial work to normalize each of them as the same index. The equation employed for this transformation was taken from HDI (human development index). To determine the life expectancy rate, a quantitative relation has been established with the particular life expectancy and a Pre-determined minimum and maximum life expectancy.

$$Index_{s_b} = \frac{S_b - S_{Min}}{S_{Max} - S_{Min}}$$

Where s_b is the original sub-component for Batiaghta, S_{Min} and S_{Max} are the minimum and maximum values, respectively for each sub-component. For example, the 'Average time to health facility' sub-component ranged from 15 to 45 minutes in the surveyed villages. These minimum and maximum values were used to transform this indicator in to a standardized index. So it could be used to calculate the value of the Health component of the LVI. After each sub component was standardized, they were averaged using the equation below to calculate the value of each major component:

$$M_b = \frac{\sum_{i=1}^n index_{s_{bi}}}{n}$$

Here explained the value of one of the seven major components for Batiaghata [like Socio-Demographic Profile(SDP), Livelihood Strategies(LS), Social Network(SN), Health(H), Food(F), Water(W) and Natural Disaster(ND)], $index_{s_{bi}}$ represented the sub-components and n was the total a number of sub-components in each major components.

After values for each of major components for Batiaghta were calculated, they were averaged using following equation to find out the value of LVI.

$$LVI_b = \frac{\sum_{i=1}^7 w_{M_i} M_{bi}}{\sum_{i=1}^7 w_{M_i}}$$

Here Livelihood Vulnerability Index is termed as for Batiaghataupazila that represented the mean of all seven main components. The weight of each major components is termed as, which were determined by the total number of sub-indicators that made up each major components. It was added to ensure that all sub-components contribute equally to overall LVI. At this approach, LVI was calculated between 0 (least vulnerable) to 1 (most vulnerable) scale.

Data Analysis and Interpretation

Survey Result on LVI Sub Components

After conducting the questionnaire survey in the selected area, the survey data was calculated in tabular form. The LVI sub-components value for Pre- and post-Aila situation was presented in following tabular form. The value of maximum sub-components was higher in Post-Aila level than Pre-Aila level. But some sub-components like average education of the head of the households, and sources of assistance received were higher in Pre-Aila level. Moreover, some sub-components did not change and had the same value in Pre- and Post-Aila level like average time to health facility, etc.

Table 3: Sub Components values of Livelihood Vulnerability Index

Major Components	Sub-components	Pre-Aila	Post-Aila
Socio-Demographic Profile	Dependency ratio	0.69	0.79
	Percent of female-headed households	0.38	0.47
	Average education of the head of the household	0.51	0.43
Livelihood Strategies	Percent of households with family member working in a different community	0.45	0.57
	Percent of households dependent solely on agriculture as a source of income	0.33	0.47
	Agricultural livelihood diversification index	0.15	0.27
Health	Average time to health facility (minutes)	0.31	0.31
	Access to sanitary latrine	0.23	0.33
	Percent of households where a family member had to miss work or school due to illness	0.17	0.31
Social Network	Availability of amenities	0.45	1
	Sources of assistance received	0.50	0.37
Food	Percent of households dependent on family farm for food	0.33	0.47
	Percentage of household losing their agricultural land	0.23	0.37
Water	Unsafe source of drinking water	0.27	0.36
	Time to travel to the source of safe drinking water	0.001	0.17
	Whether experienced scarcity of water	0.37	0.47
Natural Disaster	Percentage of households that did not receive a warning about the pending natural disasters	0.32	0.43
	Value for damages of physical assets (land, equipment etc.)	0.12	0.53
	Percent of households with an injury or death as a result of the most severe natural disaster.	0	0

Source: Field Survey, 2018

Survey Results on LVI Major Components

Major components of LVI are very much important for knowing the overall vulnerability level of Batiaghata. The major contributing components such as Socio-demographic Profile, Livelihood strategies, Social Network, Health, Food, Water and Natural Disaster were calculated to know the value of LVI in Pre- and Post-Aila situation.

Table 4: Changes in Major Components

Major Components	Pre-Aila	Post-Aila
Socio Demographic Profile	0.53	0.56
Livelihood Strategies	0.38	0.44
Health	0.24	0.32
Social Network	0.48	0.69
Food	0.28	0.42
Water	0.21	0.33
Natural Disaster	0.15	0.33

Source: Field Survey, 2018

TheTable-4 presents the LVI major components values for Pre- and Post-Aila stage in Batiaghata. The value of every major component has been increased in Post-Aila stage than Pre-Aila stage. Among them Social Network has the highest LVI value during post-Aila and Social Demographic Profile have the highest value during Pre-Aila stage. It means these components are contributing most to increase the vulnerability. Similarly, Health and Natural disaster have the lowest value respectably for Pre- and Post-Aila situation. It has the lowest power to increase vulnerability.

Moreover, households of Batiaghata have suffered much because of Aila. It hampers all of their major livelihood components and makes the area more vulnerable. The safe water sources of the area like tube-wells have been destroyed or partially damaged because of Aila. Also, there is no proper warning system for natural disaster and it does not provide proper health facilities. So these types of major components make the area more vulnerable.

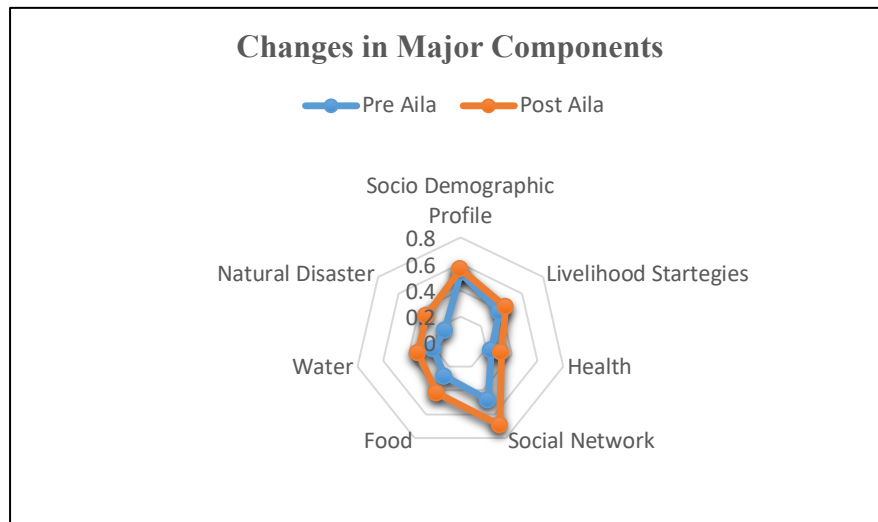


Figure 1: Spider diagram of Major components

Source: Field Survey, 2018

The results of the major component calculations are presented collectively in a spider diagram. The scale of the diagram ranges from 0 (less vulnerable) at the center of the web increasing to 1 (more vulnerable) at the outside edge in 0.1 unit increments. It showed that every major component is more vulnerable in Post-Aila situation.

Comparison between Pre- and Post-Aila LVI Values

As all the main indicators of LVI are similar for Pre- and Post-Aila situation, so the changes are quite significant for overall LVI value. The overall value of Livelihood Vulnerability Index is 0.318 in Pre-Aila Period and is 0.416 in Post-Aila Period. Due to the increasing value of components and sub-components in LVI, the area is much vulnerable in Post-Aila level.

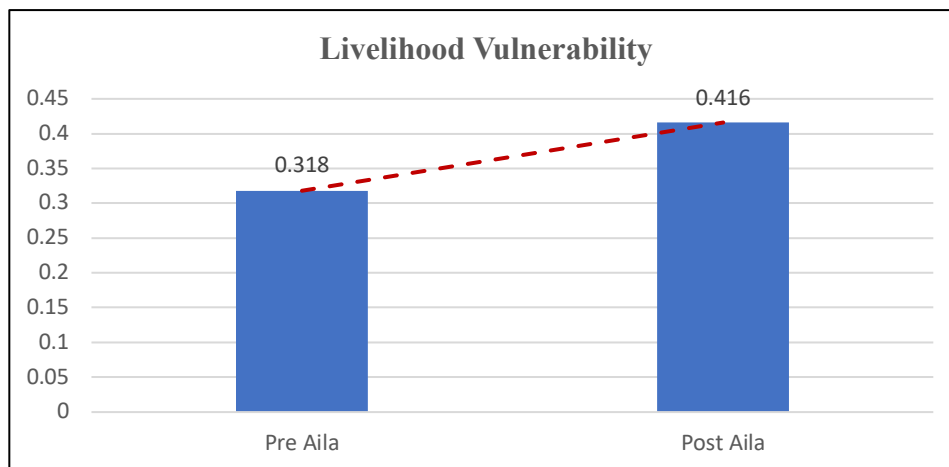


Figure 2: Livelihood Vulnerability value in Pre- and Post-Aila level

Source: Field Survey, 2018

In Pre-Aila Period, The most contributing major component to increase vulnerability level was Socio Demographic Profile (0.53) and the least contributing major component was Natural Disaster (0.15). In Post-Aila Period, The most contributing major component to increase vulnerability level is Social Network (0.69) and the least contributing major component is Health (0.32).

Findings

- I. The area has a low adaptive capacity in Post-Aila phase than Pre-Aila as a result of an increasing vulnerability in different sectors.
- II. It has also been observed that people are still migrating to other upazilas for higher possibilities of income and safety.
- III. It has been observed that shrimp culture and salinity is the controlling factors over the major land use changes in Batiaghata. However, with the increased productivity of land, people have been diverted to agricultural activities.
- IV. There has been a sudden change in the dependency ratio after Aila because of lack of knowledge regarding the agricultural activities, shortening the scope for economic growth.
- V. Before the cyclone Aila, the major water sources for safe drinking water were shallow tube-wells, wells, deep tube-wells, ponds, etc. After the Aila, most of the sources have been either broken or partially damaged so locals cannot have adequate safe water.
- VI. Many educational institutions were damaged due to Aila, education of the local children suffered the most.
- VII. Government and NGO intervention have not been significant during Aila and in helping people to recover themselves. The warning system and the recovery process was not so effective.

Conclusion

Cyclone Aila was one of the most known climate change-induced natural disaster ever to affect the south-western coastal regions of Bangladesh. The after-effects of Aila are still omnipresent in our study area in Batiaghata upazila, Khulna. This study has measured the change in the Livelihood Vulnerability Index (LVI) between the Pre- and Post-Aila in the study area. From an extensive literature review, a total of seven major components and 19 sub-components were selected to measure the Pre- and Post-Aila LVI. A total of 64 household level data were collected using a semi-structured questionnaire.

The major findings of this study are that, first, even after 20 years of the cyclone Aila, the Post-Aila LVI of the residents of Batiaghata has remained higher than the Pre-Aila LVI – almost all of the five components have showed higher LVI in Post-Aila than Pre-Aila. Such findings signify that natural disaster not only causes havoc to the existing social and economic structure but also recuperation from the loss is a time-consuming matter. Secondly, natural disasters like Aila bring about long-term suffering and change to existing economic activities. In this case, increasing salinity in the drinking water along with the change in the occupation was most noticeable after-effects. Finally, even though many government and NGOs are operating in the study area providing essential life

supports, their interventions are yet to bring positive change to the Post-Aila vulnerability of Batiaghata. Therefore, more targeted and coherent interventions by the government and NGOs in the major components of the LVI are needed to bring positive change in the Post-Aila LVI in the study area.

References

- Alam, G.M., 2017. Livelihood cycle and vulnerability of rural households to climate change and hazards in Bangladesh. *Environmental management*, 59(5), pp.777-791.
- BBS, 2013. *District Statistics*, Dhaka. Government of the People's Republic of Bangladesh, Dhaka. [Accessed 23 December 2018].
- Hahn, M.B., Riederer, A.M. and Foster, S.O., 2009. The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change—A case study in Mozambique. *Global Environmental Change*, 19(1), pp.74-88.
- Hossen, M., 2016. *Livelihood Vulnerability Assessment and Local Adaptations against Climate Change in South West Coastal Belt of Bangladesh* (Doctoral dissertation, Khulna University of Engineering & Technology (KUET), Khulna, Bangladesh).
- Islam, M.R. and Hasan, M., 2016. Climate-induced human displacement: A case study of Cyclone Aila in the south-west coastal region of Bangladesh. *Natural Hazards*, 81(2), pp.1051-1071.
- Qaisrani, A., Umar, M.A., Siyal, G.E.A. and Salik, K.M., 2018. What Defines Livelihood Vulnerability in Rural Semi-Arid Areas? Evidence from Pakistan. *Earth Systems and Environment*, 2(3), pp.455-475
- Saadatfar, A., Barani, H., Bavani, R. M. & Bahemand, R., 2015. Livelihood Vulnerability of Semi-Mobile Pastoral Communities to Climate Change in Arid and Semiarid of Iran. *Journal of Environment and Earth Science*, 21 November. Volume 5.
- Sadik, M.S., Nakagawa, H., Rahman, R., Shaw, R., Kawaike, K. and Fujita, K., 2018. A Study on Cyclone Aila Recovery in Koyra, Bangladesh: Evaluating the Inclusiveness of Recovery with Respect to Predisaster Vulnerability Reduction. *International Journal of Disaster Risk Science*, 9(1), pp.28-43.
- Toufique, K.A. and Yunus, M., 2013. Vulnerability of livelihoods in the coastal districts of Bangladesh. *The Bangladesh Development Studies*, pp.95-120.
- UNDP, 2010. *Human Development Reports*. [Online] Available at: <http://hdr.undp.org/> [Accessed 13 July 2018].
- U. N., 1997. *United Nation General Assembly*. [Online] Available at: <http://www.worldlii.org/int/other/UNGA/1997/10.pdf> [Accessed 23 December 2018].

Acknowledgement

We thank the respondents who selflessly participated in our questionnaire survey. We also thank the and experts who helped us with their expert opinion and kind cooperation during the study.

Assessing the Water Supply, Sanitation and Waste Dumping Condition of Urban Slum: A GIS Based Approach

Md. Nazmul Haque*

Md. Rakibul Islam**

Saifullah Bin Ansar***

Abstract: The objective of the paper is to assess the water supply and sanitation condition including the waste disposal status of Khulna slum. To accomplish the research, three issues are considered, such as, the location of tube wells, present condition of waste generation and the available space for new waste dumping zone. For finding out the suitable location of waste dumping zone in the candidate area the research focus on three major criteria: i) distance from the water body, ii) distance from road, iii) drainage facilities of the area. This research was based on primary source data collection from all slum residents involved in the water supply and sanitation system. ArcGIS 10.5 is used to find the suitable location for waste dumping zone by analyzing the multi criteria characteristics. The outcome of this study suggests that the poor slum dwellers kept an unhealthy life because, the lack of pure water and sanitation. Water quality and availability had the poorest state in the area. Only one area can be used as a waste dumping site. About 11.92% area is suitable in the south-west portion of the slum for dumping site and another 88.08% area is categorized as unsuitable.

Introduction

Water supply and sanitation system is a basic human needs. United Nations International Children's Emergency Fund (UNICEF) and World Health Organization (WHO) reported that one sixth of people are deprived from the upgraded and nontoxic water supply system within 1 km of their living place and again, one fifth people are unprivileged from enough, better-quality disposal system (Davison, 2005). Many government and non - governmental organizations work together to increase the number of users of sanitary latrines and also to provide improved water, but 2.4 million people have no way of using developed water supply and sanitation systems (Telmo, 2002). WHO, UNICEF, Water Supply and Sanitation Collaborative Council (WSSCC) had launched a program on "Global Water Supply and Sanitation Assessment" where about 40% (2.60 billion) people of the world were deprived from safety water in 2012 which is reported by WHO, UNICEF, WSSCC (Fan and Azad, 2017). About 663 million people are unprivileged from good drinking water in 2015 (UNICEF, 2015). About 2.2 million deaths due to 4 million cases of diarrhea in the world (Fan and Azad, 2017).

* Lecturer, Department of Urban and Regional Planning, Khulna University of Engineering & Technology (KUET), Khulna -9203, Bangladesh; Email: nhaque.kuet13@gmail.com (Corresponding Author)

** Graduated student, Department of Urban and Regional Planning, Khulna University of Engineering & Technology (KUET), Khulna -9203, Bangladesh; Email: mdrakibulislamrakib07@gmail.com

*** Under Graduate student, Department of Urban and Regional Planning, Khulna University of Engineering & Technology (KUET), Khulna -9203, Bangladesh; Email: kuetsiam30@gmail.com

Khulna is the third largest city in the southwest of Bangladesh, located in the Ganges Delta. The city is surrounded by a lot of industry, and for its geographical, political, archaeological and financial reasons it has a lot of importance. Water and sanitation scarcity has been gradually increased due to increased resettlement from the surrounding districts, urbanization and industrialization, but lack of parallel expansion in the necessary water supply and sanitation facilities. The number of slum in Khulna 1134 which is 8.14 % of total area (BBS, 2015). KCC (Khulna City Corporation) and other NGO's are working together to develop the sanitation condition. But many of projects are failed. Rupsha slum is our study area. The most of the latrines are provided there by Nabolok NGO. Nabolok can't provide enough latrines and tube well for many reasons such as: man powers, lack of skill etc. The study tries to assess the existing water supply and sanitation facilities maintained by NGOs in slum area. The main goal of this study is to assess the status of sanitation like the existing sanitary condition, the distance between sanitary latrines and water supply like water source, how many people are benefited etc. of Rupsha Notun Bazar Slum. This study also helps us to find out the problems of water supply and sanitation which are behind for this existing condition.

Literature Review

Due to poor drinking water, 500 million people suffer from waterborne diseases of various types every year. About 500,000 children die because of insufficiency in the supply of pure water. Only about 55% of the urban population in developing countries had connections to their homes and 20% had access to taps (WHO, 1991). In terms of quality and quantity, water supply facilities are almost essential for evaluating the slum's living conditions. In Bangladesh, tube - wells (hand - pumps), taps or ring wells are accessed by more than 97% of the total population (BBS, 1998). And effectively reduced the coverage of safe drinking water to just 74% of the population (Ahmed, 2002). A large number of people use unsafe sources of water for personal and domestic needs such as cooking, bathing and washing utensils because of a lack of awareness of the safety of the water (Rana, 2009).

Sanitation is the science and practice which helps to keep the environment unpolluted. It indicates all the situation which affect the health, food sanitation, solid waste disposal etc. The main purpose of sanitation is to improve the health and at the same time, to keep the environment free from pollution (Ahmed and Rahman, 2000). Sanitation is the collection, transportation, treatment and disposal or recycle of human excreta, household wastewater, solid waste and hygiene (Kaniambady et al., 2017). The term ' sanitation ' also relates to hygienic circumstances such as waste management and waste water disposal (WHO, 2014). Simply said sanitation relates to measures required to improve and protect human health and well - being (USAID, 1999). There are about 13 crore people living in Bangladesh. These 13 crore people make an average of 30–50,000 tons of excreta every day (BBS, 2004). Poverty and lack of education are the causes of poor health status. This is why the environment is dangerously polluted (CUS, 1990)

Water supply means a system to provide water for a local area. It can be provided by pipelines, a water reservoirs. The objective of good quality water supply is to improve the public health and also reduce the water borne diseases (Ahmed and Rahman, 2000) The

Sustainable Development Goals, a set of objectives to guide global development to 2030, include a specific objective to "ensure accessibility and sustainable water and sanitation management for all." In pursuing this objective and fulfilling children's rights, UNICEF is working to reach the most vulnerable and disadvantaged children (Nitow, 2010).

Materials and Methods

Study area

Notun bazar slum, Khulna is adjacent Rupsha ghat. The location of the study area is between $22^{\circ}48'30''\text{N}$ and $22^{\circ}48'10''\text{N}$ latitude and $89^{\circ}34'40''\text{E}$ and $89^{\circ}34'50''\text{E}$ longitude (Source: Field survey, 2019) and it is one of the compactly populated area. Most of the people are migrated from southern part of the Khulna city, Bangladesh. The main reason of the migration is natural disaster. Such as Cyclone, Sidr, Flood which affects those area every year and they loss their land, and family members. Migration procedure is completed from their ancestral home or land is to lead a better life, getting better housing facilities and with additionally to get a better job. Another reasons of migration is political force and soil erosion. The migrated people of the study area start work shrimp manufacturing company as the slum is located beside the Rupsha River. This is the main reason behind selecting the Rupsha slum as study area.

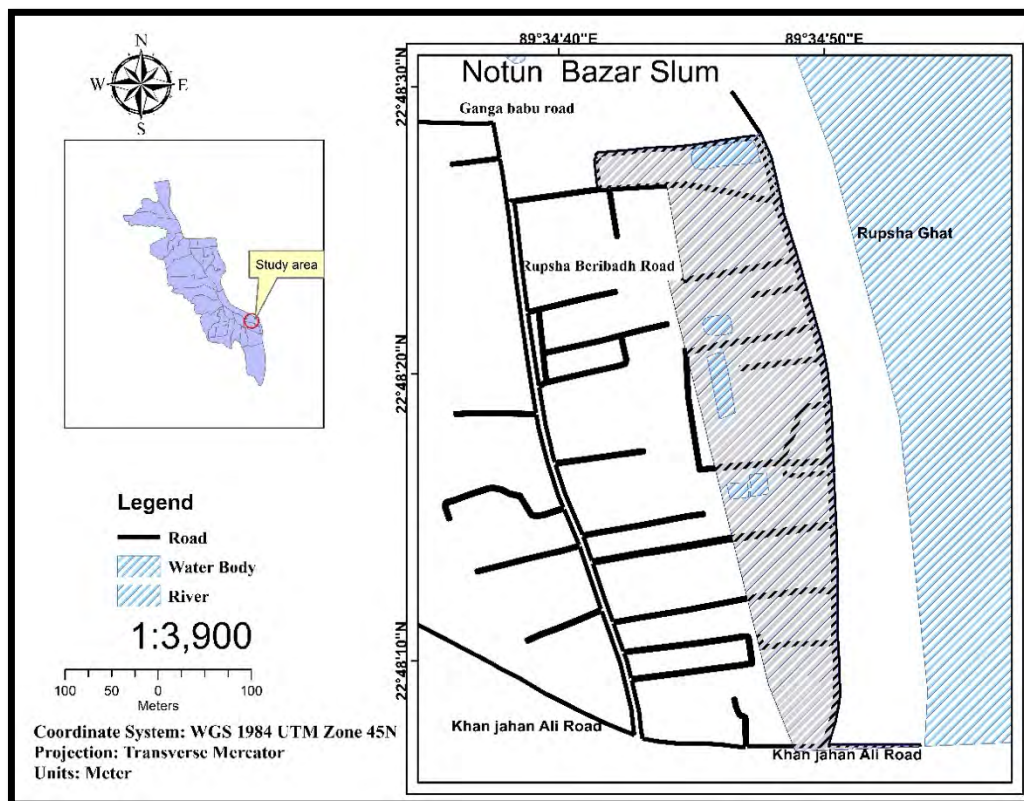


Figure 1: Notun Bazar slum, Khulna. Author, 2019

Methods

First of all, Notun bazar slum was selected due to their existing condition of water supply and latrine is very bad. Secondly, the sample size was selected about 100. Qualitative and quantitative data are collected according to the objective. Household survey, observation was conducted to fulfill our objective. To do household survey, a questionnaire was prepared by the help of supervisor. Primary data was collected by household survey. Secondary data was collected by KCC and NGO. The collected data are analyzed by the statistical tool. "Microsoft Excel" and SPSS were used to analyze the data. GPS machine was used to collect the coordinates of existing tube well and latrine. Then a map was prepared by GIS software. To analysis the suitable dumping site, "Multiple ring buffer, weighted overlay etc. tools were used. ArcGIS 10.5 was also used to calculate the suitable, unsuitable and moderate suitable and area percentage. Here the explanation of different types of suitability in tabular format is giving below.

Table 1: Explanation of different suitability

Criteria	Explanation
High suitable	This site is most convenient place to dump the waste without hampering the environment and stakeholders. It's also stands for the most convenient site on the basis of transportation, vacant land and the available of open space to construct a dumping site.
Moderate suitable	It's one kind of site that may be chosen or that may be selected for that reason what the most suitable site is not available and this site may hamper little bit environment but not a full scale. This site is also convenient for use and is not so worse condition. Moderate distance from road and moderate distance water body and all other things. These type of suitable criteria may satisfy the environment also.
Unsuitable	An unsuitable is very worse condition. If the place is selected, it hampers the environment. Associate peoples, stakeholders. This is not so much renowned place than more vacant land. It indicates that there is no vacant land, well transportation system, open space i.e. which place is not suitable for dumping site on the environment issue as well as the satisfaction of population.

Source: Expert opinion survey, 2019

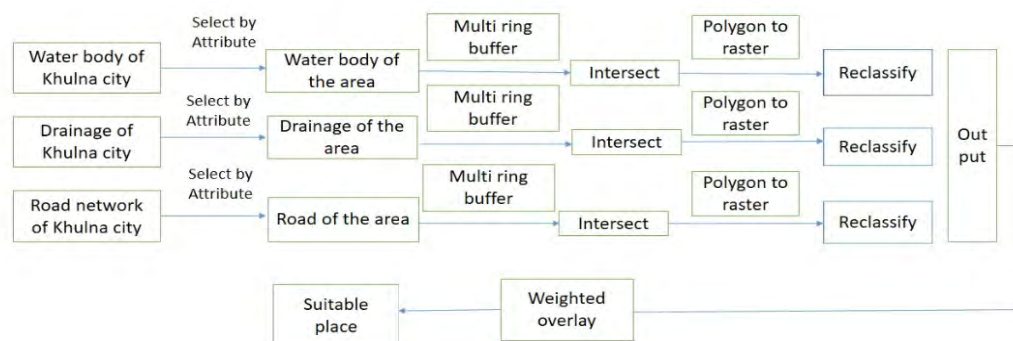
From the table 1 it can be noted that in our methods most highlighted things are 3 types of criteria. As well as, the final output of the research would suggest that which place will be high suitable or which place should be suitable to introduce a new dumping site. Site selection criteria on the basis of expert opinion survey. Different types of weightages, influences listed in the below table.

Table 2: Criteria for site selection

Serial No	Factor	Suitable Level	Distance (m)	Influence
1	Water	High suitable	150-350	60%
		Moderate suitable	100-150	
		Unsuitable	0-100	
2	Road network	High suitable	70-100	20%
		Moderate suitable	50-70	
		Unsuitable	0-50	
3	Drainage	High suitable	100-150	20%
		Moderate suitable	50-100	
		Unsuitable	0-50	

Source: Expert opinion survey, 2019, (Haque et al, 2017)

In the table 2 the fourth column indicates the different types of variation in distance which is measured in meter. The data is inputted or carried from GIS shape file and KDA authority. From the fourth column, the more the distance from the these types of factors indicates that the chance or probability of choosing the best site for waste dumping zone is more or more suitable. Because if the wastes are dumped near to the water body then it may hamper the water. Simple as like road network, if the waste dumping zone adjacent the road that will hamper the people on going. Some distances from road side with the tertiary road, connectivity road, and the final dumping site here and this road must be convenient for entering the KCC provided collection vehicles. This should be most suitable and then at last drainage is an important issue. If the waste dumping zone close to the drainage system, it may lead very worse condition as well as this is also same for water body. That's why the fourth column is selected in this criteria to high suitable, moderate suitable, and less suitable. At the same time the influences are categorized from expert survey opinions and also some literature review and then it is selected what types of things are most influence to choosing a new waste dumping zone. The entire procedure has an analytical framework to establish the clear concept of the study and multi-criteria analysis in ArcGIS 10.5. Different tool types and techniques that are described above are used. To maintain the research output, the procedures are followed which are given below.



Source: Author's design

Figure 1: Working Procedure of suitability analysis

Results and Discussions

Status of Water Supply

The drinking water is limited in the Coastal area like as Khulna. Khulna WASA needs 240 million water to fulfil the demand of Khulna city people but they can only provide 35 million (Khairuzzaman, 2011). So it is very difficult to them to provide enough water to slum. The nongovernment NGOs are come forward to reduce the water demand in slum area by providing tube well. The slum people do not have their own household water source. To do this, they must rely on common water supply sources. All usually use the same water for domestic and cooking purposes. But most of them (67 %) get water from the deep tube wells in their surroundings showed in fig 3(A). Generally, these people store water because they have not a source near their homes.

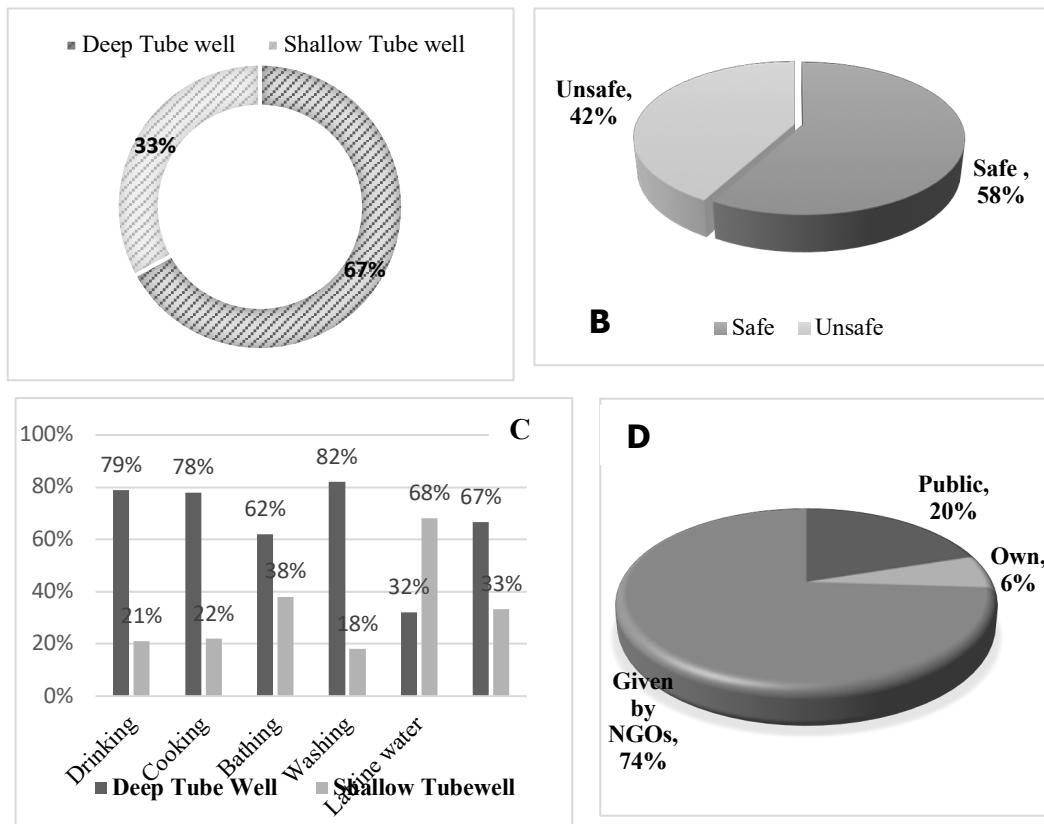


Figure 3: (A) Primary source of Water, (B) Perception of safe drinking water, (C) Sources of water for various purposes, (D) Tube well ownership ratio. Source: Field survey, 2019

However, the quality of the water does not vary greatly between shallow tube wells and deep tube wells. From figure 3(B), spontaneously, the majority of respondents (57% female and 43% male) described boiled water as the safest drinking water. However, 58% of respondents in different segments believed that tube well water was safe. There was less mention of piped water as safe for drinking (18% for women and 23% for men).

In addition to the above, the respondents mentioned other sources or characteristics of safe water, in order of frequency, filtered water, arsenic - free water, rain water, clear water, tablet water, etc. Similarly, but with less frequency, young generation responded. Figure 3(C) shows about 79% people use deep tube well for drinking purpose and 78% people use deep tube well for cooking purposes. On the other hand 68% people use shallow tube well for latrine purposes. Most people in the slum area don't have a private tube. Figure 3(D) shows about 74% people use tube well which is given by NGOs and 20% people use tube well which is install by KCC.

Status of Sanitation

Improved sanitation system is important for public health. Bangladesh government has taken many steps to provide good sanitation system so that lower and poor quality sanitation system can't affect human health and environment.

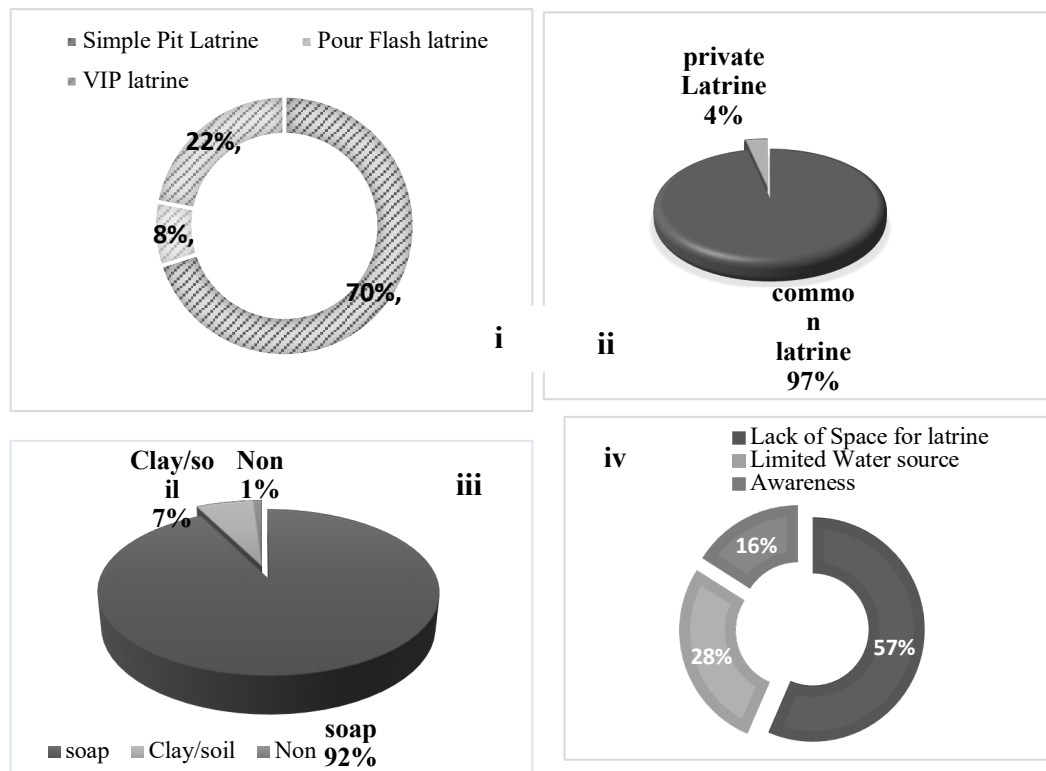


Figure 4 (i) Sanitation system, (ii) Ownership of latrine, (iii) Hand washing products, (iv) Reasons of bad sanitation system. Source: Field survey, 2019

There are three types of sanitation system in the study area such as simple pit latrine and pour flash latrine and VIP (Ventilated Improved Pit Latrine) latrine. One latrine is used for twenty family. About 70% people use simple pit latrine. 22% people use VIP latrine showed in Figure 4(i). Only 8% percent people pour flash latrine. Most of the latrine are provided by different NGOs and also City Corporation.

Most of the latrines are provided by different government non-government organizations. About 96 % people use common latrine and only 4% people use private latrine which is shown in figure 4(ii). This private latrine owners are the landlords. Only one latrine for twenty household. Most of the person of that area said that they use soap. Figure 4(iii) shows about 92 % people use soap after returning from latrine. Again, only 7% person people use different type materials such as soil, clay, ash etc. Figure 4(iv) shows that there are many reasons for bad sanitation system. First of all, lack of enough space (57%) to provide a pour flash latrine. Secondly, lack of enough source of water (28%) and thirdly, lack of enough knowledge about sanitation (16%) are responsible for bad sanitation system.

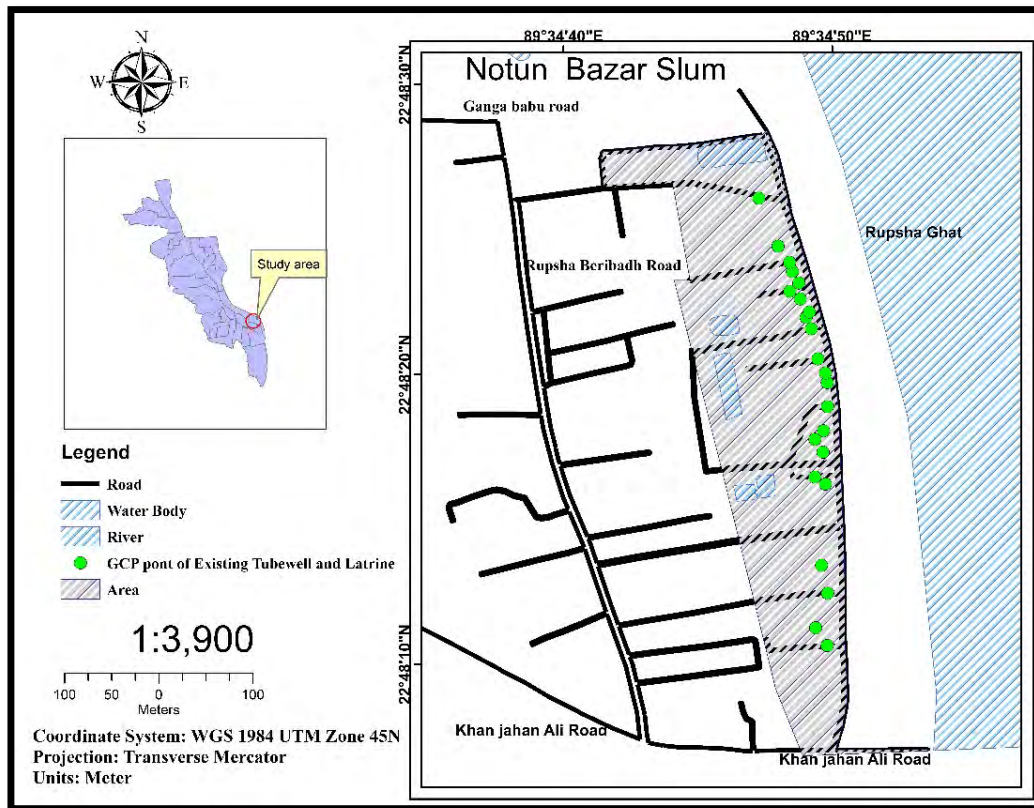
Spatial Distribution of Tube wells

The existing scenario of the study area is not good due to insufficient management of water supply and sanitation system. As the slum dwellers use common latrine and tube well, that's why they face water borne diseases such as diarrhea etc. Those latrines and tube wells are provided by NGO named Nabalok or KCC but the maintenance cost is carried by the slum dwellers. Only 23 tube wells and latrine exists in the study area but thousands of people live there. Actually one latrine for twenty families (Source: Field survey, 2019). So the number of latrine and tube well is very limited due to some reasons. First of all, the necessary space for establishing tube well and latrine is not enough as a result people can't establish private latrine and tube well. Since the free space or vacant land is very unavailable for establishing new tube well and latrines. If a building found two room, one room is used for this tube wells and latrines and another one is used for living purpose. Secondly, lack of money. That's why the surrounding people dependent on NGO and local government. Though the area is under KCC, Khulna WASA don't provide drinking water. Here the spatial distribution of tube wells are located here and the map next in the figure 3, there is the circle places are indicated the location of tube wells and latrines in the slum area.

Table 3: Existing tube wells and latrines

Tube well No	Longitude	Latitude	Served Family	Tube well No	Longitude	Latitude	Served Family
1	89°34'48E	22°48'11N	10	12	89°34'49E	22°48'19N	20
2	89°34'48E	22°48'10 N	1	13	89°34'48E	22°48'20N	20
3	89°34'49E	22°48'12 N	8	14	89°34'48E	22°48'21N	20
4	89°34'48 E	22°48'13N	10	15	89°34'48E	22°48'21N	20
5	89°34'49E	22°48'15 N	20	16	89°34'48E	22°48'21N	10
6	89°34'49E	22°48'15 N	22	17	89°34'48E	22°48'22N	10
7	89°34'48E	22°48'16N	20	18	89°34'47E	22°48'22N	20
8	89°34'48E	22°48'17N	20	19	89°34'48E	22°48'22N	20
9	89°34'49 E	22°48'17N	20	20	89°34'47E	22°48'23N	20
10	89°34'49E	22°48'18N	20	21	89°34'48E	22°48'23N	20
11	89°34'49E	22°48'19N	1	22	89°34'47E	22°48'24N	22
				23	89°34'46E	22°48'25N	22

Source: Field survey, 2019



Source: Field survey, 2019

Figure 5: Existing Facilities

Suitable site selection for Waste Dumping Zone

Suitable Location On the Basis of Water Body

The whole site is very close to the Rupsha River. There are 3 types of criteria for choosing the suitable location of water body such as most suitable, moderate suitable and unsuitable. Among them most of the places are unsuitable. Because these areas are very close to the river. The farthest area may be chosen for the suitable location for as a waste dumping zone. As there is no available land that's why on the basis of water body residential area should not be suitable for dumping in that location. The other two part of areas of southern part is available for dumping site on the map showed in Figure 6 that shows this types of portion is suitable area. According to table 4, only 11, 92% portion of area is suitable and 81.37% area is unsuitable that is calculated by Arc GIS 10.5.

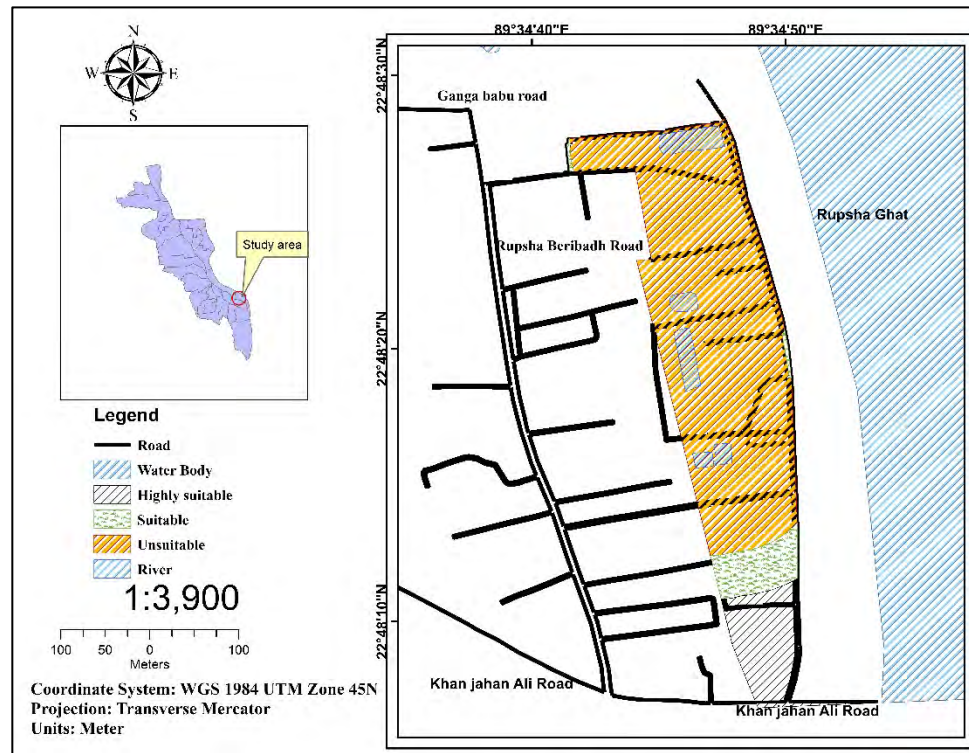


Figure 6: Suitable place for waste dumping in respect of water body Author, 2019

Table 4: Waste dumping on the basis of water

Area status	Area (m ²)	Percentage
Highly suitable	9185.05	11.92%
Moderate suitable	5175.57	6.71%
Unsuitable	62718.5	81.37%
Grand Total	77079.12	100.00%

Source: Field survey, 2019

Suitable Location On the Basis of Road Network

If any other criteria considered and only the road network is considered two portion of land may be chosen for suitable location for dumping. This portion of land suitable as wastes will not be excavated by birds and other animals. If the designated area is not used as dumping site, then during monsoon the waste will be washed with water to form blockage in the drain. In Figure 7, the study area is very well circulated with transportation system. Actually the spatial location of distance is main issue here. No particular analysis is done such as nodal test.

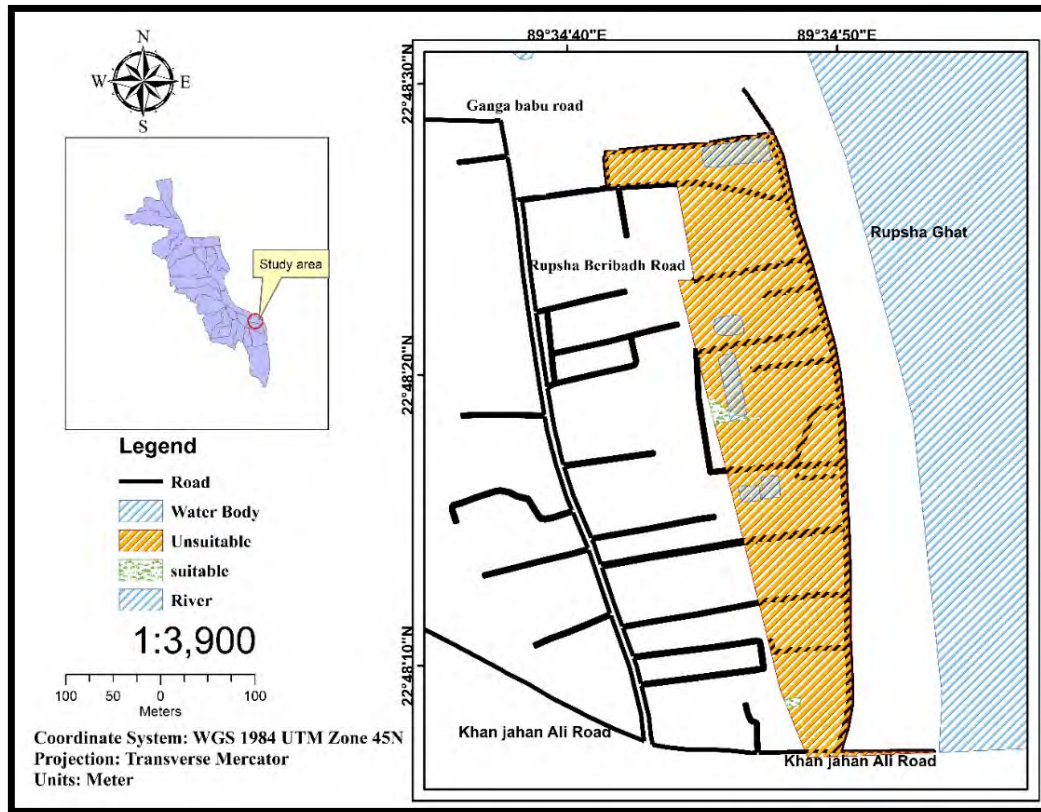


Figure 7: Suitable place for waste dumping in respect of road network Author, 2019

Table 5: Dumping site distribution on the basis of road network

Area status	Area (m ²)	Percentage (%)
suitable	657.293	0.85%
Unsuitable	76421.9	99.15%
Grand Total	77079.19	100.00%

Source: Field survey, 2019

Suitable Location On the Basis of Drainage

Analyzing the drain line study found that two sites are most suitable for waste dumping zone, among them one in the west and the other in the southern part. But maximum area is unsuitable for dumping site. Here the suitable areas are far away from the drain. It means that there is no possibility to blockage drainage from the waste disposal sites. As most of the drains in the study area are not covered with slabs and are full of wastes, it may cause harm to serious physical problem like that diarrhea or any other infection. Table 6 shows that about 1.384% area is suitable for dumping site as well as 98.615% area is unsuitable to use.

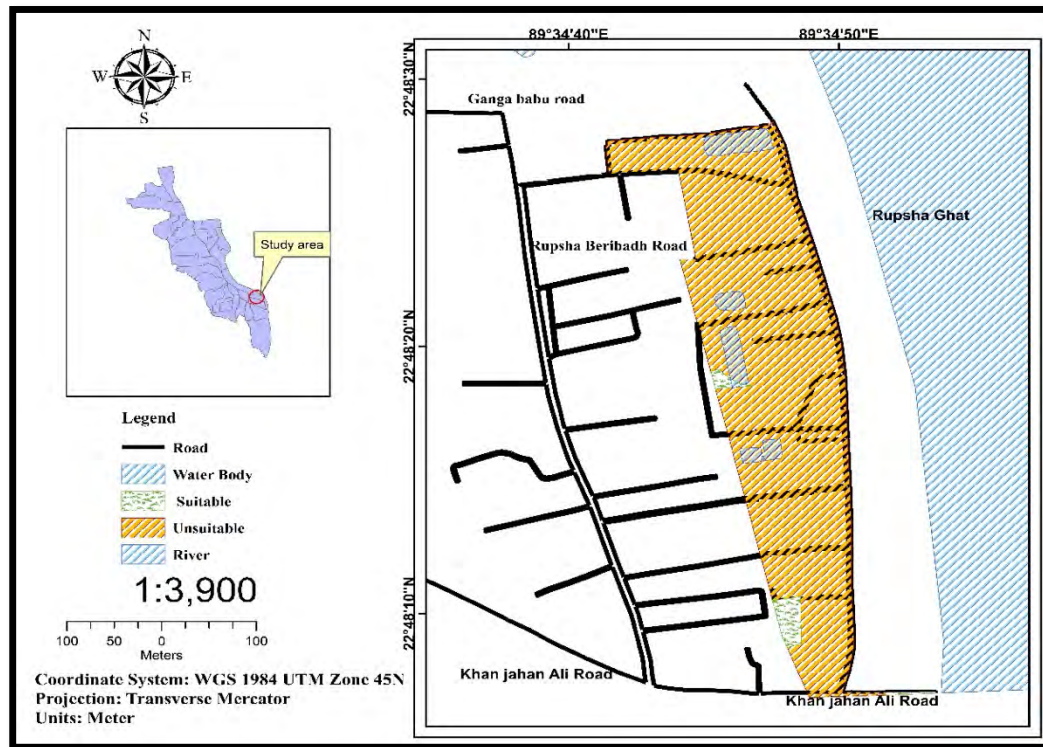


Figure 8: Suitable place for dumping site in respect of drainage Author, 2019

Table 6: Waste dumping zone on the basis of drainage

Area status	Area (m ²)	Percentage
Suitable	1067.394	1.384%
Unsuitable	76011.796	98.615%
Grand Total	77079.19	100.00%

Source: Field survey, 2019

Suitable place for waste dumping zone

The most important issue is that the all sides of selected dumping site is very far away from the water body. But it is near to the road side while the area will be surrounded by anything. The southern portion of land is suitable for dumping site for the study area. The main portion is why chosen the main influence on water body? Here influence is 60% of water body due to the whole lion share of area has body. The analyzed dumping site is not so close with drainage system. About 88.08% area is unsuitable for dumping site and 11.92% area is suitable as dumping site.



Figure 9: Suitable dumping site Author, 2019

Table 7: Selection of dumping zone

Area status	Area (m ²)	Percentage (%)
Suitable	67894.07	88.08%
Unsuitable	9203.05	11.92%
Grand Total	77097.12	100%

Source: Field survey, 2019

Conclusion

In this study it was observed that the poor slum dwellers kept an unhealthy life because of lack of pure water and sanitation. Water quality and availability had the poorest state in the area. However they got rid from extreme open defecation and unhygienic behavior, hence they are faced with diseases very often because of the poor environment surrounding them. The dwellers who got intervention from the NGO have improved their health and as well as their livelihood and income. The poor slum dwellers also have lack of opportunities in their life. By overcoming the barriers of their situation they could keep a healthy environment that would improve their health and income activities. The condition of slum dwellers including existing water supply, sanitation and waste dumping zone is not that good in the candidate area. Dwellers suffer from their lack of pure water and safe sanitation and often fall into sickness that undermines their health and productivity. These dwellers should therefore bring training and motivation program in order to improve their water and sanitation in a smart way. By providing toilets and latrines that flow into a sewer or safe enclosure, improve sanitation facilities. Through education, promote good hygiene habits. Hand washing properly with soap and water can reduce diarrhea. Implement rainwater harvesting systems for drinking and recharging

underground aquifers to collect and store rainwater. Provide the capacity of home water treatment by using filters, solar disinfection or flocculants to make drinking water safe. Promote low-cost solutions to improve the quality of water, such as chlorine tablets or plastic bottles that may be exposed to sunlight. Progress is slow, especially in the study area, as governments do not see sanitation as a fundamental necessity. Need to develop specific targeted and smart strategies for each group in order to reach different poor communities and their different needs. It is a seven-rung sanitation ladder based on functions where the functions can be widely divided into health and the environment.

Again, the spatial analysis for suitable location of waste dumping zone suggests a new thinking that may enrich the existing waste management system. Finally, the selected area (south-west portion) of the slum can be used to make the environment clean, livable and convenient to the users or the community. The research states that it is the high time to make the initiative for a decent life in a urban slum.

References

- Ahmed, M. (2002). *Alternative Water Supply Options for Arsenic Affected Areas of Bangladesh*. Dhaka: ITN-Bangladesh.
- Ahmed, M. F., & Rahman, M. M. (2000). *Water supply & sanitation*. Dhaka, Bangladesh: ITN-Bangladesh.
- BBS. (1998). *Urban Poverty Monitoring survey*. Dhaka.
- BBS. (2004). Dhaka.
- BBS. (2015). *Census of slum areas and floating population*. Dhaka.
- CUS, C. (1990). *The Urban Poor in Bangladesh*. Dhaka: Centre for Urban Studies.
- Davison, A. (2005). *Water Safety Plans*. GENEVA: Water, Sanitation and Health Protection and the Human Environment.
- Fan, Q., and Azad, M. A. (2017). *Towards a cleaner Bangladesh: safe water, sanitation and hygiene for all*. World Bank.
- Haque, M., Khan, M. H., & Chakraborty, T. (2017). A GIS based Suitability analysis for waste dumping zone-to improve the present condition of the community: A case study on ward 24 (Nirala), Khulna city, Bangladesh. 5th International Conference on Solid Waste Management in South Asian Countries (p. 4). Khulna, Bangladesh: waste safe 2017.
- Khairuzzaman, Z. (2011). *Bringing Clean Water and Sanitation to Khulna Slums*. Dhaka: The Daily Star.
- Nitow, S. (2010). *Behaviour Change Communication (BCC) formative research for water access, sanitation & hygiene for the urban poor (WASH-UP) in 5 slum communities in Accra and SekondiTakoradi*.
- Rana, M. S. (2009). *Status of water use sanitation and hygienic condition of urban slums: A study on Rupsha Ferighat slum*. Khulna: Desalination.
- Telmo, A. c. (2002). *A water supply and sanitation study of the village of gouansolo in mali, west africa*. Michigan.
- UNICEF. (2015). *25 Progress on Sanitation and Drinking Water*. USA: UNICEF.
- USAID. (1999). *Water and Sanitation Indicators Measurement Guide*. USAID.
- WHO. (1991). *The international drinking water supply and sanitation decade, End of decade review*.

Is the Railway plus Property model of Hong Kong replicable in Dhaka's TODs?

Afsana Haque^{*}
Fatima Kabir Sharna^{**}
Asif Khan^{***}

Abstract: Value capture is the public recovery of a portion of increased property value induced by transit or other public infrastructure investment. Cities around the world are increasingly looking toward innovative funding sources and strategies along with TOD planning; Land value capture (LVC) is one of them. Like other transit-oriented cities of the world, relying solely on fare revenue was barely sufficient for Hong Kong to cover the construction and maintenance costs of the transit. Therefore, they introduce an integrated rail-property development model which is more than a simple combination of railway and property and brands Hong Kong as one of the most successful public transport systems in the world. Property-related revenue has enabled MTR to not only pay off debts but also invest in the construction of the railway to generate net profits to finance the service. This study aims to review the mechanism of Hong Kong's R+P model and its transferability to offer insights and strategies for Dhaka city which is aspiring to become transit-oriented.

Key words: Joint Development, TOD, R+P model, Transport Economics.

Introduction

'Value capture' is the mechanism that seeks to re-capture some of the windfall benefits from rail transit stations and re-direct them to finance the construction and operations of the rail system (Consultancy, 2013; Mathur & Smith, 2013). It rests on the logic that increased traffic volume and improved accessibility generated by a rail system enhances the value of the land by virtue of its location. As the windfalls so conferred upon the land, come from social investment rather than individual effort, 'society has a principled right to its claims' (Batt, 2001). When the 'unearned increment' of land value is captured by the public authority and channeled to public uses, this will help reduce the corresponding public expenditures in transit investment (Ingram, 2012; Mathur & Smith, 2013; McIntosh, Newman, Trubka, & Kenworthy, 2017; Smolka, 2013).

In the light of the heightening government budget constraints, Batt (2001) argues that value capture provides a 'painless opportunity' and 'promising approach' to finance capital infrastructure such as public transit development, and recurrent fee revenues should then be used to recover operating expenses and environmental costs. It is suggested that land values may rise as much as 25% due to public transit for land within walking distance to

* Assistant professor, Department of Urban and Regional Planning, Jahangirnagar University, Savar Dhaka 1342, Email: afsana@juniv.edu

** Graduate, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka 1342, Email: sharna.kabir@gmail.com

*** Graduate, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka 1342, Email: khanasif113051@gmail.com

stations (typically $\frac{1}{4}$ mile in the US) and may be even higher if allowing greater development density (Cervero & Landis, 1997; D. B. Hess & Almeida, 2007; Lakshmanan & Chatterjee, 2005; McDonald, Osuji, & economics, 1995). Extensive research has shed light on the capitalization of transport infrastructure in the land and property market. A number of studies have focused on the influence of public transport infrastructure. These findings in general suggest an appreciation of property value within a walkable distance (500 to 800 m) from transit services, both before and after their opening (Cervero & Landis, 1997; Gatzlaff & Smith, 1993; D. B. Hess & Almeida, 2007; Knaap, Ding, Hopkins, & Research, 2001; Lakshmanan & Chatterjee, 2005; McDonald et al., 1995). The actual degree of appreciation, however, varies considerably across study contexts. Through a meta-analysis of case studies, Mohammad, Graham, Melo, and Anderson (2013) found that this variation can be attributed to factors related to the local land market, the degree of public transport maturation and other social-economic contexts.

Re-capturing these induced values by the public authority could be in the form of ‘rents’ to service the debts or to fund the operating expenses of the railway (Mathur & Smith, 2013; Medda & Modelewska, 2011; Sun, Chen, Cheng, Wang, & Ning, 2017). By levying a tax on the windfall gains from the surrounding private land owners, this is considered administratively simple, efficient and compatible with all sound taxation principles (Suzuki, Murakami, Hong, & Tamayose, 2015). Land value capture techniques can take many different forms, ranging from charges on benefiting private properties, joint venture with the private sector, user charges and marketing and merchandising approaches (Jillella, 2017; Olajide, 2015; Page, Bishop, & Wong, 2016). Cities around the world have adopted these as a most effective financial tool for transit financing; some of the cases are compiled in Table 1.

Table 1: Cities adopted LVC mechanism

Case study	City	Project type	Value capture mechanism
Allston/Brighton station	Boston	New infill station for commuter rail line	Negotiated exactions ¹
Denver union station	Denver	Reconstruction of historic station with light rail terminal, commuter rail and bus terminal	Special assessment district ² , sales tax district, tax increment financing
Hong Kong Mass Transit Railway corporation	Hong Kong	Integrated subway transit and real estate development business strategy	Air rights leases ³ , joint development ⁴

¹ Negotiated exactions involve payments made by a developer as a condition for receiving municipal approvals; are determined on an ad hoc basis for individual projects, usually as part of the development approval process. They often take the form of one-time land transfers or cash payments but may also involve construction activities or the provision of public services.

² Special assessments are a financing strategy by which property owners within a designated geographic area, or “special assessment district (SAD),” are levied a charge for certain public projects.

³ The transit agency sells the development rights above stations and transit adjacent land to developers to raise funds to finance transit investments.

⁴ Public transit agencies are directly involved in transit station development and adjacent property development in partnership with private developers.

Case study	City	Project type	Value capture mechanism
Kansar city streetcar	Kansar city	A 2-mile starter of a new modern street car system	Special assessment district, sales tax district, supplemental surface parking lot assessment
Portland streetcar	Portland	modern street car system of 16 track miles, built in phases	Special assessment district, tax increment financing
Dulles Metrorail	Washington D. C.	A 23-mile extension of Washington D. C. Metrorail system	Special assessment district

Source: Author, adapted from (Cervero & Murakami, 2009; Consultancy, 2013; Gihring, 2009; Ingram, 2012; Levinson & Istrate, 2011; Smolka, 2013; Suzuki et al., 2015; Zhao & Larson, 2011).

Hong Kong's Mass Transit Railway (MTR) is known as one of the most successful public transport systems in the world. In a city of over seven million people, the MTR system enjoys a daily ridership of over 5.5 million passenger trips (Lo, Tang, & Wang, 2008; Tam, 2007). This level of ridership is among the highest across all motorized transport modes in Hong Kong (Loo, Chen, & Chan, 2010; MTRC, 2014, 2016). MTR is also one of the few transit systems in the world that has managed to operate without relying on subsidies from the government (Cervero & Murakami, 2009). The success of MTR has in large part been attributed to its unique 'rail-plus-property' (R+P) model. The key feature of this business model is the pursuit of synchronized development between the rail transit station and adjacent land (Tang, Chiang, Baldwin, & Yeung, 2004). It integrates urban land development into the planning and development of a rail transit service, and by doing so, ensures stable revenue and captive ridership for the MTR (Tang et al., 2004; Cervero and Murakami, 2009).

This study aims to review MTR's land value capture (LVC) model and its transferability in Dhaka's context. Dhaka is going to implement metro rail (MRT) project with an expected completion deadline of 2021. The first mass transit corridor MRT line 6, will connect the northern peripheral area to the CBD through 16 stations (RSTP, 2015; STP, 2005). The latest structure plan of Dhaka proposed TOD around transit stations (RAJUK, 2016) but fails to address the linkage between transit and surrounding land uses for smart sustainable development. Moreover, there is no concrete financial plan to ensure stable revenue that can support future operation or maintenance cost which could be burden for government in future. In an era where TOD is seen as a promising way forward for urban development, in both developed and developing countries, this study, albeit focusing on Hong Kong, may offer insights and strategies for other cities aspiring to become transit-oriented with a special focus on Dhaka.

Hong Kong's MTR system and emergence of (R+P) model

Comprising a total route length of 221 km serviced by 87 main stations (shows in figure 1), the MTR serves as a key component of Hong Kong's public transport network and accounts for 48.5 % of the city's overall public transport ridership (or some 1.9 billion passenger trips on an annual basis) (MTRC, 2016). It was initially owned and operated by two companies: the MTR Corporation Limited (MTRC) and the Kowloon-Canton Railway Corporation (KCRC). MTRC and KCRC, established in the late 1970s and 1980s,

respectively, were the two major operators of rail transit services in Hong Kong (Cervero & Murakami, 2009; Tang, 2017). Operated under prudent commercial principles, the former initially provided service routes through Hong Kong Island, while the latter supplied services between the urban area and the New Territories (Lo et al., 2008). The railway constructed under the two companies has formed the main body of today's MTR network. In 2007, MTRC and KCRC were merged under the name MTR to achieve enhanced operational efficiency (Tang and Lo, 2008; Cervero and Murakami, 2009). Although previously the Hong Kong government was the sole owner of MTR, in 2000, by offering 23% of its stock shares to private investors, MTR transitioned into a traded company in pursuit of a more business-minded mode of operation (Cervero and Murakami, 2009).



Figure 1: MRT system of Hong Kong

Source: MTRC, 2016

MTRC and Property Development

Hong Kong's MTR development is a "Rail plus Property" design model whereby MTR property owned real estate development is planned in relationship to a 500 m catchment area to the main station, within a TOD zone. MTR's rail-oriented community devices a number of urban design principles for a more walkable lifestyle. This includes people and vehicular segregation to promote a safe and healthy living environment. The R+P model is characterized by different programmatic breakdowns based on market projections in real estate targets and demands. HK's TOD property development models vary between urban regions between Hong Kong islands, Kowloon and the new territories. The advantages of adopting the R+P model have been shown to be numerous. First, property-related revenue

has enabled MTR not only to pay off debts and invest in the construction of the railway but also to generate net profits to finance its rail service (Cervero and Murakami, 2009). Over 2.78 million people (over 41% of the total population) and over 1.34 million workers (over 41% of the territory total) live within 500 m of an MTR station. Over 43% and 20% of the housing units in Hong Kong lie within 500 m and 200 m, respectively, of an MTR station (Tang et al., 2004).

'Taikoo Shing' is one of the first major privately built residential real estate developed and operated by Swire Properties, a Hong Kong and mainland China based real-estate development company. This huge new town development is centered on a large shopping mall complex only accessible to MTR by pedestrian subways. It is characterized by MTR's Rail & Property Development's large-scale residential typologies, with 16% of the total development land allocated to commercial and mixed use, 'Taikoo Shing' is a self-sufficient neighborhood, dependent on rail transit. Property related revenue comes from a variety of sources, including the land premium paid by the private developers, property rent and management fees. Such revenue has largely fueled the expansion of the MTR network. By the end of 2015, 96,066 residential units in conjunction with 764,018 square meters of commercial and office space were managed by MTR (MTRC, 2016). The assembly of land uses to be built at the station is largely determined by market demand, constrained by zoning regulations. Commercial property development has occurred mostly central city MTR stations while residential projects have been built mainly in outlying areas and at the terminal stations (Cervero & Murakami, 2008). Figure 2 shows the typology of development around different stations. Thus, an integrated rail-property development model is more than a simple combination of railway and property. Between 2001 and 2005, property development produced 52 percent of MTRC's revenues. By contrast, railway income, made up mostly of fare box receipts, generated 28 percent of total income (Suzuki, Cervero, & Iuchi, 2013).

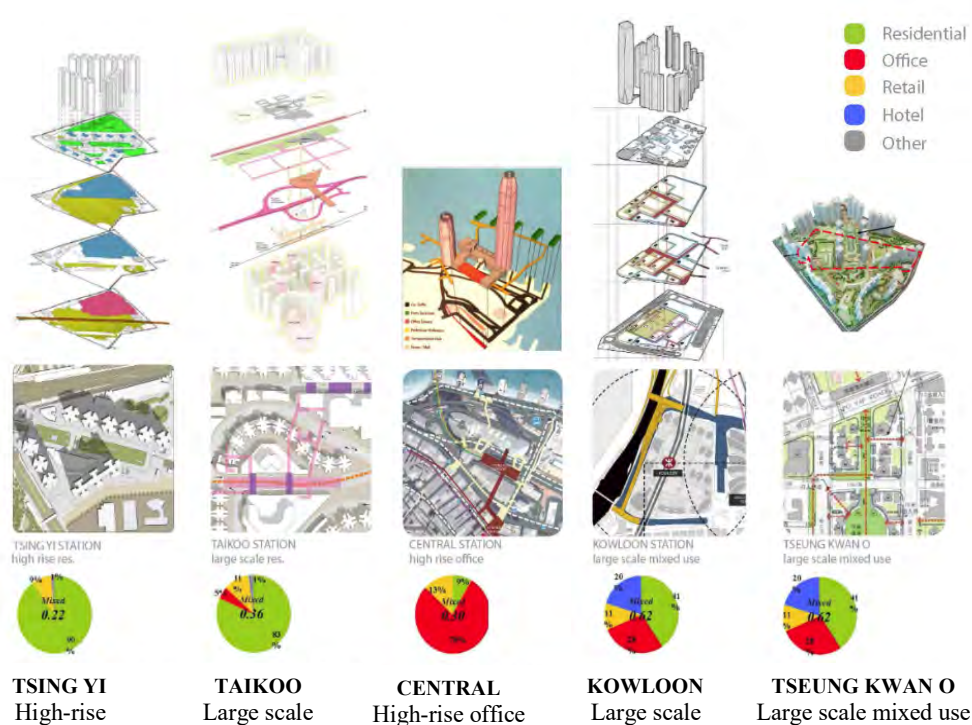


Figure 2: MRT's five types of TOD station development

Source: MTRC, 2016

MTRC's involvement in all property-related activities—development, investment, and management—produced 62 percent of total income, more than twice as much as fares. Revenues from MTR's Transit Operations for 2014 was \$2.09 billion dollars (a 7 percent increase from 2013 revenues). MTR currently enjoys a recovery of 186 percent – one of the highest in the world (Olajide, 2015). Importantly, it is not the same as the integrated railway and property development above stations; these are only the outcomes of the model. According to Tang et al. (2004) four principal elements make up the MTRC's approach of implementing integrated rail-property development project successfully:

- Policy:** Favorable government policy support in terms of its exclusive land grant to the MTRC and its commitment in mass transit railway as an essential mode of public transport.
- Process:** Superb planning, management and control procedures and effective development processes that seek to maximize the synergy between railway and property from the stages of project inception to completion.
- Project:** Development of high-quality real estate projects that integrate well with the railway facilities at the appropriate locations and at the right timing.
- Organization:** A well-experienced and efficiently managed company that is committed to providing excellent railway services and developing top-quality property development projects in order to enhance the quality of life in Hong Kong.

R+P: act and actors

R+P model of Hong Kong is a unique approach in handling the relationship between railway and land development through joint development⁵ mechanism with air right lease⁶. In a high-density city like Hong Kong, relying solely on fare revenue was still barely sufficient to cover the construction and maintenance costs of operating a rail transit system (Tang et al., 2004). This, in part, justified the inclusion of alternative and arguably more-lucrative revenue sources to subsidize the MTR system (Tang et al., 2004). Since the 1980s, an integrated Rail + Property (R+P) model has been adopted by MTR. Three key parties are involved in the R+P model: Government, Mass Transit Railway Corporation and private developer. Following are the process how (R+P) projects are implementing through mutual acts from each party, shows in figure 2 (Cervero & Murakami, 2009; He, Tao, Hou, & Jiang, 2018; Loo et al., 2010; MTRC, 2014; Olajide, 2015; Suzuki et al., 2013; Tang, 2017; Tang et al., 2004):

- i. In an R+P project, the government plays an initiating role by identifying a location for railway development and setting forth the general development strategy.
- ii. Upon receiving the government's invitation, MTRC with the government assess the construction costs, prepares a master plan that details the design of a new MTR station and the development of the surrounding area in terms of density, building types and use of urban space. The company will then discuss with the government the related property development opportunities that enhance the rate of return on the overall investment. If the master plan is approved for implementation, an exclusive development right over the targeted area for a period of 50 years is granted to MTR by the government.
- iii. The project agreement between the MTRC and the government for the construction of the railway line typically contains the undertakings from the government to grant land for property development (at Greenfield price) at identified sites along the alignment. The company will apply for, obtain all the necessary statutory planning approvals for the developments, and negotiate the terms of the land grants with the government.
- iv. Private developers are solicited by the MTRC as the partners in implementing the projects. The development packages are offered to the developers through public tenders. Tender packages normally contain a design scheme prepared by the company to assist developers to respond to the tender and, if awarded, to implement the development. Successful private developers are responsible for the detailed design of an awarded development package in accordance with the specifications of the development agreement with the MTRC. MTRC carry out the civil works, enforced the technical control standards and requirements for interfacing between its railway premises and the property development. The property developer is

⁵ Public transit agencies are directly involved in transit station development and adjacent property development in partnership with private developers (Gihring, 2009; Suzuki et al., 2015).

⁶ The transit agency sells or lease the development rights above stations and transit adjacent land to developers to raise funds to finance transit investments (Levinson & Istrate, 2011).

responsible for all development costs, including the land premiums, construction costs, finance costs, professional fees, marketing costs, and expenses related to the selling and leasing of the completed properties.

- v. The private developers who win the contract are responsible for all the expenses related to the construction, selling and leasing of the properties within these packages. MTR then shifts from a plan making to a supervisory role. Finally, the management and profits of the completed property are shared between private developers and MTR.

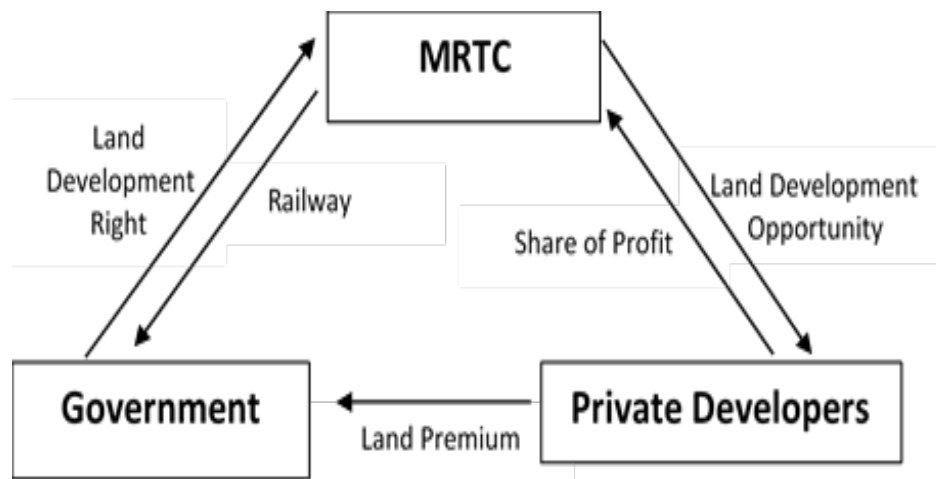


Figure 2: Key parties and their act in (R+P) model

Source: Author, adapted the idea from (MTRC, 2016; Tang et al., 2004)

- vi. The MTRC derives economic benefit from property developments through profit sharing with the developers in agreed proportions of any cash profits from the sale or lease of the properties, the sharing of assets in kind, or through up-front payments from developers. A 'no cash, no risk' approach has been adopted in its joint venture partnership with the developers (Cheng, 1988). The MTRC will not allow the property interests to be used as collateral by the developers to seek finance. Equally, the MTRC will not be liable under the joint venture agreement to any losses arising from the development. The developers have to take up all the losses.

Challenges for replicate (R+P) model in TOD precinct of Dhaka

Transit history reveals that since 1970's transit agency realized the importance of lasing their land to generate revenue, which further referred to as 'Joint Development' when they fail to recover two-third of its cost from fare revenue. Their subsidizer, local, state and federal government realize the large-scale development as a means to reduced subsidy, which because of the partnership between transit agency and private developers. Throughout the 1970's to 1980's this form of development receive great attention as a fiscal tool (Cervero, Ferrell, & Murphy, 2002) conferred other benefits by increasing ridership that because of development intensity near transit station. The most direct impact of transit

leads to the real estate market which in-turn enhance value to a place that means transit alone can influence to drive the real estate market (Babsin, 1997; Becker, Bernstein, & Young, 2013; ULI & PW, 2012) but need support of policy and other market forces for optimum return. If other market forces are not available, intervention is needed to ensure the TOD success (Becker et al., 2013).

Factors that have made this property development programme possible in Hong Kong could be the challenges for other cities like Dhaka aspiring to become transit-oriented. The most important among these are the ***land market of Hong Kong***. The land market of Hong Kong has clearly contributed to the success of (R+P) programme. Hong Kong's land market is strictly controlled and owned by government and characterized by high level of land scarcity. Hong Kong has used only 24% of their total land for development purpose, among which 7% for the residential purpose. Despite the additional costs and constraints of developing property above a railway station, private developers have been attracted due to limited alternatives. In addition, real estate prices have been skyrocketing, making most real estate projects profitable, for example house prices are 15 times higher than in 1980 (Tang, 2017; C. Q. Xue & Sun, 2018). Land ownership structure is discrete in the context of Dhaka city. Though RAJUK is the main responsible authority for any development projects in the capital city, they don't have direct land ownership. RAJUK has to acquire land from open market or private owner. Government can acquire land for public interest in exchange for compensation equal to market value with "Acquisition and Requisition of Immovable Property Ordinance 1982" (Masum et al 2016) which is a great challenge for initiating public projects. Most of the south Asian cities where lands are owned by private would be found it difficult to control or acquire land for (R+P) model.

The second important element is ***integrated policy environment of Hong Kong*** that helps (R+P) to bring in real. Successful implementation of joint development requires supportive growth management policies not only to encourage high density development around stations, but also to restrict intensive development in areas not served by the rail transit (Roeseler & von Dosky, 1991). Reference can be drawn from Chapter 8 of the Hong Kong Planning Standard and Guideline for such a policy:

"Stations/public transport interchanges should preferably be located within a walking distance of 500m from major housing, employment, shopping, commercial, cultural and other population intensive activity centers.....consideration should be given as early as possible in the planning process to including facilities, such as traveller or moving walkway, to assist pedestrian movement between the stations/public transport interchanges and the other development". In the Third Comprehensive Transport Study noted, "Rail should and will form the backbone of the passenger transport system and the development of rail stations should synchronize with land-use development".

Land use planning and transportation planning interact between themselves to determine development patterns (Luca Bertolini, 1999; Litman, 2005; Newman & Kenworthy, 1996; Polzin, 1999). However, successful policy is aware of the complexities of the transport-land use relationship and thus contributes to shape it. TOD means the formation of denser, mixed use activity nodes that is connected by high quality transportation (Niles & Nelson, 1999) that brings benefit from both transport and land use perspective. Transit underpins

the land use development which also depends on land market and land use policy (D. Hess & Lombardi, 2004; Renne, 2005). Similarly, land use is the important factor to increase ridership for transit (Chava, Newman, & Tiwari, 2018; Sung & Oh, 2011). D. Hess and Lombardi (2004) agree about the role of policy for successful implementation of TOD. Hong Kong use this opportunity and optimize the synergy of transit-land use interaction to achieve the two-way benefit. They guided the development within 500 m of stations to upsurge transit ridership and increased traffic volume in return creates huge commercial potential for the properties connected to the railway network. This is a great challenge for the cities with weak planning practices like Dhaka. Previously Dhaka has a long history of weak planning practice that results in a chaotic development of the city. Draft Structure Plan (2016 -2035) had addressed TOD along the corridor of MRT line 6, however fails to craft appropriate strategies to integrate transit and land use in an effective way.

The other underpinning factor or challenge is *institutional setup*. The close relationship between MTRC and the government in Hong Kong has facilitated the planning and granting of development rights along railway lines. For private developers, having MTRC as a partner has also made it easier to address technical issues. MTRC has developed strong internal expertise in property management and development (Cervero & Murakami, 2009; Tang et al., 2004). Institutional Setup context for Dhaka city is quite spiny due to lack of coordination among government agencies. As for example, the transport network and facilities of RAJUK area are owned and operated by different government agencies as city corporations, DTCA. Due to lack of superior authority over agencies, RAJUK or DTCA can't play their proper role as envisioned during its formation and many well-planned projects cannot be implemented (RAJUK, 2016). The model requires the MTRC to act as a single entity and the intermediary between the government and market players for coordinating the implementation of these joint development projects at its stations, converting strategic objectives into site-specific requirements, transforming policies into deals and balancing possible conflicts between public and private interests. Such expertise, however, would be difficult to replicate in one-off projects or for cases with limited market potential (Tang et al., 2004).

Socio-economic context could be another challenge as TOD associated with transit-induced gentrification. Despite its successful financial performance, the R+P model has been criticized for raising the price of nearby residential properties (He et al., 2018). Drawing on four MTR-affiliated housing projects, (Tang et al., 2004) found an average increase in housing premium of HK\$100-300 per square foot. In a related study, Cervero and Murakami (2009) reported a 30% increase in housing prices near MTR stations. Such capitalization by MTR may have created a market that encourages more private than public housing development in the precincts of MTR stations, which in turn induces social injustice. While widely acclaimed, Hong Kong's MTR has also been under scrutiny in the urban (re)development context as being a catalyst for neighbourhood gentrification. Like other TOD projects, MTR projects operating under the R+P model have driven up the value of adjacent land (Tang, 2017; C. Q. Xue & Sun, 2018), which creates a land market that potentially encourages more private residential development than public development (Tang et al., 2004). Given this, the impact of MTR on the low-income community, particularly in terms of its potential to trigger gentrification and inequitable spatial

distribution of accessibility, is subject to debate. As a backbone in Hong Kong's public transport system, whether MTR's development is associated with transit-induced gentrification and the loss of prime locations for public housing estates, inclusionary public housing policy for lower income helps to minimize the gentrification. According to the current planning practice of Bangladesh, the price and the mechanism determined for allotment of land is hardly accessible by the lower income people. Different housing projects developed by public authorities like RAJUK, NHA, etc. hold very marginal portion for lower income group, for example Purbachal project only 4.3% (110.46 acres) of land has been reserved for the low-income groups, in Uttara 3rd Phase the share was only 7.5% (40.51 acres) and in Jhilmeel Project the allocation for the low income was only 1.2% (RAJUK, 2016). Inappropriate initiatives and lacking diverse housing finance scheme for lower income people promotes displacement (RAJUK, 2016), TOD projects may worsen the situation more. This deficit may limit the ability to inform future (R+P) development proposal of developing cities, which have an ambition of achieving better social justice.

Conclusion

Established 40 years ago for financing the first railway line, R+P model of Hong Kong continues making use of land development rights alongside railway alignment granted by Government to develop over 30 integrated communities incorporating residences, offices, shops, schools, green spaces and other public facilities above railway stations and depots (Cervero & Murakami, 2009; MTRC, 2014; Tam, 2007; Tang, 2017). The convenience and quality of life brought by the railway system attracts people to reside in the adjoining premises, which in turn increase the uses of the mass transit (Luca Bertolini, 2012; Litman, 2005; Litman and Steele, 2005). Replicating the MTR above-station property development projects in Dhaka does not necessarily achieve the benefits of the integrated rail-property development model. Importantly, the model is not the same as the project; the model contains the policy, process, organization and finally the project. Some external urban factors and complementary government policies are essential institutional factors in contributing to the success of the model. The extent in which the success of the MTRC model can be replicated depends on whether all these essential components are in place. Due to different institutions, the empirical implications of the urban railway system remain varied in different cities. As successful replication will largely refer to the contextual factors, land market, institutional set up and policy framework are the challenges for replicating R+P model in the context of Dhaka. Replicating this model may bring full return only when the contextual elements of Dhaka will be considered in effectual way.

Reference

- Babsin, M. (1997). Real Estate Trends and Transit-Oriented Development: A Compendium for 21 Metropolitan Regions.
- Batt, H. W. (2001). Value capture as a policy tool in transportation economics: an exploration in public finance in the tradition of Henry George. *American Journal of Economics Sociology*, 60(1), 195-228.
- Becker, S., Bernstein, S., & Young, L. (2013). *The new real estate mantra: Location near public transportation*.

- Bertolini, L. (1999). Spatial development patterns and public transport: the application of an analytical model in the Netherlands. *Planning Practice and Research*, 14(2), 199-210.
- Bertolini, L. (2012). Integrating mobility and urban development agendas: a manifesto. *The Planning Review*, 48(1), 16-26.
- Cervero, R., Ferrell, C., & Murphy, S. (2002). Transit-oriented development and joint development in the United States: A literature review. *TCRP research results digest* (52).
- Cervero, R., & Landis, J. (1997). Twenty years of the Bay Area Rapid Transit system: Land use and development impacts. *Transportation Research Part A: Policy Practice*, 31(4), 309-333.
- Cervero, R., & Murakami, J. (2008). *Rail+ Property Development: A model of sustainable transit finance and urbanism*. Retrieved from <https://cloudfront.escholarship.org/dist/prd/content/qt6jx3k35x/qt6jx3k35x.pdf>.
- Cervero, R., & Murakami, J. (2009). Rail and property development in Hong Kong: Experiences and extensions. *Urban Studies*, 46(10), 2019-2043.
- Chava, J., Newman, P., & Tiwari, R. (2018). Gentrification of station areas and its impact on transit ridership. *Case Studies on Transport Policy*, 6(1), 1-10. doi:10.1016/j.cstp.2018.01.007
- Consultancy, G. H. (2013). *Metrolinx Land Value Capture Discussion Paper*. Retrieved from http://www.metrolinx.com/en/regionalplanning/funding/Land_Value_Capture_Discussion_Paper_EN.pdf.
- Gatzlaff, D. H., & Smith, M. T. (1993). The impact of the Miami Metrorail on the value of residences near station locations. *Land Economics*, 54-66.
- Gihring, T. A. (2009). The value capture approach to stimulating transit oriented development and financing transit station area improvements.
- He, S. Y., Tao, S., Hou, Y., & Jiang, W. (2018). Mass Transit Railway, transit-oriented development and spatial justice: the competition for prime residential locations in Hong Kong since the 1980s. *Town Planning Review*, 89(5), 467-493.
- Hess, D., & Lombardi, P. (2004). Policy support for and barriers to transit-oriented development in the inner city: Literature review. *Transportation Research Record: Journal of the Transportation Research Board* (1887), 26-33.
- Hess, D. B., & Almeida, T. M. (2007). Impact of proximity to light rail rapid transit on station-area property values in Buffalo, New York. *Urban Studies*, 44(5-6), 1041-1068.
- Hong Kong Planning Standard and Guideline. (2018). Retrieved from: https://www.pland.gov.hk/pland_en/tech_doc/hkpsg/index.html.
- Ingram, G. K. (2012). *Value capture and land policies*: Lincoln Institute of Land Policy.
- Jillella, S. S. K. (2017). *Innovative Financing for Urban Rail in Indian Cities: Land-based Strategic Value Capture Mechanisms (Doctoral Thesis)*. Curtin University,
- Knaap, G. J., Ding, C., Hopkins, L. D., & Research. (2001). Do plans matter? The effects of light rail plans on land values in station areas. *Journal of Planning Education*, 21(1), 32-39.
- Lakshmanan, T., & Chatterjee, L. R. (2005). Economic consequences of transport improvements. *Access Magazine*, 1(26).
- Levinson, D., & Istrate, E. (2011). Access for value: financing transportation through land value capture.
- Litman, T. (2005). Land use impacts on transport. *Victoria Transport Policy Institute (www.vtpi.org)*.

- Litman, T., & Steele, R. (2005). *Land use impacts on transport: How land use factors affect travel behavior*.
- Lo, H. K., Tang, S., & Wang, D. Z. (2008). Managing the accessibility on mass public transit: The case of Hong Kong. *Journal of transport and land use*, 1(2), 23-49.
- Loo, B. P., Chen, C., & Chan, E. T. (2010). Rail-based transit-oriented development: lessons from New York City and Hong Kong. *Landscape and Urban Planning*, 97(3), 202-212.
- Mathur, S., & Smith, A. (2013). Land value capture to fund public transportation infrastructure: Examination of joint development projects' revenue yield and stability. *Transport Policy*, 30, 327-335.
- Masum, F., Chigbu, U. E., Espinoza, J., & Graefen, C. (2016). The Limitations of Formal Land Delivery System: Need for a Pro-Poor Urban Land Development Policy in Dhaka, Bangladesh. In *World Bank Land and Poverty Conference, Washington, DC, March* (pp. 14-18).
- McDonald, J. F., Osuji, C. I., & economics, u. (1995). The effect of anticipated transportation improvement on residential land values. *Regional science*, 25(3), 261-278.
- McIntosh, J., Newman, P., Trubka, R., & Kenworthy, J. (2017). Framework for land value capture from investments in transit in car-dependent cities. *Journal of transport and land use*, 10(1), 155-185.
- Medda, F. R., & Modelewska, M. (2011). *Land value capture as a funding source for urban investment: The Warsaw metro system*. Retrieved from [https://www.ey.com/Publication/vwLUAssets/Land_value_capture_as_a_funding_source_for_or_urban_investment.pdf/\\$FILE/Land_value_capture_as_a_funding_source_for_urban_investment.pdf](https://www.ey.com/Publication/vwLUAssets/Land_value_capture_as_a_funding_source_for_or_urban_investment.pdf/$FILE/Land_value_capture_as_a_funding_source_for_urban_investment.pdf).
- Mohammad, S. I., Graham, D. J., Melo, P. C., & Anderson, R. (2013). A meta-analysis of the impact of rail projects on land and property values. *Transportation Research Part A: Policy and Practice*, 50, 158-170.
- MTRC. (2014). *MTRC annual report, MTR Corporation : Hong Kong*.
- MTRC. (2016). *MTR Corporation Annual Report : Hong Kong*.
- Newman, P. W., & Kenworthy, J. R. (1996). The land use—transport connection: An overview. *Land Use Policy*, 13(1), 1-22. doi:10.1016/0264-8377(95)00027-5.
- Niles, J., & Nelson, D. (1999). *Measuring the Success of Transit-Oriented Development*. Paper presented at the Retail Market Dynamics and Other Key Determinants, Prepared for the American Planning Association National Planning Conference, Seattle, Washington, April.
- Olajide, O. A. (2015). *Transit value capture finance: a global review towards measuring monetary efficiency*. University of British Columbia.
- Page, S., Bishop, B., & Wong, W. (2016). *Guide to Value Capture Financing for Public Transportation Projects* (030944599X).
- Polzin, S. E. (1999). Transportation/land-use relationship: Public transit's impact on land use. *Journal of urban planning and development*, 125(4), 135-151.
- RAJUK. (2016). *Dhaka Structure Plan (2016-2035)*. Rajdhani Unnayan Katripokkho, Dhaka.
- RSTP. (2015). *Revised Strategic Transport Plan (RSTP)*. Dhaka Transport Co-ordination Authority, Dhaka, Bangladesh.
- Renne, J. L. (2005). *Transit-oriented development: Measuring benefits, analyzing trends, and evaluating policy*. Rutgers University, New Brunswick, New Jersey.

- Roeseler, W. G., & von Dosky, D. (1991). Joint development in urban transportation: a practical approach to modern growth management. *Landscape Urban Planning*, 20(4), 325-346.
- Smolka, M. O. (2013). *Implementing value capture in Latin America: Policies and tools for urban development*: Lincoln Institute of Land Policy.
- STP. (2005). *Strategic Transport Plan for Dhaka-Final Report*. Dhaka Transport Co-ordination Board, Dhaka, Bangladesh
- Sun, J., Chen, T., Cheng, Z., Wang, C. C., & Ning, X. (2017). A financing mode of Urban Rail transit based on land value capture: A case study in Wuhan City. *Transport Policy*, 57, 59-67.
- Sung, H., & Oh, J.-T. (2011). Transit-oriented development in a high-density city: Identifying its association with transit ridership in Seoul, Korea. *Cities*, 28(1), 70-82.
- Suzuki, H., Cervero, R., & Iuchi, K. (2013). *Transforming cities with transit: Transit and land-use integration for sustainable urban development*: World Bank Publications.
- Suzuki, H., Murakami, J., Hong, Y.-H., & Tamayose, B. (2015). *Financing transit-oriented development with land values: Adapting land value capture in developing countries*: World Bank Publications.
- Tam, K.-c. (2007). *The role of transit node for place making and urban development in Hong Kong*. (Master of Urban Design), The University of Hong Kong.
- Tang. (2017). Leveraging property values for metro railway development in Hong Kong: Experiences and lessons. In *Routledge Companion to Real Estate Development* (pp. 12-27): Routledge.
- Tang, Chiang, Baldwin, & Yeung. (2004). *Study of the Integrated Rail-Property Development Model in Hong Kong* Retrieved from http://www.bre.polyu.edu.hk/rccree/select_proj/1Land_Const_Eco/Integrated_Rail_Property_dev_Model.pdf.
- Third Comprehensive Transport Study . (1999). Retrieved from: https://www.td.gov.hk/en/publications_and_press_releases/publications/free_publications/the_third_comprehensive_transport_study/index.html.
- ULI, & PW. (2012). *Emerging Trends in Real Estate*, Urban Land Institute & Price Waterhouse, Retrieved from: <http://www.pwc.com.au/industry/real-estate/assets/Real-Estate-2012-Americas-Oct11.pdf>.
- Xue, C. Q., & Sun, C. (2018). How Much Development Can a Rail Station Lead? A Case Study of Hong Kong. *International Journal of High-Rise Buildings*, 7(2), 1-15.
- Xue, L., & Fang, W. (2015). Rail plus property development in China: the pilot case of Shenzhen. *World Resource Institute Working Paper*. Retrived from: <http://www.wri.org.cn/publications>.
- Zhao, Z. J., & Larson, K. (2011). Special assessments as a value capture strategy for public transit finance. *Public Works Management Policy*, 16(4), 320-340.

Sustainable Urban Compact Form Measurement: A Case Study on Dhanmondi and Uttara

Ashraf Uddin Fahim*
Sania Sifat Miti**

Abstract: Dhaka has been going through rapid urbanization for last several decades. Providing accommodation to this fast growing population is creating a high stress on the limited available resources. Thus it creates unsustainable condition for the residents of Dhaka. In this regard, achieving urban sustainability has become a prime goal for urban planners. This study aims to explore different dimensions and relevant indicators to understand and measure compactness in the context of Dhaka. Dhanmondi and Uttara, two neighborhoods of Dhaka City are selected as the case study areas. This study is conducted by using both qualitative and quantitative approaches. Information regarding compactness measurement of those neighborhoods were collected through questionnaire survey and field observation survey. Sample of 200 individuals were taken for collecting data. Number of professionals i.e. academicians and town planners were selected for key informant interview to get standard regarding compactness measurement for Dhaka City. Dhaka is partially compact to some extent but there is absence of sustainability due to haphazard and uncontrolled growth, lack of planning etc. It needs a proper consolidation of policy, programs and plans to achieve the urban sustainability.

Key Words: Compactness, Sustainability

Introduction

As a developing country, Bangladesh is bothered by different issues associated with rapid urban sprawl. To solve problems related to these issues, the development authorities advocate compact development and intensive land use (UN-Habitat, 2014). The outcome of the new strategies of the compact city planning will make neighborhoods more lively, safe and relevant for all groups of people. So cities must be focused on sustainable development goals (SDGs).

Urban compaction has been considered as a sustainable form of development. Ideas about compact cities can be divided into high density, mixed use, and public transport as well as urban intensification. High density aims at locating more people close enough to community facilities and at strengthening land use efficiency. Mixed use makes city living closer to work, shops, and other basic social, educational, and leisure uses (Urban Task Force, 1999). Public transport can enhance urban efficiency, reduce the use of private cars, and improve the efficient use of energy. Urban intensification is the process of making cities more compact through urban regeneration or through improvements in urban density, mixed use, and public transport system. For example, high-density development provides

* Ashraf Uddin Fahim, Registration No. 35432, Session: 2012-2013, Department of Urban and Regional Planning, Jahangirnagar University, e-mail: fahim.urju42@gmail.com

** Sania Sifat Miti, Assistant Professor, Department of Urban and Regional Planning, Jahangirnagar University, e-mail: miti@juniv.edu

the concentration of people, making public infrastructure more efficient and promoting mixed-use development. (Burgess, 2000).

Dhaka, the capital city of Bangladesh is one of the ancient cities in South Asia. The city has been enjoying most of the physical, economic and social advantages and thus has been receiving primary impulses for its growth (Islam, 2005). It has been growing faster than the other cities of the country. According to the United Nation's assessment (1985), Dhaka was the 31st largest city in the world in 1985. Due to the continuing rapid pace of growth, the city had already become the 11th largest megacity in 2000 and was the 6th most populous city in 2010 and the 2nd largest megacity in 2015 (Alam, *et al*, 2016). The growing tendency is creating various problems within the city and affecting the lives of its residents.

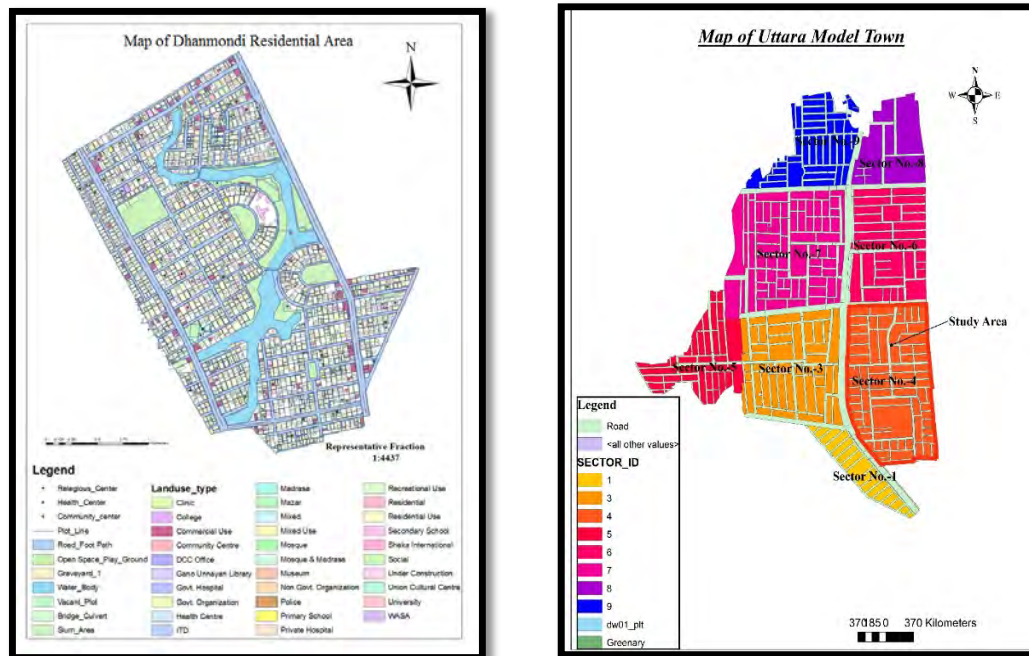
The environment is degrading by the continuous development within the city. This is disrupting the ecosystems and misusing the green space and natural resources. This situation can be handled if properly guided. This study illustrates some indicators by which the people and concerned authorities can identify and measure the compact development so as to get rid of various negative impacts of the fast growing cities and to preserve and enhance the qualities of urban life by the sustainable compact urban form. The findings of the study will be useful in guiding future urban planners, researchers as well as related organizations and agencies in promoting and creating user friendly and compact urban form.

Research Objective

The objectives are to identify the indicators of sustainable urban compact form and to measure the compactness of the cities in the context of Dhaka City.

Study Area

Dhaka city is selected as study area because this city has been going through rapid urbanization for last several decades. It is the primate city as well as the capital of Bangladesh housing 33% of the country's total urban population (UNDESA, 2011). Dhanmondi Residential Area and Sector 4 of Uttara Model Town are selected as two case study areas because they are planned residential areas of Dhaka City. They have all kinds of features of a compact city planning approach. Figure 1 shows the maps of the two study areas.



Source: Author, 2018.

Figure 1: Maps of the study areas (Dhanmondi and Uttara)

Methodology

This study is conducted by using both qualitative and quantitative approaches. Information regarding compactness measurement of two study areas are collected through field observation and questionnaire survey of the residents and key informant interviews with the professionals. A sample of 200 individuals are taken for the questionnaire survey. From these 200 samples, 100 samples are collected from Dhanmondi area and 100 samples are collected from the Uttara Sector 4. Academicians and professionals like town planners and other officials who are actively related with the spatial planning process are selected for the key informant interview to create a matrix on the standards regarding compactness measurement for Bangladesh.

UN-Habitat (2014) provided five principles of compactness: high density, mixed land use, social mix, limited land use specialization and an efficient street network. Bertuad (2001), Liaqut (2016), and Wisma (2010) also mentioned some standards regarding the compactness in their studies. The academicians and professionals also mentioned some indicators based on the present and practical condition of Bangladesh. All the above mentioned principles and indicators are the basis of creating the matrix for this study with the help of these total 10 indicators are selected to make a matrix of measuring the compactness for the study areas of this research. The matrix is shown in the Table 7.

The relevant documents are collected from secondary sources like books, journals, conference proceedings, reports and plan on urban form, compact urban form, mixed use development, sustainable compact form etc.

Urban Context in Dhaka

Dhaka Improvement Trust (DIT) was established in 1956 as an independent planning and development authority. In 1959, the first master plan for Dhaka was prepared and DIT had the responsibility to implement it. Most significant developments of this period include the development of Dhanmondi Residential Area (1955), Gulshan Model Town (1961), Banani (1964), and Uttara (1965). These are predominantly residential areas developed for the high government officials and higher income group people. To accommodate the migrant Muslim population, Mohammedpur and Mirpur were developed in the mid 60's along the second north-south axis formed by Mirpur Road (Nilufar, 2000).

With the independence of Bangladesh in 1971, Dhaka as the capital became the focus of all development activities. The phenomenal growth of population mainly due to rural-urban migration led to the occupation of the low-lying areas around the already developed areas. Baridhara, another residential area for the upper-class, was developed in 1972, following the already established northbound development trend occupying the available highlands that was started initially by the Mughal founders. Apart from this, any serious cohesive planning for the growth of Dhaka was absent until 1991 when a new project was initiated to prepare multi-level development plans for Dhaka (Imon, 2001). The overall land use pattern of Dhaka City is given below:

Table 1: Land Used of Dhaka City of the year of 2013

Land Use Category	Area in Acres	Area in Hectares	%
Agriculture	145670.85	58976.05	38.49
Residential Area	138013.93	55852.51	36.47
Water bodies	47641.60	19288.10	12.59
Restricted Area	11971.73	4844.81	3.16
Industrial Area	9873.09	3995.50	2.61
Public Facilities	9560.75	3869.12	2.53
Road/Railways	8705.54	3523.04	2.30
Commercial	3781.55	1530.37	1.00
Mixed Use area	2247.29	909.44	0.59
Recreational Area (Park/Playground/Urban Green Area)	996.29	403.19	0.26
Total	378462.63	153192.12	100.00

Source: Rajuk, 2013

Analysis and Findings

Density

Dhaka is the most populated city in Bangladesh with a density of 23234 people per square kilometer within a total area of 300 square kilometers (BBS, 2011).

The average population of the urban areas of Bangladesh belongs to low and lower middle income groups whereas the majority of the population of Dhaka City belongs to the middle income group. 53% of the people of Dhanmondi belongs to middle income groups where 54% people of Uttara Sector 4 are middle income groups (Field Survey, 2018).

Table 2 shows the population density and built up density that is person per acre in built up area of the study areas.

Table 2: The population density and built up density of Dhanmondi and Uttara

Year	Dhanmondi		Uttara	
	Density (Per Acre)	Built Up Density (Per Acre)	Density (Per Acre)	Built Up Density (Per Acre)
1981	16	114	--	--
1991	19	107	--	--
2001	64	324	64	91
2011	164	575	92	114

Source: BBS 1981, 1991, 2001 & 2011

Both the population density and built up density of Dhanmondi area more than the Uttara Sector 4 (Field Study, 2018).

Average Land Occupancy

The land occupancy per person is derived from the total population and total area. The total land cover of Dhanmondi is 500 acres (2023428 sq. meters) and its total population is 81889 in the year of 2011. So the average land occupancy of Dhanmondi is 24 square meters. On the other hand, the total land cover of Uttara Sector 4 is 145 acres (586794.12 sq. meters) and its total population is 13342 in the year of 2011. So the average land occupancy of Uttara Sector 4 is 44 square meters (Huda, 2014 and Alam, *et al*, 2016).

Land Use

The land use pattern of the two study areas are given below. This table helps to identify the amount of mixed used land, open spaces and ratio of residential to non-residential area of the study areas.

Table 3: Land uses of two study areas

Types of Land Use	Dhanmondi		Uttara Sector 4	
	Area (acre)	(%)	Area (acre)	(%)
Residential	142.56	38.66	91.5	63.10
Commercial	23.61	6.45	9.5	6.25
Health	8.61	2.34	--	
Educational	19.48	5.30	2.5	1.72
Institutional	6.13	1.94	2	1.38
Recreational*	2.91	0.69	--	--
Religious	1.16	0.32	2	1.38
Mixed**	15.99	4.35	4	2.77
Open Space***	12.88	3.50	2.5	1.73
Playground	11.34	3.08	1	0.63
Water Bodies	31.22	8.49	--	
Vacant****	1.96	0.53	11	7.63
Under Construction	9.62	2.64	6	4.16
Road	69.26	21.55	14	9.72

* Recreational land use represents Indoor recreational facilities

**Mixed land use represents one plot having multiple uses

***Open space represents parks

****vacant land represents undeveloped plots/ plots without any constructions activity performed

Source: Huda, 2014 and Alam, et al, 2016

From the above table it is found that land use pattern of Dhanmondi is in mixed form. Though the residential use is more than the other uses but compared to the rest of the uses it is only 38.66% in the year of 2014. On the other hand, the residential use of Uttara Sector 4 is dominant than the other uses. This use is 63.10% of the total land uses during the year of 2016.

Amount of mixed used land of Dhanmondi and Uttara Sector 4 are 4.35% and 2.77% respectively.

Generally open space include park, playground, water bodies and vacant land. From Table 3, four land use categories (open space, playground, water bodies and vacant land) are sum up for the open space indicator of the compactness measurement Matrix. Thus 15.6% of total land is found as open space in Dhanmondi and 9.99% in Uttara Sector 4.

Housing Affordability

Housing experts often define housing affordability as households spending less than 30% of their budget on housing including maintenance and repairs and basic utilities. But the newer approach defines affordability as households spending less than 45% of their budge

on housing and transportation combined (UN Habitat, 2014). Here 30% of the budget is considered as affordable housing limit.

Table 4: Housing affordability

Affordability	Percentage of Population	
	Dhanmondi	Uttara Sector 4
Affordable	28	24
Moderate affordability	33	27
Expensive	39	49

Source: Field Survey, 2018

From the above table it is seen that majority of the population of the two study areas are residing in houses above their affordability. Comparing the two areas, the condition of housing affordability of Uttara Sector 4 is worse than Dhanmondi.

Building Height

Following table describes number of storeys, number of structures of the buildings of the study areas.

Table 5: Percentage of the buildings according to their height

Number of Storey	Number of Structures/Plots		Percentage (%)	
	Dhanmondi	Uttara Sector 4	Dhanmondi	Uttara Sector 4
1	41	59	2.53	7.53
2	101	136	6.24	17.35
3	201	156	12.42	19.90
4	330	116	20.39	14.80
5	413	83	25.42	10.59
6	426	189	26.30	24.11
7	21	45	6.60	5.74
8	16			
9	23			
10	11			
Above 10	33			
Total	1618	784	100	100

Source: Huda, 2014 and Alam, et al, 2016

Form the above information it is clear that 6 storey buildings are dominant in the both the study areas.

Transportation

Dhanmondi has grid iron pattern of roads and almost all the plots are rectangular shape. 21.55% of the total area of Dhanmondi is covered by the road network and 9.72% of the total area of Uttara Sector 4 is covered by road network (Table 3). Road network density

indicates total percentage of road network in respect to the total area. Higher value of road network density shows sustainable urban form.

Accessibility

Different types of Accessibility regarding community facilities, urban facilities and transportation services are assessed in terms of required time and distance of people of the two study areas.

Table 6: Accessibility of community facilities

Community facility	Dhanmondi		Uttara - 4	
	Average Time requirement	Average Distance	Average Time requirement	Average Distance
Educational Institution	8 min	400 meter	10 min	450 meter
Health Facilities	16 min	750 meter	12 min	500 meter
Shopping Facilities	12 min	600 meter	10 min	450 meter
Community Centre	18 min	800 meter	20 min	1000 meter
Religious Facilities	5 min	100 meter	6 min	200 meter
Recreational Facilities	8 min	350 meter	12 min	500 meter
Open Space	6 min	400 meter	8 min	400 meter
Average	10.43 min	485.71 meters	11.14 min	500 meters

Source: Field Survey, 2018

The study found that the average distance of the community facility in terms of both length and time of Dhanmondi is less than Uttara Sector 4. This means the community services and facilities are closer to that residents of Dhanmondi than Uttara.

100 samples are collected from Dhanmondi area and 100 samples are collected from the Uttara Sector 4. These samples have different public transport accessibility. Total distance of public transport from houses of each sample are divided by the total sample number and thus average distance of public transport for each sample is calculated. From the field survey, it is also found that the average length distance from the residence to public transport is 400 meters in Dhanmondi and 350 meters in Uttara Sector 4 (Field Survey, 2018).

Matrix of Sustainable Urban Compact Form

Compactness matrix is developed indicating the following key indicators.

Table 7: Matrix for the sustainable urban compact form

Indicator	Standard	Standard (Expert Opinion of BD)	Dhanmondi	Uttara Sector 4
Population Density	15000/km ² 150/ha, 61/acre (UN Habitat, 2014)	250 persons/acre	164 persons/acre	92 persons/acre
Average Land Occupancy	40 Square meters/person (Bertuad, 2001)	----	24 Square meters/person	44 square meters/person
Mixed Use	40% of the Land (UN Habitat, 2014)	40% of the land	4.35%	2.77%
Open Space	15% of the land (UN-Habitat)	10%	15.60%	9.99%
Ratio of residential to non-residential area	50% (Liaqut, 2016)	----	38.66%	63.10%
Housing Affordability	Spending less than 30 percent of income (UN Habitat, 2014)	Spending less than 30 percent of income	28% people spend 30% of income	24% people spend 30% of income
Building Height	----	Residential-6 Storied Commercial-8 Storied	Majority 6 storied Building	Majority 6 storied Building
Road Network Density	30% of land (UN Habitat, 2014)	25% of the Land	22% (639.40 sq. m/acre) and 3.09 sq. m/person	20% (388.05 sq. m/acre) and 4.26 sq. m/person
Public Transport Accessibility	0.4 to 0.5 Kilometers (Wisma, 2010)	0.4 to 0.5 kilometers	0.40 kilometers	0.35 kilometers
Community Services accessibility	0.4 to 0.5 Kilometers (Wisma, 2010)	0.4 to 0.5 kilometers	0.49 kilometers	0.50 kilometers

Source: UN Habitat, 2014; BBS, 2011; Bertuad, 2001; Liaqut, 2016; Wisma, 2010 and Interviews and Field Survey, 2018

As discussed earlier, the major key factors for the urban sustainability in compact city approach are density, transportation and land use.

The findings of the study describe that the population densities of Dhanmondi and Uttara are 164 persons and 92 persons per acre respectively. It means that density of Dhanmondi

and Uttara are more than the UN-Habitat scale. But the expert of our country suggests that almost 250 persons per acre are appropriate on the context of our country. Both the study areas are far behind the expert opinion. That is to say that there are ample scope of both the areas to be more compact in respect to population density.

In compact cities, there should be affordable housing for every residents. But it is noticed that 28% and 24% residents of Dhanmondi and Uttara Sector 4 respectively are spending 30% of their income for housing purposes. Majority of the residents of the study areas are residing in the houses more than their affordable limit. So both the study areas do not satisfy the indicator of housing affordability from the perspective of sustainable compact form.

The average land occupancy rate is higher in Dhanmondi (24 sq. meter/person) than the standard described in the Matrix (40 sq. meter/person). But Uttara Sector 4 has a chance to increase its land occupancy as it has 44 sq. meters for each of its residents.

Both Dhanmondi and Uttara Sector 4 have very little mixed used characteristics of land uses. So it can be said that mixed use development is not established enough in both areas. But Dhanmondi has mixed use land little more than Uttara. Uttara Sector 4 has more than 60% and Dhanmondi has less than 40% of its land as residential use. So it can be said that it will be easy for Dhanmondi to convert itself as a mixed use area if further residential development is controlled and other uses are accelerated in proper and balanced way. If this can be done then Dhanmondi can achieve the standard of mix use as an indicator of compact form.

In Dhanmondi, the ratio of residential to non-residential area is within the limits given by UN-Habitat but Uttara crosses the limits and the ratio is 1.3 times of the considered standard. To be in compact form Uttara has to reduce its residential use and convert this use as mixed use or increase other uses for a desired sustainable compact form.

The open space is a prime element in a city. Dhanmondi has a good number of open spaces and satisfy the standard. On the other hand, Uttara has not enough open spaces in terms of standard given by the UN-Habitat but marginally fulfill the standard value obtained from the expert opinion.

Building height of both the study areas are within the limits of the standard for residential building. As both the areas have residential building as dominant feature, it can be concluded that both the areas fulfill the standard for building height.

The road network density is higher in Dhanmondi than Uttara. The existing road network provision in Dhanmondi is 639.40 sq. m/acre where it is only 388 sq. m/acre in Uttara. Both the areas lack the standard amount. To serve a compact city form both the areas have to construct roads.

Public transport accessibility and community service accessibility of Dhanmondi and Uttara satisfy the standards of the identified Matrix of the compact city form.

So it can be concluded that the Dhanmondi Residential Area is closer to a compact city form than Uttara Model Town because the indicators of compact form of Dhanmondi are closer to the identified Matrix of sustainable compact urban than Uttara Sector 4d. It is also seen that different portion of the Dhaka city has different form of compactness. Some areas

are more compact than others. On the other hand, some areas are still vacant which creates land speculation. Thus the whole Dhaka City still has opportunities to become a compact city. It needs a proper consolidation of policy, programs and plans to achieve urban sustainability through a compact form.

Recommendation

Based on the findings, the following recommendations are proposed to develop an appropriate growth for a compact Dhaka City.

- A uniform density throughout Dhaka City should be promoted to make the city a sustainable compact form.
- Land occupancy rate is different in different areas of Dhaka City. This means some portion of Dhaka City is dense and some are not. The extra population from the densely populated area should be distributed its population to the low density areas.
- Growth should be stimulated within the city center reducing the development of urban sprawl into the surrounding countryside of Dhaka City.
- Mixed land uses should be provided instead of zoning as residential, commercial, institutional etc.
- Adequate open spaces should be kept to maintain the environment.
- Affordable housing is of great concern for Dhaka City. Majority of the inhabitants are deprived from the affordable housing. Policies should be taken to promote affordable housing for all classes of population. Government can subsidized housing sector in this matter.
- Transit oriented development (TOD) should be promoted for Dhaka City and car dependency should also be reduced promoting walkability and public transport.
- Walking and bicycling to the transit station should be provided for the convenient and safe access of people besides the streets and sidewalks within TODs.

Conclusion

Dhaka, the capital city of Bangladesh is one of the fastest growing mega cities in the world. It has grown so crowded that existing infrastructure make it almost impossible for many to lead a comfortable life. Dhaka, with very high population growth and shortage of flood-free land, puts much stress on the precious agricultural lands around the fringe. Space occupied by the residences of upper income-group covers significant portion of the urban land where density is very low compared to the areas occupied by the middle and lower income groups of population of Dhaka. Urban sprawl has become a worldwide problem, and it has brought a series of negative effects, such as encroachments into cultivated lands, the deterioration of the ecological environment, and the increasing cost of infrastructure construction. To avoid these negative effects and to promote sustainable development, compact development, which has been successfully applied in developed countries, can be a solution. And this study tries to identify the compactness of Dhaka City in this regard.

Reference

- Alam, F. Kaiser, R. Amin, M. N. 2016. An analysis of growth trend and development process of Uttara Model Town, BURP thesis, Department of Urban and Regional Planning, BUET, Dhaka.
- Bangladesh Bureau of Statistics (BBS) (1981). Community Report: Dhaka Zilla, Bangladesh Bureau of Statistics, Bangladesh.
- Bangladesh Bureau of Statistics (BBS) (1991). Community Report: Dhaka Zilla, Bangladesh Bureau of Statistics, Bangladesh.
- Bangladesh Bureau of Statistics (BBS) (2001). Community Report: Dhaka Zilla, Bangladesh Bureau of Statistics, Bangladesh.
- Bangladesh Bureau of Statistics (BBS) (2011). Community Report: Dhaka Zilla, Bangladesh Bureau of Statistics, Bangladesh.
- Bertaud, A. 2004. The Spatial Organization of Cities: Deliberate Outcome or Unforeseen Consequence? Institute of Urban and Regional Development, University of California at Berkeley.
- Burgess, R. 2000. "The compact city debate: A global perspective", pp. 9-24, in Jenks, M. and Burgess R. (eds.), Compact cities: Sustainable Urban Forms for Developing Countries, London and New York: Spon Press.
- Huda, K. 2014. Illegal land use trends and consequence: A Case study on Dhamondi residential Area, BURP Thesis, Department of Urban and Regional Planning, Jahangirnagar University.
- Imon, S. S. 2001. Evaluating the Option of Compact Development as a Sustainable Urban form for the Growth of Dhaka, Unpublished M. Sc. In Urban Planning Thesis, University of Hong Kong, Hong Kong.
- Islam, N. (ed.) 2005. Urbanization, Urban Planning and Development and Urban Governance, CUS, Dhaka, p. 141)
- Liaqut, H. and Waheed, A. et al. 2017. Measuring Urban Sustainability through Compact City Approach: A Case Study of Lahore, Journal of Sustainable Development Studies, ISSN 2201-4268 Volume 10, Number 2, 2017, p. 61-81
- Nilufar, F. 2000. Study of Responsive Public Open Spaces for Supporting Urban Life in Dhaka city. Dhaka: Asiatic society of Bangladesh.
- Rajdhani Unnayan Karttripakkha (RAJUK), 2013. Ministry of Housing and Public Works. Government of the People's Republic of Bangladesh.
- Shrivastava, P. A. 2009. Exploring Compact City: Reconfiguring The Compact City, Masters of Architect thesis, Department of Architect, Ball State University, Indiana https://cardinalscholar.bsu.edu/bitstream/handle/123456789/193596/Pshrivastava_2009-1_BODY.pdf;sequence=1 retrieved on 25 February, 2018.
- UN-Habitat. 2014. A new strategy of sustainable neighbourhood planning: five principles'. Urban Planning Discussion Note 3. https://unhabitat.org/wp-content/uploads/2014/05/5-Principles_web.pdf retrieved on 7 February, 2018.
- Urban Task Force, Britain 1999. Towards an Urban Renaissance, London: E & FN Spon.
- United Nations Department of Economics and Social Affair. 2011. World Urbanization Prospects, the 2011 Revision. New York. UNDESA.
- Wisma, U., et al. 2010. 'A review of international best practice in accessible public transportation for persons with disabilities. UNDP Malaysia. http://www.my.undp.org/content/malaysia/en/home/library/poverty/PubPovRed_PublicTransportation.html retrieved on 25 February, 2018.

Housing Preferences of the Urban Poor: Case Study of Selected Low Income Settlements in Dhaka

Dr. Halima Begum*

Abstract: Conventional Shelter policies that focus on slum clearance, public housing, sites-and-Services, upgrading of core dwellings and government assisted self-help are inadequate to meet the growing needs of the urban poor in developing countries for low-income housing. Governments in developing countries must give more attention to tailoring housing policies to the needs of the urban poor, to developing multiple modes of shelter provision. Since the urban poor comprise different groups with diverse needs and aspirations it is important to understand the community perspective on the housing needs and preferences. This paper addresses housing preferences of the urban poor and policy options in Bangladesh. The paper is based on research carried out in four low-income neighbourhoods in Dhaka. Data was collected from a random sapling survey of 329 households in three slums and one resettlement colony in Dhaka. Following a review of people's perspectives on different types of housing development options, land tenure and property rights, the paper shows a plurality of perspectives on housing choice. The paper ends with a discussion of the need for housing strategies to consider these differences among the choices and preferences.

Keywords: Urban poverty, slums, Dhaka, housing preference

Introduction

Over the past few decades the developing world cities are experiencing a proliferating growth of urban slums. Currently about one billion people live in urban slums and this population is growing by 2.2 per cent per year. Unplanned urbanization, extreme poverty and consequent rural urban migration are contributing to the growth of slums in the cities. The research is conducted in Dhaka, the eleventh largest mega city of the world. Nearly five thousand slum and squatter settlements are home of about 30 per cent of the total population of the city. These slums and squatter settlements built both on government vacant land and private property provide cheap and affordable housing to the urban poor who are mostly, with low level of education and skill, engaged in the informal sector of the economy. These slums in the city are characterized by over crowding, lack of basic services, poverty, poor housing and lack of security of tenure. Providing adequate shelter to the poor is a major problem for the governments. The current shelter strategies for the poor though play an important role, are inadequate to the growing demand for low-income housing. It is increasingly being felt that the conventional housing strategies such as public housing, slum clearance, site and services, core housing, assisted self help etc. should be replaced or supplemented by other options (Keivani & Werna, 2001a, 2001b; Rondinelli, 1989, 1990a, 1990b; Wang & Li, 2006) such as private or informal sector construction, cooperative housing, security of land occupation, low income rentals etc. In the developing countries the housing policies show a tendency towards treating the urban

* Professor, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka-1342, Email: halima.sayed@juniv.edu, Ph:+8801675021805

poor a homogenous entity. However, there is considerable evidence to suggest that the urban poor are far from being a homogenous group to be treated together. They can be split into different groups (Sinclair, 1978). In the literature there is considerable debate on cultural homogeneity or heterogeneity of urban poor. While some authors consider urban poor as culturally homogeneous group (Lewis, 1959) others such as Hennerz (1969), Anderson (2002), Salcedo & Rasse (2012) believe that it is possible to find different behaviors, expectations, decision-making processes, and outcomes among people living in seemingly identical structural conditions. Therefore, formulation of housing policy should inform the heterogeneous urban poor community. While suggesting the policy options it is important to know the choice and housing preferences of the people and community's readiness to participate in such shelter strategies. In this regards the article attempts to find out the array of housing needs and preferences and its interconnectedness with possible participation in housing development. The main objective of the article is to analyse social and economic situation of urban poor and present critical analysis on housing needs, housing and neighbourhood satisfaction and affordable housing preferences of the urban poor. This will help the policy makers conceiving the housing poor for the purpose of devising housing strategies for them.

Methodology

This paper is based on data obtained from four low-income communities in Dhaka, Bangladesh. The low-income communities include Baunia Bandh resettlement community, Begun Tila, Kallyanpur Pora Basti and Balur Math in Mirpur. A random sampling survey of total 329 households was conducted with an aim to investigate urban poor's socio economic condition and residential preferences. Data was analyzed using simple descriptive statistics.

Housing for poor in Dhaka

Dhaka being the capital is the most populated city in Bangladesh. The city has a long history of 400 years as a dominant city: first as provincial capital of the Mughals in 17th century then as the second-largest city in Bengal after Calcutta under British rule and later, after the partition of India in 1947, as the administrative capital of East Pakistan. The historical dominance of the city as the political, administrative and trading hub played a major role in gaining its primacy over the others. As the main centre of administrative, political, cultural and economic life in the country with the most developed urban infrastructure, it attracts the largest share of direct foreign investment in trade and industry, and consequently has become the largest agglomeration of different sectors of service, education, manufacturing, business and infrastructure. This has opened up massive employment opportunities in the formal and informal sector encouraging large influx of skilled and unskilled population from other urban and non-urban areas into the city. According to Bangladesh Bureau of Statistics (2001) The statistical metropolitan area i.e. the city and surrounding municipalities has a population of over 18 million, while the city has a population of 8.5 million. The annual growth rate of population in the city is averaging around 4.2 per cent (4.67 per cent in 2011) against a national annual urban population growth rate of 3.3 per cent. With a density of 23,234 people per square

Kilometre within a total area of 300 square Kilometres, it is one of the most densely populated areas in the world. Recent Household Expenditure Survey shows that 12 per cent of Dhaka's urban population lives at or below the poverty level BBS (2016). Centre for Urban Studies (CUS) in 2005 estimated that more than 37 per cent of the people living in Dhaka City are residents of slums and squatter settlements (Islam et al, 2006). Though there is no recent statistics available on actual housing requirement in Dhaka, the city had an annual requirement of 0.22 million dwelling units up to the end of the century, which included 80,000 new dwellings; 102,000 replacement units and 35,000 backlog units (BCL-IDSS-Prashika, 1996). According to Real Estate and Housing Association of Bangladesh (REHAB, May 2011) the requirements of urban poor is 0.14 million units, which constitute almost two-thirds of the total requirements.

Slums in Dhaka

According to the Bangladesh Bureau of Statistics a slum is a 'cluster of compact settlements of 5 or more which generally grow very unsystematically and haphazardly in an unhealthy condition and environment on government and private vacant land. Slums also exist in owner based household premises'. There are several criteria of slums. These are: 1) Predominantly very poor housing, 2) Very high housing density, housing materials are very cheap and low quality, 3) Poor sewerage and drainage or even absence of such facilities, 4) Inadequate and unhealthy drinking water supply, 5) Insufficient or absence of street lighting, 6) Little or no paved street, and 7) Inhabited by poor, uneducated and below poverty level people.

The Centre for Urban Studies (2005) defines slums as settlements with a minimum of ten households and having characteristics such as predominantly very poor housing, very high population density and room crowding, very poor environmental services, specially water and sanitation, very low socio-economic status and a lack of tenure security. An urban community has to meet at least four of the above criterion to qualify as slums. In short these are composed of cluster of dwellings which are densely populated, temporary in nature, built lawfully or unlawfully, having very minimum water supply, sanitation facilities or electricity supply. Most of these are one-roomed dwellings and extremely over-crowded.

As mentioned above, slums and squatter settlements are not distributed uniformly throughout the Dhaka metropolitan area but rather they are concentrated mostly on the marginal areas and spontaneous urban growth areas. Due to an acute demand for land and high land prices, especially in the central zones and in upper class residential areas, the slums and squatter communities have moved or are moving towards the city's peripheries in the search for cheap shelter. According to the CUS among the 4,966 slums and squatter settlements an overwhelming majority of these are located on land owned by private individuals (89.8 per cent), Only 9 per cent are located on government and semi-government land (Islam et al, 2006). Slum and squatter settlements do not develop in the planned part of the city. They mostly developed in the peripheral thanas of Mirpur, Mohammadpur and Demra when they were the city periphery in the late 1970s and 1980s.

Settlements profile

Baunia Bandh

The settlement is situated in the north-eastern part of Dhaka. It falls within the administrative boundary of Pallabi Thana of Dhaka district. According to the DCC's administrative division, Bauniabandh is located in Section 111 of Ward 2 13 within the Mirpur. The site of the settlement was a low-lying public land that has been earth filled and protected with a flood protection embankment which is the primary road surrounding the settlement on three sides. It is one of the oldest resettlement colonies in Dhaka city, currently having population of around 35,716 (BBS, 2011) within land area of 96 acres. The resettlement colony is a planned residential project implemented by the Housing and settlement Directorate (NHA) with funding from donor agencies in early 1980s. Unlike the other settlements, this settlement is much bigger in term of its area and is characterized by a wide internal road and relatively better housing structures and facilities. It is divided into five residential blocks. Although the settlement was originally designed to rehabilitate 2,600 families, according to Dhaka city corporation records (2009), it accommodates more than three times that number, about 8,472 households.

Kallyanpur Pora Baste

Kallyanpur Pora baste situated in the northwestern part of Dhaka. It is located adjacent to Mirpur Bangla College and the Vocational Training Institute. It falls within the administrative boundary of Mirpur Thana of Dhaka district. According to the DCC's administrative division, the settlement is located in DCC Ward 11 of Zone 7. Unlike the other case study areas, this settlement is situated in the middle of highly developed areas. The slum was developed on an area of nine acres of public vacant land during the early 1990s. The evicted slum dwellers from surrounding areas were settled with help of local political leaders after payment of Tk 3,000-6,000. It is called 'Pora Basti' as it has caught fire several times over last twenty years. Currently it is home to 3,000 households and an estimated total population of the area is 15,000 (BBS, 2011).

Kalapani Begun Tila

Begun Tila, situated about three kilometres north of Bauniabadh and falls within the Pallabi Thana of Dhaka district. According to the DCC's administrative division, it is located in Ward 2 of Zone 8. The slum development process started with relocation process of evicted people in 1999. After being uprooted from other slums in Dhaka city, the slum dwellers were organised with the help of local political leaders and NGOs and demanded justice and rehabilitation. They demonstrated outside the High Court and appealed to the High Court against the eviction. According to the local sources, on August 29 1999, the High Court declared an order to resettle 5,454 families and government took initiative to relocate them temporarily on government land. About 900 households were resettled with assistance from local political leaders on a four acre plot of public land in Begun Tila. According to the BBS, the settlement is home to 700

¹ Section stands for simple geographical sub-division within a *thana*

² Ward is the lowest administrative unit of the Dhaka City Corporations.

households of 3,000 people. However, according to the local community leaders, currently there are only 754 households in the settlement. Though the settlement is situated on plain land surrounded by water bodies on the east, it is free from regular floods. Those water bodies were used for communal purposes such as bathing and washing as well as primary outlets for sanitation. Almost all houses are of 24 x 18 feet in size. Most of the structures are made of temporary materials, however, few semi-permanent two-storied structures characterizes the settlement.

Balurmah Bastee

Balurmah is situated about 15 kilometres north of Dhaka city centre and about a kilometre north of Bauniabadh colony. It also falls within the Pallabi Thana of Dhaka district. According to the DCC's administrative division, it is located in Ward 2 of zone 8. This slum has been developed on public vacant land. It is situated on land that is about two meters lower than the surrounding roads which makes the slum hidden. The process of this settlements development started when the surrounding areas were being developed with filling in low-lying land for construction of roads and other public infrastructure during late 1990s early 2000s. According to the local community leaders, people from Kalshi No 5 Bastee, which is located on the other side of the road facing the Balurmat Bastee (falls in DCC Ward 5), settled on the land. Each of them paid about Tk 7,000-10,000 to local community leaders who allowed them to construct temporary structures on the land. This slum is newly developed compared to other slums in the locality. According to the local community leaders, there are about 527 owner-occupied households and about 150 tenants in the settlement. It has a total population of around 3,000 and an area of two acres.

Settlement characteristics

Survey respondents in the four settlements were approximately two-thirds female and one-third male (64% & 36% respectively). The study area is predominantly Muslim (96% of households), with a minority Hindu (4% of households). Education levels in the community are fairly moderate, with 30 per cent of respondents having no formal education. Among all respondents, 25 have completed up to primary level (Class 5), 30 per cent have studied up to secondary level (Class 10), 7 have senior secondary (Class 12), and another 5 per cent have post-secondary education or university degrees. Within the settlements average household size is 4.8 persons. All the households were family dwelling. The most common household structure is nuclear families (78%, followed by extended families with (14%), single-parent families (6%) and other types (2%). Majority of the households are male headed (85%) with only 15 per cent households being female headed.

In all the settlements together, nearly 84 per cent of the dwellings were owner occupied and the rest 16 per cent were occupied by tenants. Almost half of the dwellings were permanent and semi-permanent and the rest were temporary in nature. The sense of security of occupancy seems to be a factor for making investment on the housing. In Bauniabadh settlement where the residents have occupancy rights, only 8 per cent of the houses are constructed with temporary materials. Whereas in Balurmah, almost 70 per cent of the houses are temporary and the remaining 30 per cent are semi-permanent.

Among the owner-occupied houses in all four study areas only 30 per cent of the respondents felt that they do not have security of occupancy and 78 per cent of those owner-occupied houses who disagreed with the current security of occupancy were temporary and on the other hand about 80 per cent of the owner-occupied houses who agreed that they had security of occupancy were permanent or semi-permanent in nature.

Table 1: Settlement Characteristics

		Name of the settlement			
Settlement Characteristics		Balurmah	Kallayanpur	Begun Tila	Bouniabadh
Median Family size		5	4.5	4	5
Total Population		15000	8500	-	32000
Total households		-	1800	754	6500
Area (Acre)		NA	NA	NA	96
Median HH income (Taka)		12000	12000	12000	14000
Mean HH Income (Tk)		14234	12722	12943	16175
Income range		8000- 35000	7000-35000	6000-45000	8000-40000
Median HH working member		2	2	2	1
Income Per centiles	20	10000	9000	12000	12000
	40	12000	12000	12000	12000
	60	12000	12000	12000	15000
	80	20000	15000	15000	20000
Construction Materials of dwelling	Permanent	0%	1.4%	0%	21%
	Semi permanent	30.6%	37.8%	30.2%	71%
	Temporary	69.4%	60.8%	69.8%	8%

Source: Field Survey, 2017

An analysis of people's mobility pattern shows that about 41 per cent of the residents came to their respective settlements from nearby areas within a radius of four kilometres while about 17 per cent of the respondents came from villages through their relative and close acquaintances. Majority (70%) of the respondents are first generation of the rural-urban migrants coming from different parts of the country. However, they changed their place of residence several times before coming to the present settlement. The average length of time in Dhaka was found to be seventeen years, which indicates that they were not recent arrivals. The remaining 30 per cent were born in Dhaka. It is interesting to note that more than 75 per cent of the respondents staying in the respective areas for over ten years and 33 per cent for more than twenty years, the largest share living in Bauniabadh and Kallayanpur-Porabosti area.

Income and Employment

Employment data reveals that the majority of household heads are engaged in the informal tertiary sector. Activities primarily include vending and petty trading (hawker, shopkeeper), transport (rickshaw puller, auto-rickshaw driver), services (tailor, mechanic, street-sweeper), manufacturing/construction (factory-worker, carpenter) and daily labourers (no specific activity). While about 72 per cent were engaged in the above-mentioned activities, 18 per cent were engaged in the formal sector particularly in the manufacturing industry (ready-made garments) and the remaining 10 per cent with the government services. Income data reveals that the income level varies among households and settlements. In the communities, the most obvious variation in income status is between the owners and the tenants and squatter residents and the resettlement colony residents. The average monthly income of households was found to be Tk 15,000 (USD 200). However, the income range per month was found to be Tk 6,000-45,000. Overall, the median monthly income was 12,000. The income variation was found to be manifested in the housing quality. It was also evident from the survey that female participation in the workforce is high among the residents. In most of the household number of working member were two. However, the 32 per cent of the male working member and 14 of the female working members were found to be engaged in more than one economic activity. It is important to note that though the statistics on female workforce is low the issue of household chores largely goes unnoticed here.

Housing & Neighbourhood Satisfaction

While it is important to assess the quality of housing and living environment, it is also important to know people's perspective on this. Housing satisfaction is not only about quality of the building materials or quality and accessibility to services, it is also about nearness to workplace, rent and social networks. While participants were asked to rate the levels of satisfaction with current housing aspects majority of them indicated that they were somewhat happy with the overall housing situation, 53 per cent being happy and 44 per cent being moderately happy in all the study areas. However, it is important to note that the overall housing satisfaction of the residents is comparatively lower among the lower half income strata than that of their counter half. In the Bauniabadh area 75 per cent of the residents are happy and the rest are moderately happy. While in Begun Tila 63 per cent of the residents are moderately happy, in Balurmath and Kallayanpur settlements more than 50 per cent of the residents were happy with the existing housing situation. While measuring the level of resident's satisfaction issues such as indoor space, utilities, construction materials and community facilities got the lowest average score below 3.5, and satisfaction with the community life attained the highest score.

One-third of the respondents like the mutual understanding and trust and community cohesion most about living in their respective communities. This is followed by other reasons such as the linkage of the settlement with other areas, the social environment and cheap housing. However, their responses varied widely within settlements. For example, in Begun Tila and Kallayanpur 49 per cent and 10 per cent respondents liked the social environment, whereas in rest of the two settlements no one mentioned about it rather emphasized on other factors such as community feelings and community facilities.

The research indicates almost 80 per cent of the residents are happy and 19 per cent are moderately happy with the neighbourhood they live in. An income group wise distribution of the resident's responses shows that 51 per cent of the total households are happy with the housing and neighbourhood earns less than 13,000 Tk per month. However, there are negligible share of households (1.5 per cent) that are unhappy with the neighbourhood within that income range. Similarly, the per centage distribution of housing satisfaction reveals that the levels of satisfaction are higher in the lower income households. The findings suggest that though people are not very happy with the indoor space, quality of the structure or security of tenure, majority are happy to compromise the quality with cheap rent and social network. According to majority of them the slums provide cheap accommodation and a platform to build social capital which are prerequisite to their survival in the city.

Community Participation of Slums dwellers

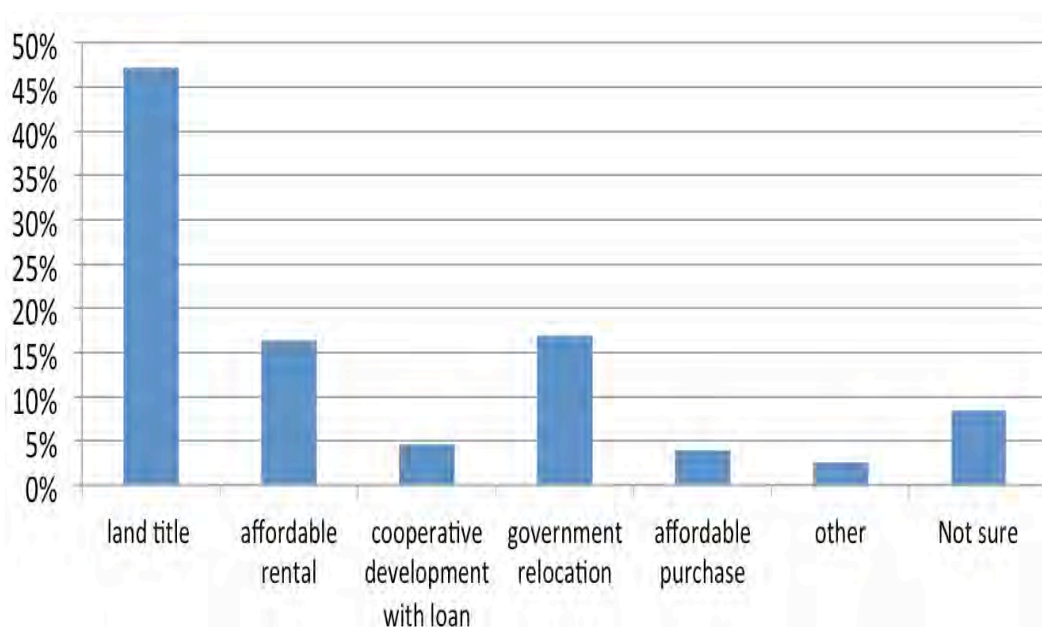
From the research it was found that the poor have the tendency to form committees or get involved in associations which are either organized by themselves or by an external agent like an NGO to solve existing problems or improving the current conditions. An analysis of respondents' current involvement with a local association or organization shows that 72 per cent of the respondents are members of one of more association or local groups. A multiple response analysis shows that 71 per cent of the respondents are members of a credit/savings group, 54 per cent of the respondents are members of a resident group, 43 per cent of the respondents are members of a cooperative and 36 per cent are members of a union.

According to the findings, 54 per cent of the total residents are currently involved with development activities of the settlements with different NGOs. The highest level of participation is recorded in Kallyanpur (63%) followed by Begun Tila and Bauniabadh (54% & 52% respectively). However, residents' participation also varies across income groups. It is evident that more than half of the respondents are currently involved either as a beneficiary, a member, a volunteer or as a staff with NGOs working in the neighborhood. The participation rate ranges from 45 per cent in Balurmath to 63 per cent in Kallayanpur. Tenancy wise distribution shows that among all the respondents involved with NGOs, 83 per cent are owner and 16 per cent tenants. The lower participation rate of the tenants is attributed to the fact that tenants are relatively more mobile and NGOs are reluctant to involve the tenants for long-term contracts. While more than half of the residents are involved with NGOs the nature of the activity varies across settlement and income categories. While half of the residents participate in community improvement programs the richer households tend to be less involved. The middle-income strata (income ranging between 10,000-13,000Tk) are participating in community infrastructure development, informal education, training and micro-credit program which is slightly over the poorer or richer income groups within the settlements. In addition, in activities such as community awareness programs and addressing the social problems, there is greater participation of the lower and middle-income groups in the settlements.

Housing preference and Choice

The community demonstrated a wide variety of preferences regarding housing development choices such as land title, cooperative housing development, land title, community rental, relocation to a better place by the government etc. Among them land title was preferred by about 46 per cent of the residents, as it is comparatively the easiest and cheapest method of housing. Nevertheless, government relocation and affordable rental was also preferred by 16 percent and 15 percent of the respondents respectively.

Figure: Housing Preferences of residents



Source: Field Survey, 2017

In addition to housing preferences and residents self-effort with external assistance, to obtain an in depth understanding of people's preferences, opinion were also sought on a number of individual housing options including cooperative housing, government relocation, land-sharing, and direct construction by NGOs and rental housing in the community. On the question of cooperative housing about 57 per cent of the respondents do not consider this as a feasible option. According to them, the main obstacle for cooperative housing hinge on factors such as lack of financial ability and unity among people, and lack of any legal provision. Yet, for 33 per cent of the total respondents, cooperative housing is a possible solution to address the housing problem in the community. However, they also believe that for doing so there should be a strong and active intervention of external agencies.

On the other hand, people's perception on land sharing is also not positive particularly in the two rehabilitation areas of Begun Tila and Bauniabadh. More than half of the total respondents (54%) and 69 per cent of respondents in Bauniabadh are not ready to share

their land and believe that sharing land with other people or organisations to build houses is not a viable solution to the overall housing problem in the communities. However, a quarter of the total respondents and about 38 per cent in Kallayanpur think that option is possible to accept. In addition, it is interesting to note that another about 20 per cent of the total respondents including 36 per cent of the respondents in Balurmath consider security of the tenure is a major condition to be met before accepting such an option.

It was also interesting to note people's opinion on government's decision to relocate them to a new place. In total one third of the respondents were willing to be relocated and another 30 per cent wanted to remain on the same place. Community perspectives were also sought on what choice they would like to make if they were provided low interest rate loan by NGOs to construct housing on their own on the land they were residing. The survey shows that most of the people are more interested in taking long-term low-interest housing loans for constructing or developing their houses on their own. Indeed, 66 per cent of the total respondents and more than 70 per cent of the respondents of Kallayanpur and, Begun Tila said that they prefer to take housing loans from NGOs and repay the loan on monthly instalments. Among the rest of the respondents, 22 per cent showed concern about the land tenure issues and are hesitant of taking loans without legal ownership of land. A small fraction of the respondents (5 %) were unwilling of taking any loan considering the financial hardship. On the other hand, another 5 per cent of the total respondents and 13 per cent from Bauniabadh thought that they did not require any loan for their housing.

In response to question regarding NGOs role as builder for constructing the houses and renting out to the people, the residents showed mixed responses. While 47 per cent of the total respondents had negative responses including as high as 69 per cent in Bauniabadh and as low as 22 per cent in Balurmath, a considerable fraction of the respondents (24%) agreed and wanted NGOs intervention in construction and renting out the properties to them. As the table below shows, the response widely varies across settlements. In Balurmath 47 per cent of the respondents readily accepted that NGOs should come forward constructing better houses, whereas in Bauniabadh, the majority declined NGOs to do so. These views seem to be interconnected with their sense of security regarding the tenure and their future prospects of permanent stay within the settlement. For example, in contrast to Bauniabadh, in Begun Tila 40 per cent of the respondents said that they were ready to accept a hire-purchase mechanism in which they would pay the rents only to own the dwelling one day. Again, in Balurmath and Kallyanpur more people prefer NGOs involvement in NGO-led constructing and letting to the residents leading to house ownership.

Table 2: Residents Views on Prospective Role of NGOs in Housing in Respective Settlements

What would you like the NGOs to do on housing in this settlement	Name of settlement				Total
	Balurmath	Kallayanpur	Begun Tila	Bauniabadh	
Nothing, we can do on our own	4.1%	0.0%	1.9%	14.0%	5.5%
A place to stay and work opportunity	2.0%	5.4%	0.9%	0.0%	1.8%
Don't know	16.3%	6.8%	1.9%	11.0%	7.9%
Help building permanent houses with permanent land allotment	20.4%	36.5%	40.6%	9.0%	27.1%
Housing loan with low interest and monthly repayment	26.5%	12.2%	17.9%	31.0%	21.9%
Help getting legal rights of the land	10.2%	20.3%	20.8%	19.0%	18.5%
Improve community facilities and infrastructure	14.3%	4.1%	11.3%	15.0%	11.2%
Construct houses and sale on long term instalments	6.1%	14.9%	4.7%	1.0%	6.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Field survey 2017

Finally, when asked about the NGO's priority activity related to housing in this settlement, about 27 per cent mentioned that they want NGOs to help them with permanent land allocation along with permanent housing in the respective settlements. The next dominant group consisting of 21 per cent of the total respondents wanted long-term low-interest housing loans that will help them to build or improve existing housing. The third group of people accounting 18 per cent wanted NGOs to negotiate with government for permanent on-site rehabilitation including legal rights and land title. According to them this is the way NGOs can help them in building permanent housing. However, this again varied widely across settlements. In Bauniabadh where people enjoy relatively more sense of tenure security, respondents prefer NGOs to provide easy housing loans. A considerable share of the respondents also mentioned about the legal rights of land and improving the community infrastructure. On the other hand, in Begun Tila, where people are temporarily rehabilitated by a court order, 41 per cent of the respondents opted for permanent rehabilitation and 21 per cent for legal rights of land including title. Similarly, in the other two areas, respondents prefer NGOs assistance for permanent allocation of land before any other kind of involvement. Therefore taking the example of the Bauniabadh community, it can be said that once the residents have some sort of security of their stay on the occupied/temporarily allotted land they are interested in investing either on their own or taking loans from NGOs. Nevertheless, majority of the respondents want NGOs to intervene as an intermediary between the government and the community for permanent housing.

Discussion and conclusions

The above discussions provides comprehensive picture of the communities' perspectives on their housing needs and preferences as well as a number of options of participation in housing development. Given the findings above, it can be concluded that even though each informal settlement possess some common characteristics in terms of tenure, housing features, and provision of amenities, they accommodate people with wide variety of income, place of origin, and employment. Thereby the settlements are heterogeneous in social structure offering affordable housing to low-income strata. It is interesting to note that while the majority of the respondents are happy with the overall housing situation, the level of satisfaction with components such as indoor space, materials and utilities was low. However, level of satisfaction with community life, cost, and nearness to work was found be relatively higher. Though there was no relation found with level of satisfaction with tenancy, lower income strata was found to be happier than people with relatively higher income within the settlements.

The primary reason for staying in the settlement was identified to be affordable rent and easy communication for both owners and tenants. A very small segment of the respondents also mentioned they were living in the settlements as the plots belonged to them. They were found to be highly motivated for future participation in development activities of the NGOs and in NGO-led housing efforts. But improving the housing security of tenure was identified as the major barrier. Thus it can be said that a healthy secured housing is more preferred among communities rather than ownership or land title and all the respondents, irrespective of income, ownership, or education, expressed concern over security of tenure. Thus land title was found to be as a means of security of tenure to many and a healthy secured housing and living environment was much sought after.

Housing preferences were not found to be related to either tenancy or duration of stay. With regards to a number of prospective housing options, residents expressed their willingness of participation on a variety of housing development options. When asked about interventions by NGOs for housing development, a number of options were mentioned by the respondents irrespective of level of income. The responses include low-interest housing loans, land-sharing, provision of community facilities, land title, and direct-housing development by the NGOs. Some of the respondents also mentioned that they wanted to be rehabilitated to some other area by the government. From these findings it can be said housing preferences vary among people and groups. In such a situation, a unified policy is likely not to address the housing problems for all the slum residents.

On the other hand, involvement of residents with community development activities of NGOs also shows that residents with lower income considered that participation could bring more benefits in terms of improving the living conditions of the settlements. Therefore existing participation for them was much higher than those with relatively higher income. It was also interesting to note that the majority of residents were interested in further participation in anticipation of better housing and neighbourhood environment. Thus, participation is instrumental for attaining a better living environment.

The picture that emerges from the above discussions is that the urban poor are a heterogeneous community in terms of income, employment, housing needs and preferences. Different groups within the urban poor have different housing needs, housing preferences where some wants to rent accommodation, some wants to buy affordable accommodation while some prefer provision of site and service. Some of them wants to go back to the village and some want to stay in the city. Therefore, binding the slum dwellers within a place based community and designing a unified housing strategy for the slum community is likely to fail addressing the long term affordable housing goals a the country. It is suggested that on analysis and predicting the extent and nature housing needs demand for the urban poor can proceed by more careful analysis of the urban poor who makes the demand.

Bangladesh Bureau of Statistics. 2011. Statistical Yearbook of Bangladesh. Statistics Division, Ministry of Planning, Dhaka, Government of the People's Republic of Bangladesh.

Bangladesh Bureau of Statistics. 2016. Preliminary Report on Household Income and Expenditure Survey 2016. Statistics Division, Ministry of Planning, Dhaka, Government of the People's Republic of Bangladesh.

References

- Anderson, Elijah. 2002. The ideologically driven critique. *American Journal of Sociology*, 107(6), 1533-1550.
- Bangladesh Bureau of Statistics (BBS). 2001. Population Census 2001, Preliminary Report. Dhaka: Bangladesh Bureau of Statistics.
- BCL-IDSS-Prashika. 1996. Urban Poverty Reduction Project. Dhaka ADB-GOB.
- Hannerz, Ulf. 1969. *Soulside: Inquiries into ghetto culture and community*.
- Islam, Nazrul, Angeles, G, Mahbub, A, Lance, P, & Nazem, NI. (2006). *Slums of urban Bangladesh: mapping and census 2005*.
- Keivani, R., & Werna, E. 2001a. Modes of housing provision in developing countries. *Progress in Planning*, 55(2), 65-118.
- Keivani, R., & Werna, E. 2001b. Refocusing the housing debate in developing countries from a pluralist perspective. *Habitat International*, 25(2), 191-208.
- Lewis, Oscar. 1959. *Five families: Mexican case studies in the culture of poverty*.
- Rondinelli, Dennis A. 1989. Policy options for urban housing in developing countries *The Urbanization Revolution* (pp. 19-35): Springer.
- Rondinelli, Dennis A. 1990a. Housing the urban poor in developing countries: Other policy options for national shelter strategies are examined since conventional ones are inadequate. *American Journal of Economics and Sociology*, 49(3), 257-270.
- Rondinelli, Dennis A. 1990b. Housing the Urban Poor in Developing Countries: The Magnitude of Housing Deficiencies and the Failure of Conventional Strategies Are World-Wide Problems. *American Journal of Economics and Sociology*, 49(2), 153-166.
- Salcedo, Rodrigo, & Rasse, Alejandra. 2012. The heterogeneous nature of urban poor families. *City & Community*, 11(1), 94-118.

- Sinclair, Stuart W. 1978. Housing preferences and the urban poor in less developed countries. *Ekistics*, 243-246.
- Wang, Donggen, & Li, Si-ming. 2006. Socio-economic differentials and stated housing preferences in Guangzhou, China. *Habitat International*, 30(2), 305-326.

Kitchen Market Waste Management System and Opportunities: A Case Study on New Market Bonolata and Mirpur-1 Kitchen Market

Abu Zubair*
Farhana Akter**

Abstract: A huge amount of wastes are generated from the kitchen markets every day and these are not properly managed. Most of the kitchen market wastes are organic wastes and there is huge opportunity of converting these organic wastes into resources like composting of waste, producing biogas and electricity generation. At present wastes are just dumped in landfills which require huge land. There is no intermediary systems in practiced like recycling, incineration, composting, converting into other resources. Countries like Bangladesh with a small land and huge population have to suffer for the issue of waste management. This study is conducted on Kitchen Market Waste Management in Dhaka City Corporation and the study areas were Bonolata (New Market) kitchen market and Mirpur 1 kitchen market. This study tries to show the present waste management system of kitchen markets based on case study and also tries to provide some waste management systems that can be used to manage kitchen market wastes.

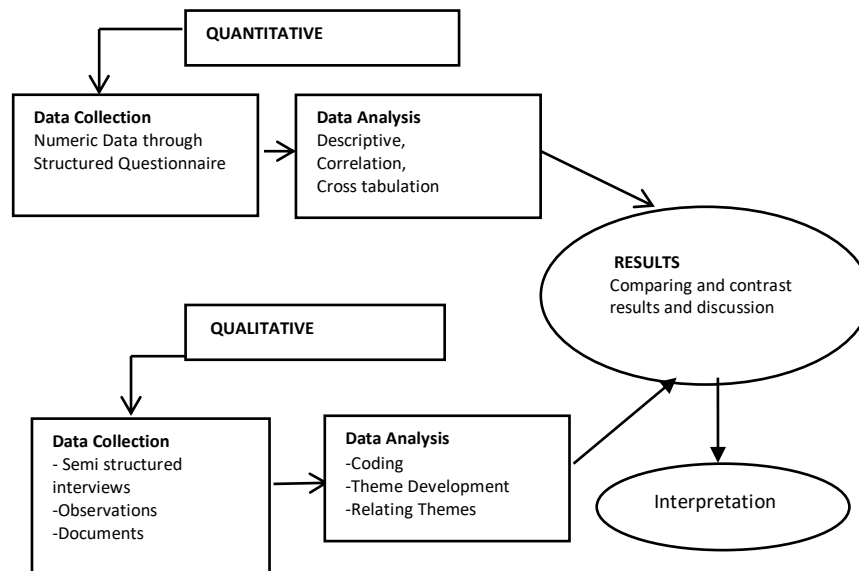
Introduction

Waste is a result of human activities which tends to increase with rapid urbanization, improved living standards and changing consumption patterns (Chandrappa and Das, 2012). The Asian Development Bank (2011) estimates that the South Asian region has the potential to produce around 8 million tons of compost per year, worth an estimated US\$709 million, or alternatively, an estimated 3,340 million kilowatt-hours per year of electricity (from biogas) with a market value of around US\$701 million per year. Furthermore, diverting this waste from landfills would save around 27.88 million cubic meters of landfill volume, with associated cost savings at the municipal level. Dhaka generates approximately 1.65 million metric tons of solid waste annually. At present there are 112 markets registered to operate in the north and south parts of Dhaka City Corporation (DCC) (north and south). These include more than 87 are Kitchen markets. Vegetable, fruit, fish, poultry and meat shops are usually found in these food markets. Apart from the registered food markets, there are also many other kitchen markets in the area, all of which generate an enormous total of waste every day (DSCC and DNCC, 2014). DCC, with its limited resources, technical know-how, and inadequate policy framework, is facing an uphill task to keep the city clean at an acceptable level (Kundu, 2008). Kitchen market wastes are mostly dumped in open places nearby; some are burnt too, in open fires. In the most common practice, various waste transfer points are established around the cities from where motor vehicles carry the waste to nearby

* MURP session-2014-15, Registration No. 31109, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka-1342. Email- abuzubair771@gmail.com

** Assistant professor, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka-1342. Email- farhana_urp@juniv.edu

landfills or dumping sites. There is no available modern sanitary landfill to accommodate the MSW generated anywhere in the country (Bhuiyan et al, 2012). The waste stream is more than 80% organic matter (APO, 2007). The unmanaged organics that form most of the MSW causes environmental pollution and consequently affects the public health (Moqsud and Omine, 2010). DNCC and DSCC are the formal organization responsible for waste. Limited capacity of the DNCC and DSCC authority to collect the waste, inadequate budget for management of the market waste, limited land for disposal, lack of public awareness etc. are the major problems regarding kitchen (food) market waste management in the DNCC and DSCC area (Reza and Hasan, 2016). This Improper management is also responsible for Environmental degradation- groundwater and surface water contamination, air and odor pollution and subsequently triggers pollution induced health problems (Bhuiyan et al, 2012).



Source: Developed by the Authors, 2018 based on Balsura, n.d.

Fig 1: The Concurrent Triangulation Approach for Conducting the Study

Generation of bio fertilizer can be a best option for managing kitchen market's organic wastes. In Dhaka UN-approved clean development management (CDM) under the Kyoto Protocol has already registered the project which will entitle its owners to get certificates for 'non-generation of carbon'. And they will sell those to developed countries. Collecting the organic waste from the markets, mainly Karwan Bazar vegetable market, local private firm Waste Concern, in association with its Dutch partners, has launched a compost plant at Bhulta in Narayanganj. But this type of environment friendly initiatives are very less compare to problem. So this study tries to study the present waste management system of these two kitchen market and finding the problems and best possible solutions.

Objectives and Methodology

Research questions for this study were, what are the problems and potentials of the kitchen market waste management in Dhaka city? and how can the present kitchen market waste management system be improved to ensure sustainable waste management system in Dhaka city? The objectives of the study are to study the existing waste management system of the kitchen markets of Dhaka city and identify the problems and prospects of kitchen market waste management system. To end with recommend some guidelines for effective and sustainable waste management system considering the existing deficiencies. This study was based on both primary and secondary data. Primary data were collected from field survey, observation, questionnaire survey of buyers and sellers and key informants. Considering $\pm 10\%$ precision level sample size has been selected. Secondary data were collected from DNCC, DSCC, Two kitchen market offices and other literatures. The qualitative data has been organized according to some themes for gaining meaningful insight to address the research questions, themes are- Problem of kitchen market waste on environment/market linkage, Perception of the buyer about the haphazard waste on their free movement, Problems created by the Kitchen market waste from buyer, seller, key Informants and officials perspective, Kitchen market waste management issues, Suggested solutions (Buyer, Seller, Key Informants and officials perspective) and Required policy support. . A field survey is conducted by the combination of Stratified, Convenience and Purposive sampling technique for collection of data. Some secondary data were collected from the market authority and the relevant organization (mainly Dhaka North City Corporation and Dhaka South City Corporation). The collected data were analysed and interpreted to find out the existing scenario of the kitchen markets.

Study Area

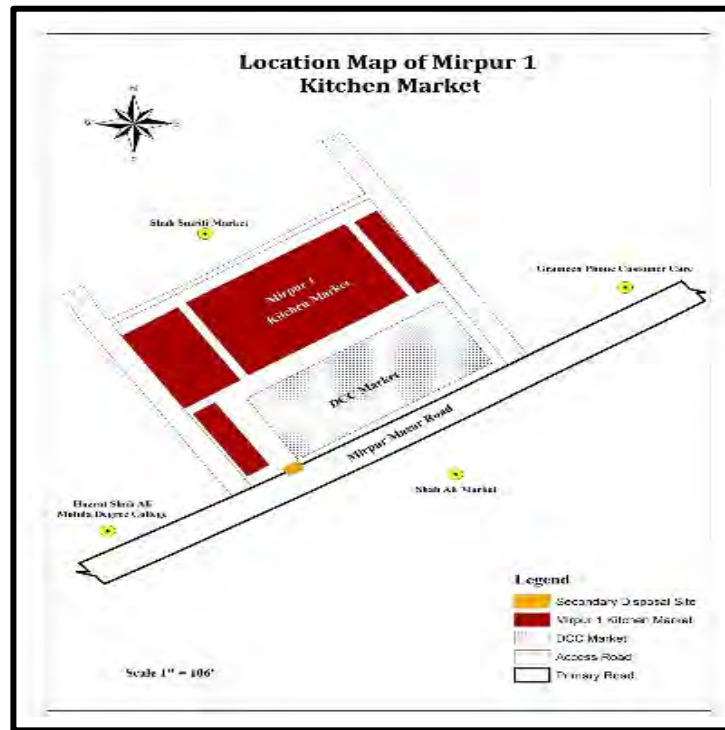
Two Kitchen markets were selected for case study; Bonolota Kitchen Market or New Market and Mirpur-1 kitchen Market. Bonolota Kitchen Market is one of the renowned kitchen markets under Dhaka South City Corporation locating besides the largest shopping complex of Dhaka, New Market. It is providing service since 1986. Due to its unique location with accessibility, it meets the kitchen market need of the residents of Dhanmondi, Staff and teacher's quarters of Dhaka University, BUET and DMC and the surroundings of this market. Besides, the various buyers of New Market are greatly influenced by this market. Mirpur is one of the prominent regions of Dhaka



Source: Constructed by Authors 2018.

Fig 2: Location map and lay out map of Bonolota kitchen market.

city. Mirpur-1 Kitchen Market locating at Mazar Road is one of the largest kitchen markets of DSCC. It was established in 1978. Mazar Road is located at the south side of the market. There are huge residential areas surrounding this market and it meets the need of a kitchen market of those areas (Field survey, 2018).



Source: Constructed by Authors 2018.

Fig 3: Location map and lay out map of Mirpur-1 kitchen market.

Existing Kitchen Market Waste Management System

Waste Generation and Waste Stream

Mainly vegetable, fish, poultry, slaughter house, fruit, plastic products and grocery shops are found in the three kitchen markets. From those shops both organic wastes (e.g. Vegetable Scrap, Fish Scale, Bird Dung, Animal Blood/ Dung/Bone, Fruit Scrap etc.) and inorganic wastes (e.g. Polythene, Plastic Paper etc.) are generated every day. The amounts of organic wastes are higher than the inorganic wastes in those kitchen markets. Waste stream is the amount of particular wastes generated from different shops. Here the waste stream is calculated in relation with the amount of particular wastes generated from the sample shops and the total amount of wastes generated from the total sample shops.

In Mirpur 1 Kitchen Market, approximately 250-270 kg wastes are generated per day. The total amount of wastes generated from the total sample shops of this market is 101 kg per day (Field Survey, 2017).

Table 1: Waste Stream of Mirpur- 1 Kitchen Market

Waste Type	Percentage	
	Organic	Inorganic
Vegetable Scrap	25	
Fish Scale	11	
Poultry Dung	39	
Animal Blood/ Dung	20	
Fruit Scrap	2	
Inorganic		
Polythene, Plastic, Paper etc.		3

Source: Field Survey, 2017

Here organic waste stream is higher than the inorganic waste stream. Among organic waste stream, the vegetable scrap occupies the higher portion (Field Survey, 2017).

In New Market Bonolata Bazar, approximately 460-480 kg wastes are generated per day (Field Survey, 2017). The total amount of wastes generated from the total sample shops of this market is 122 kg per day. The waste stream (in percentage) is shown in following:

Table 2: Waste Stream of Bonolata (New Market) Kitchen Market

Source: Field Survey, 2017

Here organic waste stream is higher than the inorganic waste stream. Among organic waste stream, the poultry dung occupies the higher portion (Field Survey, 2017).

Waste collection and disposal

- Mirpur 1 Kitchen Market Waste Collection & Disposal**

The bazar authority appoints four workers to collect the waste which is generated from the shops. They come every day at two times, one at the morning and other at the evening. The shopkeepers store the waste corner to the shop using polythene, paper or small container and then the workers primarily collect the waste from shops to shops. The

Waste Type	Percentage	
	Organic	Inorganic
Vegetable Scrap	54	
Fish Scale	10	
Poultry Dung	19	
Animal Blood/ Dung	5	
Fruit Scrap	3	
Inorganic		
Polythene, Plastic, Paper etc.		9

workers carry solid waste from the shops. But the liquid waste discharge to the surface drainage from the shops. Then the waste discharge to the underground drainage which have link to the main sewerage line.

The appointed workers use three vans to carry the generated waste to the disposal site. The capacity of each van is about 50-55 kg. Each van comes two times a day to collect the waste. There is primary disposal site to storage the waste besides the bazar. So, the workers directly dispose the waste to the primary dumping site from the bazar which is situated besides the Mazar road near the main entrance of the kitchen market. At the disposal site there are five communal depots to store the waste. The waste from the other areas is disposed here. The total area of this site is about 2000 sq. ft. Here the inorganic waste is segregated by the street children. Paper, plastics, polythene, bottle, glass etc. are the main inorganic wastes which are separated from the organic waste. The DNCC trucks collect the remaining waste and carry to the Amin Bazar land filling area which is the final disposal site.

- **Bonolata (New Market) Kitchen Market Waste Collection & Disposal**

The DSCC authority appoints seven sweepers to collect the waste which is generated from the shops. The sellers store the wastes in one corner of their shops and the collectors collect the wastes two times daily (at early morning & afternoon). The market authority has 3 sweepers of their own for shop to shop waste collection mainly in the vegetable, fish, meat and grocery shops. The poultry shopkeepers have arranged four sweepers for cleaning up the chicken wastes privately. The liquid waste is mainly generated from fish, meat, poultry and vegetable shops. The liquid waste is discharge to the surface drainage from the shops. Then the waste discharge to the underground drainage which have link to the main sewerage line. The sweepers collect the wastes by carrying carts and after the primary collection they transport the wastes by pick-up van to the dumping site near the New Market 1 no. gate for waste dumping.

The secondary disposal site is 200 yard far from the kitchen market. There are two communal depots at the dumping site. Here the inorganic waste is segregated by the street children. Paper, plastics, polythene, bottle, glass etc. are the main inorganic wastes which are separated from the organic waste. The DSCC trucks collect the remaining waste and carry to the Matulail land filling area which is the final disposal site.

Major Problems of the Both Kitchen Markets

Structural Problems

The internal drainage system in Mirpur 1 Kitchen Market is inadequate for this market. The drains are overflowed and not properly cleaned. The drains are blocked here and there because of the waste thrown by the sellers haphazardly. The sellers are not aware about the situation and thus they throw the wastes, solid and liquid, and block the drains badly (Field Survey, 2017). The drainage condition of this market is comparatively better in Bonolata (New Market) Kitchen Market.

In Mirpur 1 Kitchen Market and Bonolata (New Market) Kitchen Market some manholes are open. So the shopkeepers dump the waste into it directly. Thus manhole blocks and overflowed. It is also dangerous for the movement of the buyers (Field Survey, 2017).

The width of the internal road of these two markets is narrow and congested. This is not sufficient for easy movement. The shops are not properly arranged. It encroach the path for movement of buyers. The storage of waste beside the shops also creates encroachment. This situation is seen in two markets (Field Survey, 2017). Permanent and temporary shops expand the market area illegally. These shops block the main excess road. These shops are settled along the both sides of main access road In Bonolata (New Market) Kitchen Market, the access road is very narrow. This road is occupied by illegal parking of cars, motorcycles and other vendor. It creates congestion. In Mirpur 1 Kitchen Market illegal parking is also found (Field Survey, 2017).



Source: Field Survey, 2017

Fig. 4: Uncovered Manhole in Bonolata (New Market) Kitchen Market

Problems with Waste Management

Most of the shop storage wastes haphazardly beside the shops. Some sellers use bin or small container to store the waste. When the bin is filled the waste are stored beside the dustbin. There is no community bin for storage of waste. So, inadequacy of dustbin creates problems at the time of waste generation and storage. This scenario is found in all our study area (Bonolata Kitchen Market, Mirpur 1 Kitchen Market) as both market is leased by local business association, the market management committee tries to clean the stored waste timely (Field Survey, 2017).

Inadequacy of collection system is another cause of present critical scenario of kitchen market waste management system. In Bonolata (New Market) Kitchen Market waste collected twice a day but it is not sufficient (Field Survey, 2017). In Mirpur 1 Kitchen Market the regulation of collection of waste is to collect waste twice a day, but the waste is collected only once a day. They collect the waste during evening period. It is not sufficient.



Source: Field Survey, 2017



Source: Field Survey, 2017

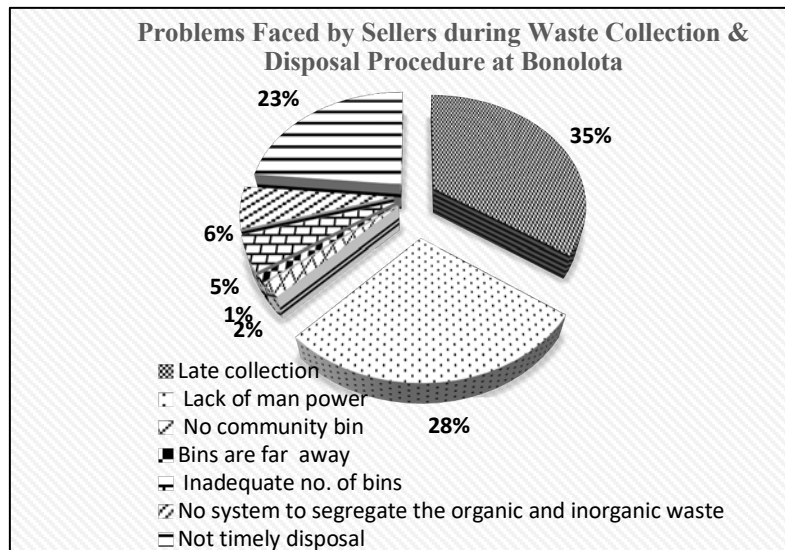
Fig. 5: Overloaded Carrying Carts in Bonolata (New Market) Kitchen Market and Mirpur 1 Kitchen Market

The throwing waste creates many problems as they are not collected properly (Field Survey, 2017). At present there remains only a very limited numbers of equipment's by which it is almost impossible to maintain and manage the total system properly. There is also lack of carrying carts and equipment of primary collection of waste is found. Lack of equipment's creates problems to collect the waste properly. In case of carrying waste from the market area to the dumping sites, the wastes are overflowed from the carrying carts and pollute the roadside environment (Field Survey, 2017).

Problems faced by Sellers during waste collection & Disposal Procedure

According to the opinion of the respondents, problems are due to late collection of the wastes by the sweepers in Mirpur 1 Kitchen Market. Besides, without adequate manpower proper disposal system cannot be ensured. In this market there is a lack of adequate dustbins. So the shopkeepers have to store the waste in the personal container or by the side of the shops which is really unhealthy and unhygienic. The sweepers do not collect the waste timely which causes a major problem to the sellers. Besides, from the market authority there is no provision for segregation of organic and in organic wastes (Field Survey, 2017).

According to the opinion of the respondents (seller), problems are caused due to late collection of the wastes by the sweepers in Bonolata (New Market) Kitchen Market. Besides, due to lack of proper manpower proper disposal system cannot be ensured. In this market there is a lack of adequate dustbins. So the shopkeepers have to store the waste in the personal container or by the side of the shops which is really unhealthy and unhygienic. The sweepers do not collect the waste timely which causes a major problem to the sellers. Besides, from the market authority there is no provision for segregation of organic and in organic wastes (Field Survey, 2017).



Source: Field survey, 2017

Fig 6: Problems Faced by Sellers during Waste Collection & Disposal Procedure of Mirpur 1 Kitchen Market

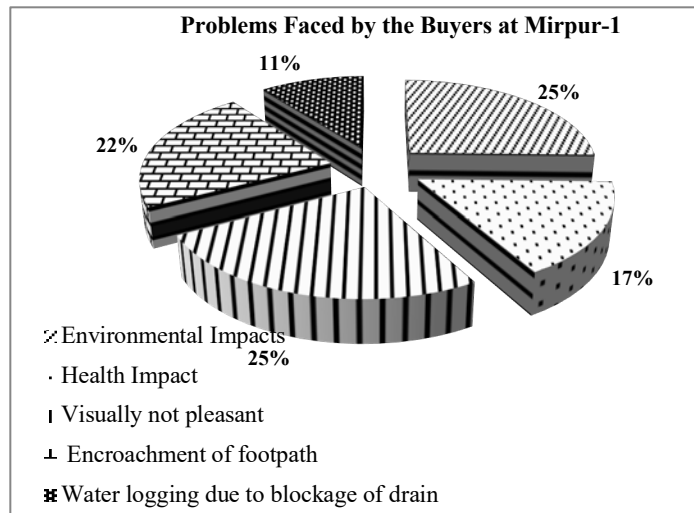


Source: Field survey, 2017

Fig 7: Problems Faced by Sellers during Waste Collection & Disposal Procedure of Bonolota (New Market) Kitchen Market

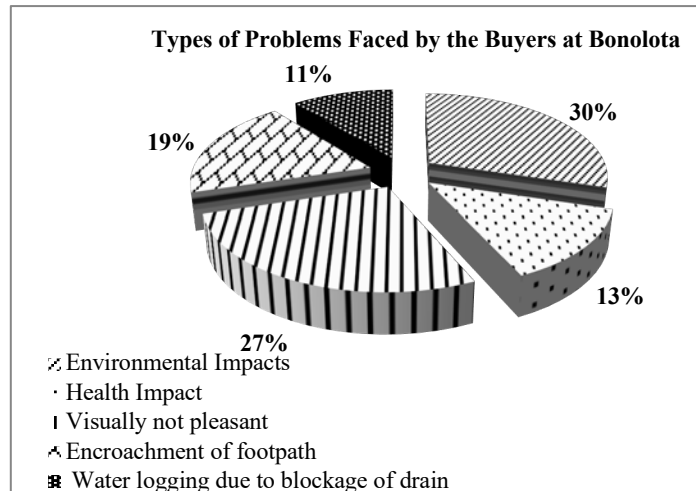
Problems Faced by the Buyers

The buyer faces problems of environmental, health and other issues due to lack of precise and adequate waste management system. The buyer usually faces environmental impacts mostly such as water pollution, air pollution, odour, termites/other insects and others (Field Survey, 2017).



Source: Field survey, 2017

Fig 8: Types of Problems Faced by the Buyers in Mirpur 1 Kitchen Market



Source: Field survey, 2017

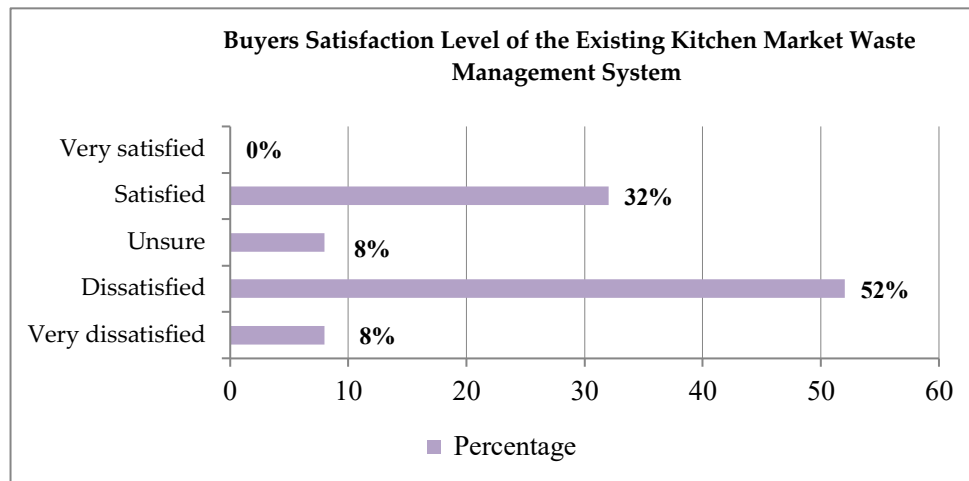
Fig 9: Types of Problems Faced by the Buyers in Bonolota (New Market) Kitchen Market

Besides, they are harmfully affected by the encroachment of footpath due to waste, illegal shops and water logging to blockage of drain. Besides, due to odours and other aspects they face health impact of vomiting, sneezing, cough and others. The dumping of waste by the side of the road is not pleasant to the buyers (Field Survey, 2017).

In Bonolata (New Market) Kitchen Market, the buyer faces problems of environmental, health and other nature. The main problem faced by the buyer is environmental impacts such as water pollution, air pollution, odour, termites/other insects and others. The illegal dumping of waste and their inadequate management creates a visual look which is not pleasant to the buyers. Besides, they are harmfully affected by the encroachment of footpath due to waste, illegal shops and water logging to blockage of drain. Besides, due to odours and other aspects they face health impact of vomiting, sneezing, cough and others (Field Survey, 2017).

Satisfaction Level of the Existing Kitchen Market Waste Management System

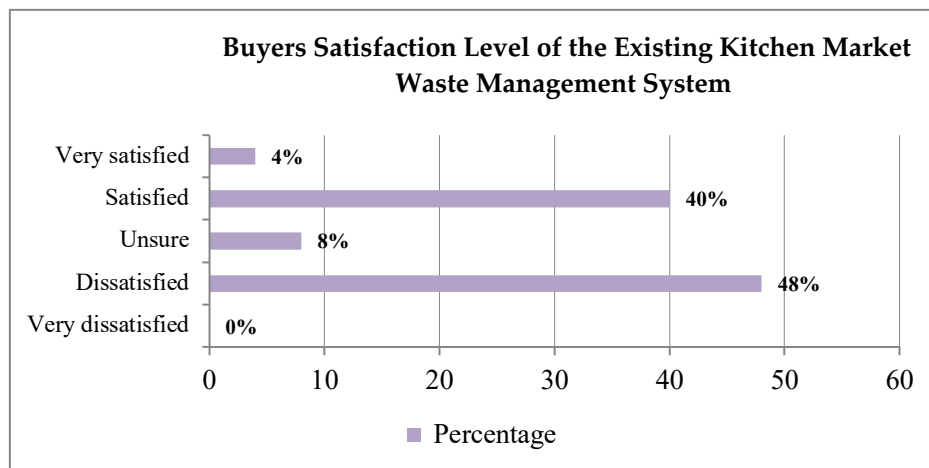
Most of the buyers expressed that they are not satisfied with existing waste management system. They claimed that wastes are placed by the site of the shops for long time which is unhygienic and unaesthetic. Odour generation of flies, and other insects are the result of inadequate waste management system. Besides, due to lack of proper management of waste water, the internal market road remains all time wet and soggy (Field survey, 2018).



Source: Field survey, 2017

Fig. 10: Buyers Satisfaction Level of the Existing Waste Management System of Mirpur 1 Kitchen Market

Most of the seller expressed that they are not satisfied with existing waste management system in Bonolata (New Market) Kitchen Market. They claimed that wastes are placed by the site of the shops for long time which is unhygienic and un aesthetic. Odor, generation of flies, and other insects are the result of inadequate waste management system. Besides, due to lack of proper management of waste water, the internal market road remains all time wet and soggy.



Source: Field survey, 2017

Fig. 11: Buyers Satisfaction Level of the Existing Waste Management System of Bonolata (New Market) Kitchen Market

Recommendations

An effective kitchen market waste management system may be helpful to ensure a clean, health hazards free and aesthetically pleasing environment. To enhance the drawbacks of present kitchen market waste management system the following recommendations may be considered.

- **Integrated Kitchen Market Based Composting**

This scheme may be either small-scale and is integrated with a Dhaka City Corporations (North and South) kitchen market waste collection service. Inputs may be either sorted at the source or after collection, depending on the degree of initiative of sellers and market authority. This composting scheme can recycle organic waste up to a maximum of 5-10 tons per day (tpd).

Other option may be the Medium-scale public/private sector-composting enterprises which may handle around 5–50 tons/day of organic waste. They mostly use the windrow or box methods of composting, and treat pure, biodegradable market waste that they collect themselves from the source of waste generation. In this case if the organic wastes, generated from the households which are served by the Dhaka City Corporations (North and South) kitchen market, are integrated with the kitchen market wastes then this option may be more viable and effective. Dhaka City Corporations (North and South) may technically and financially contributes to this type of composting option along with the respective private sectors.

An organic waste-recycling plant comprises an operation area and a green buffer zone. The buffer zone, formed by a belt of bushes and trees surrounding the operation area, improves the visual appearance of any recycling plant. It also buffers odor during windy

periods. The plant's design capacity should be based on the organic waste to be processed per hour and the number of shifts to be operated per day. The design of the plant should be modular so that as the waste-processing capacity increases, additional operational areas can be easily added. Since land is a constraint for compost plants, the box method with static pile and forced aeration, which requires less area may be considered.

The operation area of a recycling plant should be divided into different zones. A composting plant should contain space for waste unloading and sorting, composting, maturing, and sieving and bagging of the compost. Space is also required for storage of compost and recyclables, and storage and treatment of wastewater. These zones must be arranged to ensure efficient workflow of the composting process. Additional space should be allocated for storage for machinery, an office, a dining area, first aid supplies, toilet and bathing facilities for the workers, and a day-care center (for a plant processing more than 100 tpd of waste). It should be noted that the final setup of the site is strongly dependent on local conditions.

Since our country experiences 4–5 months of monsoon, the operation area should be protected with a roof in order to operate the plant year-round. This will also help avoid odour problems and leachate from fresh waste. At least 50%–55% of the plant area should be covered in compost plants. There is a need for a leachate collection tank in compost plant. Leachate may be recycled. The compost, biogas, and RDF site should have separate storm water drainage and leachate collection systems. There are always risks of rodents and ground and surface water pollution from waste treatment and recycling plants, therefore compost plants should have a concrete floor. Moreover, compost plants must have a boundary wall and green space in front to act as buffer. In addition, the following additional features may also be considered for the organic recycling facility:

➤ **Water Supply and Rainwater Harvesting**

A reliable onsite water supply is a basic infrastructural requirement in a composting site. Water is needed for hygienic purposes and for watering the compost heaps, and may be provided by a standpipe in the operational area. An additional water storage tank is, however, advisable if the water supply is not continuous. A further useful feature is a rainwater harvesting system. The roof of the composting shed and other facilities can be specially designed to collect rainwater. During the rainy season, water can be collected in a tank for use during water shortages in the dry season. Rainwater can be used for the composting process, for cleaning and washing of the composting plant, and for watering the green belt.

➤ **Organic Farming Demonstration Site**

If sufficient land and staff are available, a small plot inside the composting plant can be used as a demonstration unit for organic farming, or as a nursery for potted plants. The core idea is to encourage the owner of the composting plant to keep the facility as “clean and green” as possible. A clean, hygienic, and pleasant environment near a composting plant can combat negative perceptions of waste treatment, and the use of compost can be directly demonstrated to visitors.

➤ **Waste Water Reuse System**

A significant amount of wastewater is generated during the facility's cleaning and composting processes. Onsite-generated wastewater can be reused for new compost piles to maintain the moisture balance and enhance the decomposition process. Wastewater from the drainage system can be collected in a small covered storage tank below ground level. By mixing this wastewater with fresh water, or water from the pipes or rainwater tank, water may be conserved.

➤ **Energy-efficient lighting system**

If the compost plant is connected to the electricity grid, an energy-efficient lighting system should be fitted to reduce operational costs in the long run.

• **Barrel Type Composting**

Successful result of community based composting model helped Waste Concern to realize that a large portion of population residing in the slums of Dhaka city cannot be covered with the model of community based composting approach. A large group of urban poor are not included in the existing model. The slums are provided with two barrels- green barrel and yellow barrel. The slum dwellers were imparted with training and motivated to dispose their kitchen waste into the green barrel. Slum dwellers are motivated to dispose their inorganic waste in the yellow barrel.

This method may be applied for Dhaka City Corporations (North and South) kitchen market waste management. The green and yellow barrel may be provided to each market. The market authority and sellers should be imparted with training and motivated to dispose their organic waste into the green barrel and they should be motivated to dispose their inorganic waste in the yellow barrel. The potentials of this method are that:

- ✓ The wastes are segregated directly in the market and there is no need to segregate the organic and inorganic wastes.
- ✓ The organic wastes may be directly placed to the composting plant and the inorganic wastes may be placed to the refuse derived fuel (RDF) or other plants suitable for handling such wastes.
- ✓ There is no need to place the wastes to the land fill sites hence saving of land as well as transportation cost and additional workers for this purpose.

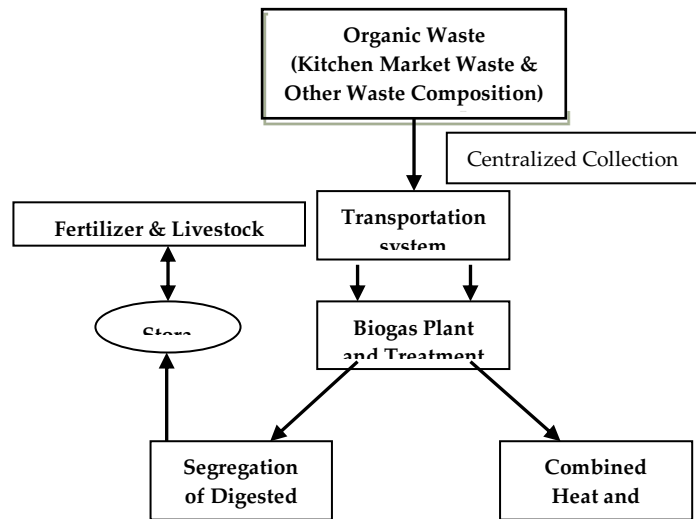
• **Biogas Production**

Biogas is produced by means of a process known as anaerobic digestion. It is a process whereby organic matter is broken down by microbiological activity and takes place in the absence of air (anaerobic means 'in the absence of air'). The amount of gas production in biogas digester depends upon the quantity of feeding added to it daily provided the plant is technically all right. Kitchen market wastes and household wastes, human excreta, urine of animals, water hyacinth, cattle dung and poultry droppings are the major feeding materials used to feed biogas plants.

The Dhaka City Corporations (North and South) Kitchen market wastes may be integrated with the following waste materials to produce biogas. The following Table shows the composition of feeding materials being used in biogas plants.

- **The Centralized Biogas Plant Concept**

This method is concerned with collecting the organic waste from the kitchen market and other composition of the waste necessary for biogas plant. Then the waste is transported to the main biogas plant for treatment. This method may be applied for the Dhaka City Corporations (North and South) kitchen market wastes management in the sense that only the wastes produced from the markets may not be of enough quantity to generate required amount of gas or other by products of the biogas plants. So by applying this method, necessary amount of waste composition may be collected from other sectors to integrate with the kitchen market wastes.



Source: Developed by Authors, 2017

Fig 12: The Centralized Biogas Plant Concept

The Centralized Biogas Plant Concept is shown in the following flowchart which represents that the kitchen market wastes along with necessary amount of waste composition is collected in a centralized approach and then transported to the biogas plant for treatment to produce combined heat and power production. The digested manure may be utilized as agri-fertilizer and also for producing livestock feed (e.g. chickens, birds, fish etc.)

- **Electricity Generation**

The Microbial Fuel Cells (MFC) use food garbage to produce electricity. A rectangular acrylic container (10 x 10 cm) was used as the cell. The container is filled with well mixed food waste (120 g), leaf mold (120 g), effective microorganisms (15g) and distilled water (80 g). The maximum generated power is 682mw/m² during the laboratory test of the MFC by using the food waste. The by-product of the electricity generation in MFC by composting method can be used as soil conditioner after further treatment which is another way to serve the agricultural based country (Mogsud and Omine, 2010).

The organic wastes from the kitchen market can be utilized for electricity generation purpose. Recently a Joint initiative has taken by DCC and an Italian company namely

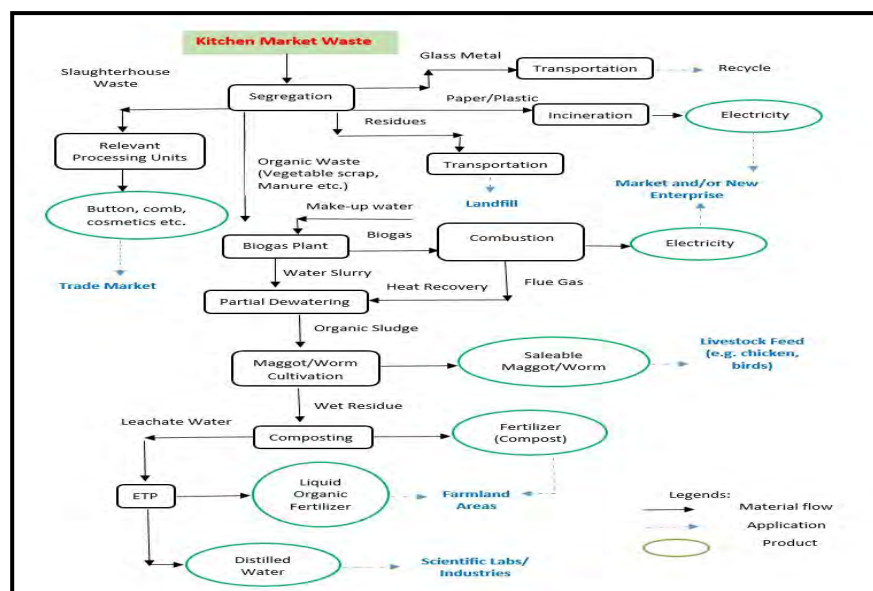
Management Environment Finance SRL to generate electricity from the wastes (The Daily Inqilab, 2013). The secondary outputs from such plants are organic manure and diesel. At the first phase 50 MW electricity will be produced which would be extended to 100 MW in second phase. This electricity would be distributed through the Dhaka Power Distribution Company (DPDC), Dhaka Electricity Supply Company (DESCO) and Rural Electrification Board.

Everyday approximate 5000 metric ton wastes are produced in DCC area and DCC will provide approximate 4000 metric ton/day to this plant (The Daily Inqilab, 2013). For this reason, Dhaka City Corporations (North and South) may introduce integrated kitchen market waste collection system to provide organic wastes to the electricity plant.

• Animal Feed and Other Products

The animal bones from the slaughter houses and the fish scales can be utilized to produce chicken/bird and animal feed, button, comb etc. The residues of organic wastes from the kitchen markets being utilized in the composting plant and biogas plants can be used to cultivate maggots/worms which may be used for producing livestock feed (e.g. chickens/birds etc.).

The fish scales from the Bonolata (New Market) Kitchen Market are being sold to a private organization which produces fish feed from the fish scales. The bones from the slaughter houses of the Mirpur 1 Kitchen Market are being sold to a private organization which produces fertilizer, button and combs etc. Dhaka City Corporations (North and South) should be taken initiatives to sell fish scale and bones. These initiatives can be advantageous both utilization of such kitchen market wastes as well as economic benefit to the market authority. The overall kitchen market waste management system for gaining the proposed potentials of the kitchen market wastes is shown in the following figure 13 :



Source: (Cahyari and Putra, 2010), (Reza & Hasan 2016) modified by Author 2018

Fig. 13: The Proposed Kitchen Market Waste Management System

Conclusion

In developing country like Bangladesh there is a huge opportunity to use the kitchen market waste for composting, electricity and bio-gas production. In Bangladesh everyday huge amount of organic wastes are generated which can be used. By this way the government, people and the nation can be benefitted. But the existing kitchen market waste management system of the concerned two kitchen markets is not at satisfactory level. Proper management option is enforced then the present scenario can be changed. The broad field of waste management is a complex discipline that includes environmental protection, waste reduction, recycling, composting, waste collection, land filling and maintenance, data gathering and analysis, government regulation, public education and awareness. It requires organization that is complying with government regulations and adapting and advancing techniques of waste collection, transportation and disposal. A planned kitchen market required a proper waste management system to ensure a better condition for both the sellers and buyers. So an efficient management system is required to overcome the existing situation. To confirm the growing concern about the sustainable environment, the management of waste should be considered with due importance. The future lies on the betterment of the environment and it is the high time to protect the environmental degradation to ensure a better environmental condition. Consideration should be focused on outlining, determining and weighting the different options of waste management that make up the sustainable environment.

Reference

- Asian Development Bank, (2011), Toward sustainable municipal organic waste Management in South Asia: A guidebook for policy makers and practitioners, Australian Government Aid Program, Available at: http://ppp.worldbank.org/publicprivate-partnership/sites/ppp.worldbank.org/files/documents/ADB_sustainable-waste-management-south-asia.pdf, accessed on: 20 June, 2017.
- Asian Productivity Organization, (2007), Solid Waste Management: Issues and Challenges in Asia, ISBN: 92-833-7058-9, Available at: <http://www.apo-tokyo.org/publications/files/ind-22-swm.pdf>,
- Balsura, C. (n.d.). Using a mixed methods approach to enhance and validate your research. Retrieved from: https://www.nd.edu.au/downloads/research/ihr/using_mixed_methods_approach_to_enhance_and_validate_your_research.pdf, accessed on: 14 August, 2017.
- Bhuiyan, A.M.W, Rahman, A.U, Haque, M.M. Islam, K.S and Hasan, A.K.M.K, (2012), A Proposal for Integrated Market Waste Management in Bangladesh, *International Journal of Engineering and Innovative Technology (IJEIT)*, Volume 1, Issue 1, Available at: http://ijeit.com/vol%201/Issue%201/IJEIT1412201201_11.pdf, accessed on: 22 August, 2017
- Cahyari, K and Putra, R.A, (2010), “Design of Biogas Plant from Fruit Market Waste in Indonesia”, Renewable Energy Conference, Berlin, Germany, 12 - 13 October 2010, Available at: http://www.ppiswedia.se/ppi/sites/default/files/user_files/Design%20of%20Biogas%20Plant%20from%20Fruit%20Market%20Waste%20in%20Indonesia.pdf, accessed on: 22 August, 2017
- Chandruppa, R. and Das, D.B, (2012), Waste Quantities and Characteristics, *Solid Waste*

- Management and Practice*, Available at: <http://www.springer.com/978-3-642-28680-3>, accessed on: 22 August, 2017
- Haque, A. 2009, *Solid Waste Management of Jahangirnagar University: A Comprehensive Analysis*, Unpublished BURP thesis, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka-1342.
- Hossain, R.H, (2011), *Municipal Waste Management and Its Impact: A Case Study of Debidwar Municipality*, Unpublished BURP thesis, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka-1342.
- Koike, Y., An, M., Tang, Y., Syo, T., Osaka, N., Morimura, S., & Kida, K., (2009), Production of fuel ethanol and methane from garbage by high-efficiency two-stage fermentation process, *Journal of Biosciences and Bioengineering*, 108
- Kundu, D. (2008), *Solid Waste Management in Dhaka City with Emphasis on Household Waste*, Available at: http://www.dipankar.com/wp-content/uploads/2008/09/article2_house_hold_waste.pdf, accessed on: 22 August, 2017
- Moqsud A. M., & Omine, K., (2010), Bio-Electricity Generation by Using Organic Waste in Bangladesh, *Proc. Of International Conference on Environmental Aspects of Bangladesh (ICEAB10)*, Japan, Sept. 2010; Available at: <http://www.benjapan.org/iceab10/30.pdf>, accessed on 22 July, 2017
- Moqsud, M. A., Rahman, M. H., Hayashi, S., & Du, Y.J., (2008), An assessment of modified composting barrel for sustainable organic waste management in Bangladesh, *Journal of Solid Waste Technology and Management*, 34 (1),
- Mithu, M.B.U, (2011), *A Study on Existing Solid Waste Management System for Residential Area: A Case Study on Savar Pourashava*, Unpublished BURP thesis, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka-1342.
- Practical Action Technical Brief, (1998), *Recycling Organic Waste*, Warwickshire, UK, Available at: <http://www.practicalaction.org/waste-management-answers>, accessed on: 22 June, 2017
- Piippo, S, (2012), *Municipal solid waste management (MSWM) in sparsely populated Northern areas: Developing an MSWM strategy for the city of Kostomuksha, Russian Federation*, Master's Thesis, Department of Process and Environmental Engineering, University of Oulu, Available at: http://nortech.oulu.fi/GREENSETTLE_files/Piippo%20Sari%20DI%20work%20PDF.pdf, accessed on: 22 August, 2017
- Reza, F and Hasan, M (2016), *Potential for Recovery of Resources from Food Market Refuse: A Case Study in Dhaka, Bangladesh* *International Journal of Environment, Ecology*
- The Daily Inqilab, (2013), *Borjo Theke Bidyut Utpadone Italio Company er Songe Sorkarer Chukti*, p-3, 19 February, 2013, Available at: http://www.dailyinqilab.com/archive_details.php?id=92328&&%20page_id=%209&issue_date=%202013-02-19 accessed on: 29 August, 2017

Analysis of Access to Water: A Case Study on Some Selected Slum Areas of Chittagong City

Muhammad Rashidul Hasan*

Md. Kausar Uddin**

Mohammad Mizanur Rahman***

Md. Rakibul Hasan Kauser****

Abstract: Water supply is a critical and important factor for public health and economic development of a country. Rapid and unplanned urbanization hamper the water supply systems and creates challenge to the availability and quality of water in the urban centers of Bangladesh. Chittagong is the second largest city of Bangladesh and commercial capital of the country. Urban poor settlements are also an integral part of Chittagong City, 53.6 % of its total population are poor. They are suffering from various problems; water supply is one of them. Chittagong Water Supply and Sewerage Authority (CWASA) is responsible for providing water, sewerage and storm water drainage services within Chittagong City. But CWASA can provide its service only 50% of its total population. This research provides brief discussion about how poor people have to manage their daily water demand from alternative sources and tried to indicate and analyze the ongoing multi-faceted problems, with concentration on formal and informal water supply and distribution in slum areas of Chittagong.

Keywords: Slum Area, Urban poor, Water supply system, Vendor's water, Pro-poor strategy

Introduction

From very beginning of human settlements water is recognized as a social as well as economic commodity (WATSAN, 1998). Water is central to the way of life in everywhere in the world and the single-most important resource for the well-being of its people. It sustains an extremely fragile natural environment and provides livelihood for millions of people (WARPO, 1999). As water is an important element in human life, the water supply is a critical and important factor in public health and economic development in all part of the world mostly needed in the developing countries like Bangladesh. Water pollution and scarcity of fresh water are the burning issues in the world. The increasing scarcity of water with rapid population growth gives reason for more concern and the need of proper management system of water. Due to rapid population growth, unplanned urbanization, surface water pollution and continuous ground water extraction hamper the

* Assistant Professor, Department of Urban & Regional Planning, Chittagong University of Engineering & Technology (CUET), Chittagong-4349, Bangladesh, E-mail: mrhasan@cuety.ac.bd, Cell No: 017220-900600 (**Corresponding Author**)

** Graduate Student, Department of Urban & Regional Planning, Chittagong University of Engineering & Technology (CUET), Chittagong-4349, Bangladesh, kawseruddin@yahoo.com

*** Assistant Professor, Department of Urban & Regional Planning, Jahangirnagar University, Savar, Dhaka. Bangladesh, Email:mizanurp@gmail.com

**** Lecturer, Department of Urban & Regional Planning, Chittagong University of Engineering & Technology (CUET)

sustainability of ecosystem and the cause of destruction in environment. However, it will be quite difficult to fulfill the demand of urban poor, if there is a shortage in water availability from the existing sources imposed by water quantity and quality issues. The urban poor are people who cannot afford to meet the basic need requirements in urban areas with their own income (Islam, 1996). They suffer from getting the basic needs such as water, sanitation, health, education, etc. The settlement may be defined as the residential location or space that lacks from the basic needs. The slums are recognized as the poor settlements. The settlements have been further characterized by high population density, poor environmental quality, poor infrastructure and services with income below poverty level. This research provides brief discussion about how slum dwellers have to manage their daily water demand from alternative sources and tries to indicate and analyze the ongoing multi-faceted problems, with slight concentration on formal and informal water supply and distribution in slum areas. The purpose of this research is to indicate the key constraints that must be addressed for significant reform in the urban poor sector in water supply provisions. It will be meant to be an informational tool that will help to understand and confront the problems that beset projects striving to bring water to the urban poor.

Objective of the Study

The following objectives are selected for the study:

- ✓ To study the existing condition of water supply system for the slum dwellers at Chittagong City Area.
- ✓ To provide some recommendations for better water supply system for the urban poor.

Methodology

The methodology provides the general guidelines or system of approach for achieving the objectives of an effort. This study is based on open ended interview of the people of different slum areas to explore existing condition of water supply system for the slum dwellers at Chittagong City Area. From the analysis and synthesis of the data, some problems regarding to the utilities of the study area along with underlying causes were identified. Then this research attempts to provide some recommendations for better water supply system for the urban poor of the study areas as well as other urban center of Bangladesh. Chittagong City Corporation area has been selected as the study area for studying problems of water supply provision for the urban poor. In Chittagong City Corporation, there are 5,778 poor settlements in 41 wards (UPPR, 2011). These settlements are contained 301,527 households where as total households in Chittagong City have been estimated at 562,500 (UPPR, 2011). On the basis of the sampling issue, the study had selected 14 wards from 41 wards where there are more than 500 households in a single settlement. The study has taken 30 urban poor settlements from these settlements which are distributed in 14 wards. The settlements are selected from all most all part of the CCC jurisdiction which settlements satisfy above issues.

Salient Feature of the Study Area

Chittagong, the second largest city of Bangladesh and the commercial capital of the country, is located in the southeast of Bangladesh. It is situated on the bank of Karnafuli River which is surrounded by the green hilly terrain and the Bay of Bengal on the west. The city is located in between 22°13' and 22°27' north latitudes and in between 91°40' and 91°53' east longitudes. Under the jurisdiction of Chittagong City Corporation, the City has an area of 168 sq. km. which divided into 41 wards (Banglapedia, 2014).

In the Chittagong City, there are 5,778 poor settlements where 27.24 percent were found to be extremely poor, 23.54 percent are very poor, 27 percent are moderately poor and the remaining 22.2 percent are marginally poor settlements. There are 301527 households in these poor settlements. As the total households in Chittagong City have been estimated at 562,500, the proportion of poor households in this city is 53.6 percent (UPPR, 2011). Thus, more than half of households in Chittagong City are poor. Each ward has 140 poor household on an average. It is shown that over 55% of the settlements where poor households live were small in Chittagong (UPPR, 2011). On average the poor settlements of Chittagong City were 32 years old. However, the actual age of these settlements varies from less than 5 years to over 50 years. The total area of poor settlements has been calculated as 2516.1 acres in 41 wards. It is observed that about 5.7 percent of the total area of Chittagong City, has been covered by the poor settlements. On that basis the average density of settlements in Chittagong was 2.3 settlements per acre of settlements area and the average household density in Chittagong City is 120 per acre (UPPR, 2011).

Study Findings

According to the Water Supply & Sewerage Authority (WASA) Act - 1996, Chittagong WASA is responsible for providing water supply, sewerage facilities and storm water drainage services within Chittagong City. The WASA Act-1996 provides high degree of autonomy to CWASA for performing its duties. At present CWASA's water production capacity is inadequate (equivalent to 35% of the total estimated demand) and the pipe network is dilapidated. Currently, about 45,000 households are directly connected with treated piped water by CWASA (out of about 600,000 households in the Chittagong City Corporation area, World Bank, 2010). Even then, within the current network water supply is not guaranteed on a regular basis. Other agencies (i.e. CCC and the Bangladesh Railway Authority) have attempted to provide some services as a partial stop-gap measure. A large portion of the remaining city population accesses water through shallow tube wells. The quality of this underground water is questionable, with high salt and iron levels (and possibly with arsenic contamination in some wells), posing health risks to the public (World Bank, 2010). CWASA provide their water supply by street hydrant or community well in poor settlements.

Table 1: Sources of Water in Poor Settlements of the Study Area

Location/ Ward		No. of poor settlements in respect of water connection system				Total
		CWASA	Shallow Tube well	Shallow Tube well & Vendors Water	Railway Authority	
Ward No.	02	0	1	1	0	2
	03	0	1	0	0	1
	05	0	1	0	0	1
	07	0	2	2	0	4
	08	0	3	0	0	3
	09	0	1	0	1	2
	11	0	1	0	0	1
	12	3	1	0	2	6
	13	0	0	2	2	4
	14	1	0	0	0	1
	17	0	1	0	0	1
	30	1	0	0	0	1
	35	0	1	1	0	2
	40	0	0	1	0	1
Total		5	13	7	5	30

Source: Field Survey, 2018

From the Table 1, it is revealed that there are four water sources available in Chittagong City Corporation areas. CWASA water supply coverage is available in only three wards in surveyed areas. Shallow Tube well is present in almost all poor settlements. When people unable to get water from CWASA or Shallow Tube well, they proceed to collect water from vendors. In CWASA jurisdiction areas, the water supply is not provided timely, so people have to collect water from alternative sources or vendor's water. The vendor supply water through monthly basis payment or daily basis payment but they provide water for short time. Bangladesh Railway Authority supplies water in its jurisdiction areas (Only on Railway Colony area). In this study, there are five study areas which are covered by Railway Authority.

Table 2: Sources of Water Supply According To the Connection Systems

Connected Water System	No. of Settlements in respect of water source					Total
	Hand Pump Tube well	Community Well	Household water supply (piped)	Street Hydrant	Community well & Household water supply (piped)	
CWASA	0	1	0	3	1	5
Shallow Tubewell	1	9	2	1	0	13
Shallow Tubewell & Vendors Water	2	3	1	1	0	7
Railway Authority	0	1	2	2	0	5
Total	3	14	5	7	1	30

Source: Field Survey, 2018

From the table 2, it is revealed that people in poor settlements collect water from community well and street hydrant in most cases. People collect water from street hydrant and community well respectively in 7 and 14 surveyed areas. In some cases, people get household pipe line water but it is seen in few areas which are served by either railway authority or vendors or water point managed by community people. To collect water from shallow tube well, they make different provisions on the basis of their capacity. When shallow tube well water does not meet their demand they collect water from vendors by the above ways. Railway authority also provides their water supply as the same manner.

Table 3: Sources of Water According to the Consumption Purpose

Criteria of water use	Sources of Water in Selected Poor Settlements					
	Deep Tube well	Shallow Tube well	Hand Pump Tube well	CWASA	Vendors Water	Provided by Railway Authority
Drinking	7	9	6	4	0	4
Cooking	7	7	2	7	2	5
Bathing	7	7	2	7	2	5
Washing	7	7	2	7	2	5

Source: Field Survey, 2018

From the table 3, it is found that people preferred deep tube well or shallow tube well for drinking water. In other cases such as cooking, bathing and washing, people prefer water which is available in their own area. When they unable to manage water, they use vendor's water.

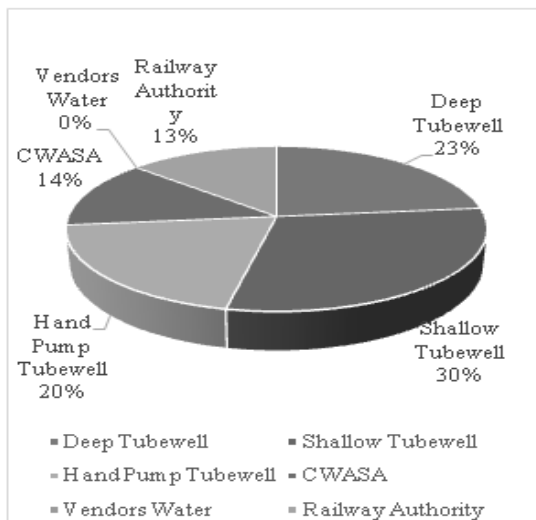


Fig 1: Sources of Drinking water

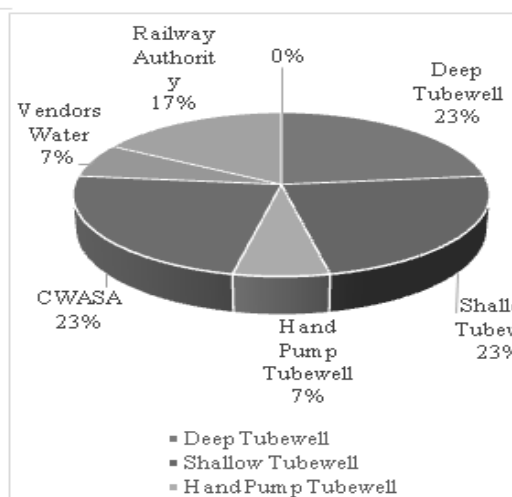


Fig 2: Water sources for other purposes

From the above Figure 1 and Figure 2, it is shown that over more than 50% households collect their drinking water from deep and shallow tube well from available sources or collect it from the vendors. So, the poor people spent huge amount of money for drinking water purpose. Few people collect their drinking water from other sources. For others purposes except drinking water the poor people try to use the available sources whatever they get in their area.

Table 4: Frequency of Availability of Water Supply

Frequency of Water Supply (No. / Day)	No. of Settlement	Percentage (%)
1	2	6.7
2	11	36.7
3	3	10.0
All times	14	46.7
Total	30	100.0

Source: Field Survey, 2018

Another important issue is the frequency of supplying water per day in the poor settlements. From the table 4, it is indicated that in the study areas, there are 14 areas where people get water all the time in a day. But this provision is made by the water point committee or settlement owner. In the CWASA jurisdiction areas, people get water on the basis of location and time period. In some areas, people get water twice or only single time in a day, some cases there are some poor settlements which get water day after day. This water availability depends upon the payment of water. Poor people have to pay for the water. The payment system varies place to place and modes of payment have different ways.

Table 5: Mode of Payment for Water

Category of Pricing		No. of Settlement	Percentage (%)
Within House rent		11	36.7
Non-metered	Less 100 tk	6	20
	101-500 tk	2	6.7
	501-1000 tk	3	10.0
	More than 1000 tk	3	10.0
Meter Unit basis		5	16.7
Total		30	100.0

Source: Field Survey, 2018

In the study areas, there are 11 settlements (36.7%) where the water bill is included in housing rent. 5 communities (16.7 %) pay as per CWASA rate. People, who collect water from deep or shallow tube well which installed by the NGOs or Community itself, have to pay 100 to 500 Tk/month as for maintenance cost. The poor communities who have to collect water from the vendors, have to spent high money for collecting water. Sometimes they paid more than Tk. 1000/month. In this study there are 30 % of the

settlements who paid around or more than Tk. 1000/ month for water consumption (Field Survey, 2018).

From the table 6 it is found that the people who living in the Chairman colony have to pay more cost in water and in the second position Barma Colony's people have to pay more cost in their monthly water. From the other data of this table the comparative price is much higher in the poor dwellers. The poor dwellers have to pay more price than CWASA rate. These 9 settlements is discussed here to make a comparison in water pricing among the poor community and the comparative rich community in the study area.

Table 6: Water Pricing In Different Surveyed Areas

Settlement Name	Water Consumption (litter/hous-ehold/day)	Cost (Tk/month)	Average cost (Tk./ 1000 litre)	Water Rate of CWASA (Tk./1000 litre)	Price Comparison	
					Actual Rate /CWASA Rate	Average higher price than CWASA
Alamgir colony	250	200	26.67	6.57	4.06	8.23
Beltola Nalar par	500	1000	66.67		10.15	
Amin colony	800	1000	41.67		6.34	
Shingnal colony	500	100	6.67		1.01	
Wireless Railway colony	250	700	93.33		14.21	
Taher colony	300	500	55.56		8.46	
Chairman colony	20	150	250.00		38.05	
Boshor colony	200	500	83.33		12.68	
Barma Colony	250	750	100.00		15.22	

Source: Field Survey, 2018

CWASA fixes up the water rate for its consumer. The water consumption rate for the residential area is Tk. 6.57 / 1000 Litre. But the table 6 revealed that the poor dwellers have to pay more price than CWASA rate. Sometimes these rates vary from slightly higher than the CWASA rate to 38 times higher than CWASA rate. In the study, it found that the poor communities averagely pay 8.23 times higher than the CWASA rate. But unfortunately this higher rate cannot insure the availability of water for the urban poor.

From the Table 6, it is revealed that people pay more for drinking water purpose in Chairman Colony (Ward No-35), people buy water more than 38 times of usual rate of CWASA. When they buy water for day long, quantity is increased and price is decreased. In Amin Colony, people pay for water more than 6 times. Both sources are expensive, because they are buying from vendors. But water price is varied according to the quantity.

Table 7: Level of Satisfaction on Water Quality

Water Service Parameter	Satisfaction Level (%)				
	Very Good	Good	Moderate	Poor	Very Poor
Quality of Water	3.3	33.3	13.3	46.7	3.4
Water Color	3.3	36.7	20	36.7	3.3
Water Taste	3.3	36.7	26.7	30	3.3
Pressure of Water	10	23.3	20	23.3	23.4

Source: Field Survey, 2018

From the above Table 7, it is shown that above 46% poor people have said that water quality is poor in the study area. The water color is varied from areas to areas and water taste is considerably good across the City. The pressure of water in some areas is good and in some areas bad.

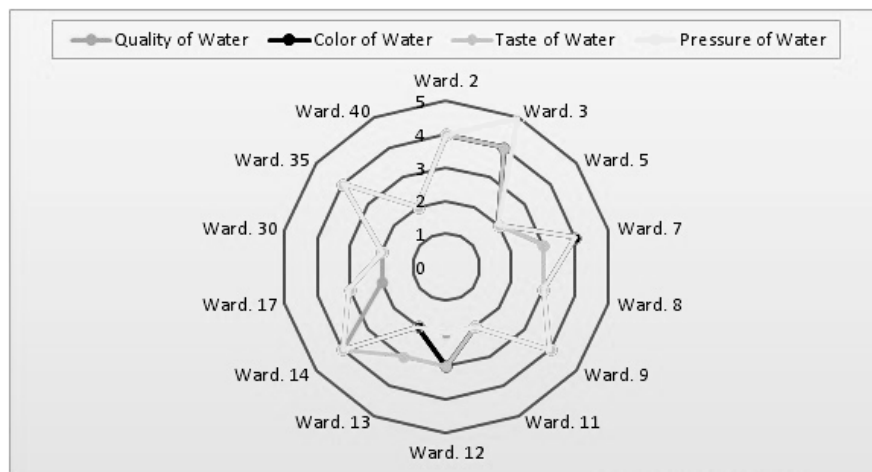


Figure 3: Ward wise Satisfaction Level of Water Service (Field Survey, 2014)

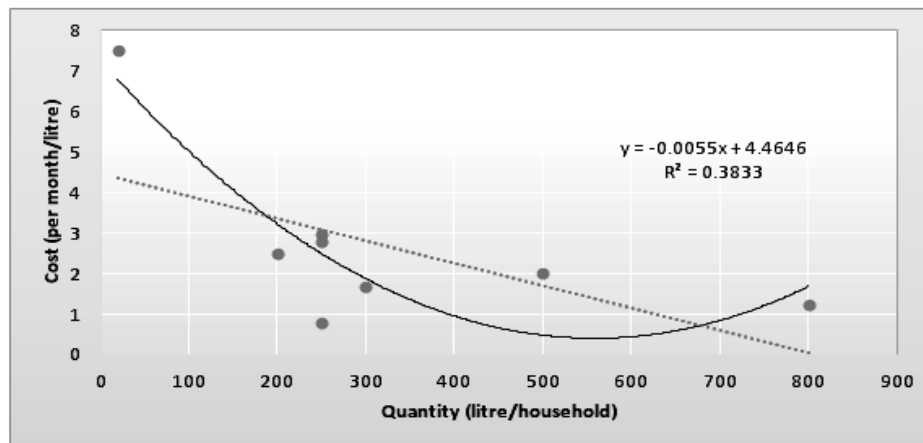
From the above figure 3, it is acknowledged that the above four parameters mentioned in table 7 are varied from ward to ward. The numeric values correspond according to the following table 8.

Table 8: Value assigned for Level of Satisfaction on Water Quality

Highly dissatisfied	1
Dissatisfied	2
Neither satisfied nor Dissatisfied	3
Satisfied	4
Highly satisfied	5

The pressure of water is very good in ward 3 and in other 5 wards it takes good level. The taste of water is same in most of the wards. The quality and color of water takes poor position in almost all wards in the study areas.

Relation Between Price and Quantity of Water



Source: Field Survey, 2018

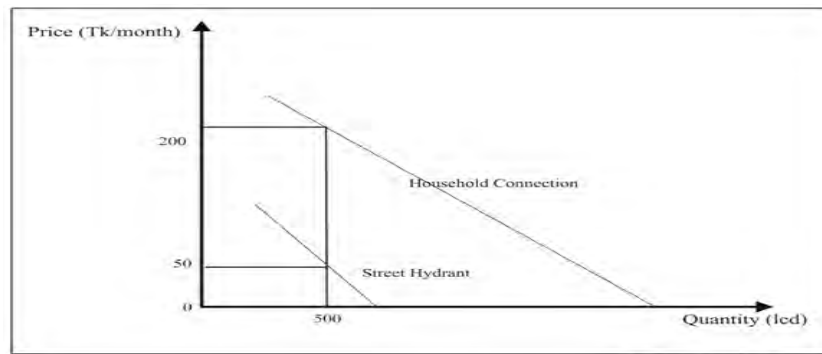
Figure 4: Relation between Consumption Quantity & Cost

From the above Figure 4, it has been seen that R square value is 0.3833. So, the value of correlation coefficient R is 0.619. As the value of R lies between correlation value ranges 0.5 – 0.8, the cost for water is moderately correlated with quantity of water. The downward sloping demand curve indicates the “decreasing marginal value” of water. The first five liters of water per capita per day will be extremely valuable as they are necessary to sustain life. This is illustrated by nonlinear curve in Figure 4. The second five liters will also be valuable, (e.g. in their use for hygienic purposes). The next five liters are valuable for food preparation, cooking and washing of clothes. All other factors being equal, for each additional increment of water, the marginal value of water tends to decline as the individual is putting the water to less and less valuable uses. Consequently, the individual’s willingness to pay for each increment of water will gradually decrease.

Preference between Street Hydrant and Household Connection

Up to a certain point, an individual is prepared to pay a higher price for a product with a higher quality. For the same “quantity” of water, an individual will be willing to pay a higher price for a higher quality product. For example, consumers are normally willing to pay a higher price for water from a house connection than for water from a street hydrant. In this case, there are two different demand curves: one for house connection and one for street hydrant as shown in Figure 5.

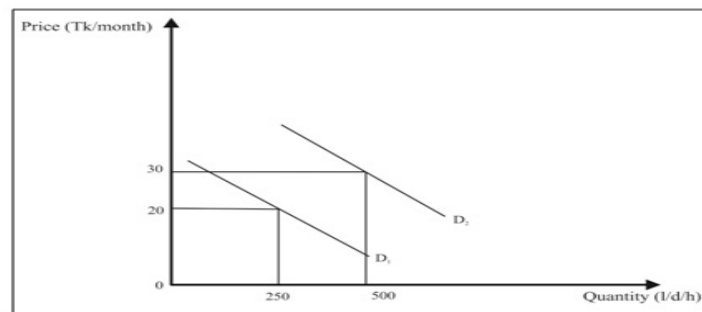
In the study area, people having household water connection such as in Beltola Nalar Par (Ward No-07), pay more than the other sources. When people get water from street hydrant, they pay little as the cost is distributed over the whole people. But in case of street hydrant people get limited water. When the quantity is increased than the usual demand in household connection, the overall price is also decreased.



Source: Field Survey, 2018

Figure 5: Preference between Street Hydrant and Household Connection

In the figure 5, people get same quantity of water but pay different amount depending on the connection system. In the surveyed area, Shignal Colony (Ward-12) get water of 500 liters per household for 50 Tk. From street hydrants but water comes alternative day. On the other hand in Abbas Company Bari, Shohedpara (Ward -03), consumers pay for some quantity of water through household connection monthly BDT 200.



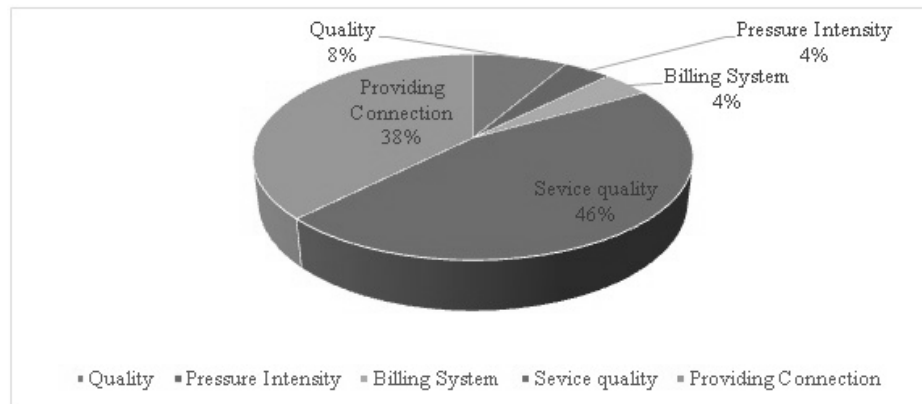
Source: Field Survey, 2018

Figure 6: Change in Water Demand

An increase in income will cause the demand curve for water to shift to the right (from D1 to D2), as illustrated in Figure 6. From the surveyed area, Raily Jute Colony (Ward No-30) has CWASA connection but the water quality is not good and sufficient. So, the community has set up shallow tube well which has increased their quantity of water consumption. In the figure 6, In Raily Jute Colony (Ward No-30), people get 250 liter per household per day from CWASA but setting shallow tube well they have increased their water consumption amount.

Scope for Water Improvement Provisions

The study areas are facing water shortage. This is acutely observed in dry season which is varied from April to July. There are 22 study areas from 30 areas which are facing water scarcity. From the figure 7 bellow, 46% of the surveyed slums want to improve service delivery in their existing water provisions and 38% of the slum dwellers want to set up water connection.



Source: Field Survey, 2018

Figure 7: Opportunity for Improvement

Willingness to Pay

Willingness to pay or contingent valuation is a method of estimating the non-market value of environmental amenities such as the value of safe drinking water. These values are measured based on the willingness to pay of the consumers for improved environment. In this case, the benefit of the project is assumed as the monetary value of WTP derived from the survey. The interesting aspect of the contingent valuation method is that it allows to estimate total value rather than components of that value. The method is appropriate and well known for valuation of environmental amenities. The people buying water from vendors has to pay high water rate. On the basis of their capacity, they want to pay for water between 50-60 BDT (Field Survey, 2018).

Summary & Findings

Table 8: Summary & Findings of the Study

Responsible Authorities	Existing Conditions	Problems/ Constraints/Satisfaction	Needs
Chittagong Water Supply and Sewerage Authority (CWASA)	- People get water from either street hydrant or household pipe line. - Water service availability is different in different wards. - In the same settlements people have to buy water from different sources.	- Fewer areas are connected by CWASA. - The cost of water connection system is hardly possible. - CWASA faces difficulty in arising water services for land tenure. - The water quality, pressure of water and water availability is not enough good, so they have to look alternative sources. - A bigger portions of poor dwellers have to buy vendors water.	- Pro poor pricing. - Establishment of Land Rights. - Willingness to pay by poor people can be improved by maintaining several measures. - Vehicles water can be provided by CWASA. - Water governance should be improved.

Dushtha Shasthya Kendra (DSK)	• They worked for poor on the behalf of CWASA. • They mainly set up hand pump tubewell from where water is supplied by CWASA. • They maintain the whole process for few years, then they handover it to the CWASA.	• They have covered little areas but they served well in the connected areas. • The area served by the DSK are performing well on the account of payment. • In some areas there are shortage of water because of limitation of providing water of CWASA.	• The coverage of served areas should be improved. • They can sell water for poor at reasonable price. • They can adopt alternative options for water such as Rainwater harvesting, Installing water banking etc.
Urban Partnerships for Poverty Reduction (UPPR)	• They have covered large areas by the help of CCC. • They have provided deep tubewell and water reservoir.	• They have raised better scenarios in the covered areas. • They have derived their water provisions by community well and poor collect the water from a certain point. • On the respect of area, they have provided more deep tubewells and reservoirs.	• CCC can set up water selling mechanism for the poor. • CCC can derive the land rights for providing water services by CWASA. • CCC can engage more NGOs for providing water facilities in poor settlements.

Recommendations

The poor people face problems in getting water supply connection. For having CWASA limitations, they are the most sufferers for water. They hardly manage everything which is necessary for living. Water supply is one of the basic needs in human life. If the certain authority cannot provide water, they have to look alternative sources. The following procedures can be obtained which are raised from the surveyed areas according to their facing problems.

Water Governance

Water governance is defined by the political, social, economic and administrative systems that are in place, and which directly or indirectly affect the use, development and management of water resources and the delivery of water service at different levels of society. Water governance can be facilitated by the following ways:

- **Equity and Efficiency:** Principles such as equity and efficiency in water resource and services allocation and distribution, water administration based on catchments, the need for integrated water management approaches and the need to balance water use between socio-economic activities and ecosystems.
- **Policies and Regulations:** The formulation, establishment and implementation of water policies, legislation and institutions.

- **Roles and Responsibilities:** Clarification of the roles of government, civil society and the private sector and their responsibilities regarding ownership, management and administration of water resources and services.
- **Pro poor Strategy:** The bearing cost for water supply is hardly possible for the urban poor. The certain authority or government can take step in this case. If the cost is cross shared between the different class of people which means some level of cross-subsidy from rates charged in middle and upper income areas to cover costs that cannot be recovered from slum.

Coordination among responsible authorities

CWASA, Railway Authority, CCC are working for water supply in city area. But there is lack of coordination among them. Railway authority do not negotiate with the CWASA and CCC provide deep tube well and reservoir without the accordance of CWASA. But they had liaison with CWASA before. DSK works for poor on the behalf of CWASA. But they have no coordination with the works of UPPR project. The Local governments can bridge the gaps between the related authorities in water supply and service delivery, ensure that those services are part of a broader slum upgrading strategy, and document the opportunities necessary to attract additional financing. Community Based Organization (CBO) could play a vital role in water supply provisions provided if coordinated approach involving all parties including the slum dwellers. They can do their works by the following ways:

- **Chittagong Water Supply and Sewerage Authority:** CWASA should improve the service delivery in connected areas. Where people are buying from vendors, CWASA can provide them water which is transported by vehicle, thus way the water payment to vendors will be reduced. The water rate for essential use is higher in vendors.
- **Chittagong City Corporation:** Chittagong City Corporation can resolve the problems about the boundary of slums for giving water connection. CCC has set up different water supply provisions in poor settlements by the UPPR Project.
- **Land Tenure:** When CWASA tries to set up water provisions, they face problem about land tenure. The people do not agree with the CWASA for various causes which is seen in providing LIC project by CWASA. So, CCC can provide role for resolving the conflicts. Public awareness, discussion can play a role to motivate the poor people. This is the barrier to CWASA to provide water supply connections in poor settlements without having legal land tenure. The following options can be obtained for establishment of land rights in slum areas:

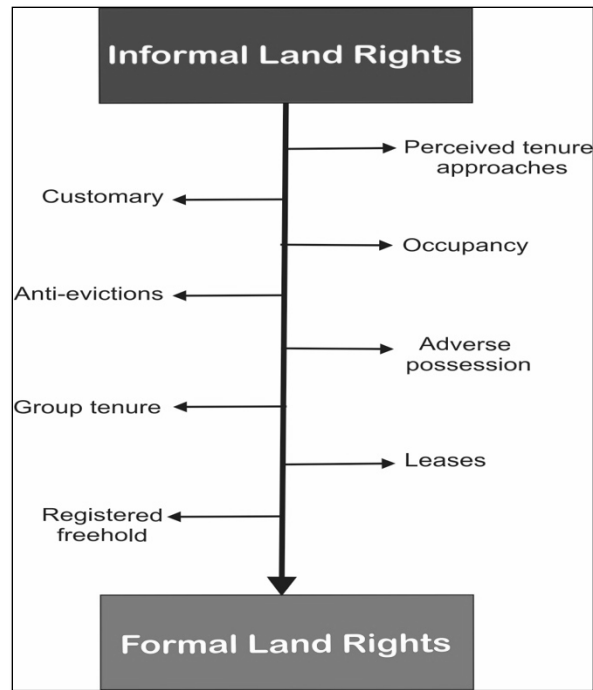


Figure 8: Establishment of Land Rights

Willingness to Pay

The city water supply system suffers from various problems including those of technological, policy, planning, coordination and managerial aspects. So, people tend to low willingness to pay. The following provisions can improve the willingness to pay:

- **Low Service Beneficiary:** People get hardly better service from CWASA, so they want to set up own water supply facilities or have to buy water from vendors. The poor need water for washing, bathing etc. But lacks of mandatory set up, they are overcrowded in a street hydrant which is less than their demand. So, the service of CWASA should be improved.
- **Water Billing System:** The middle class people pay for water which bears small percentage of their income than the low income people pay. So, they are interested to take pipelined water supply connection. CWASA is mainly worked with household pipeline system. So, poor people are unable to get water connection. CWASA Water rate is lower than the vendor water, but lacks of proper monitoring system lower class people want to avoid the fees. Water billing system should be provided according to the cross subsidy.
- **Costly Water Supply Connection:** The initial set up provisions for water supply system is higher if they have no subsidy. The poor people cannot enable to get water supply connections for insufficient money. The poor also suffer from the bureaucratic system for getting water connections and the coordination among poor

is rare if they want it together. So, the NGOs, private organization can provide the initial set up for people.

- **Insufficient water pressure:** The water pressure of CWASA should be improved in slum areas as they faced the lower pressure rate. The poor people feel confusion if they cannot get water after getting high costly connection.
- **Water quality:** The quality of water can be improved by maintaining proper ingredients and purification. If the water quality is improved, it will grow willingness among people to pay for water.

Responsibilities of NGOs

As CWASA have the limitations of served areas, the NGOs can provide their services in poor settlements for providing water supply facilities. The following measures can be taken:

- **Installing Water Banking:** A water bank is an institutional mechanism designed to facilitate transfers of water on a temporary, intermittent or permanent basis through voluntary exchange. It creates a more reliable water supply during dry season through voluntary trading and ensures a future water supply for various water needs. Water banks operate to make water available for future use by surface storage in a reservoir, underground storage in an aquifer, facilitating transactions among entitlement holders, and institutional banking. If they can make it, the dependency for water on CWASA will be reduced.
- **Harvesting Rainwater:** The poor people buy drinking water with high cost. Rainwater harvesting can be introduced to meet their drinking water demand. The initial set up have to introduce by the NGOs. By discussion and campaigning, poor people can be encouraged about Rainwater Harvesting.
- **Vendors Water:** When CWASA or any other water supply authorities cannot enable to provide water for slum dwellers, they have to buy water from vendors at a high rate. The following procedures can be taken:

Table 9: Vendor's Water Supply Provisions

Vendor's Types	Water Supply Services
NGOs and small private operators can buy and resell to poor consumers.	It will applicable at the subsidized price (50% costs of the base) rates and be restricted to resell it only to the poor consumers without profit.
Small and medium enterprises who buy raw water from public utilities and reproduce for marketing	Should be considered as 'commercial and industrial' consumers;
	Shall be brought under licensing system and within regulatory control.
Small and medium enterprises who run independent systems and undertake commercial marketing	Licensing should be introduced with a reasonable fees to be determined by CWASA on where the business is operated.
	For ground water abstraction formal procedure should be maintained but at the subsidized price.
	Pricing shall be fair and equitable to the users including poor.

Source: Field Survey, 2018 and modified by Authors

Conclusion

Chittagong City is facing a water supply problem which is acute in urban slums. Water is scarce in everywhere. The discussions on water supply system in urban slums and factors behind the situations give clear hints that the efficient participation of formal and informal organizations or various stakeholders in the management and development of water is necessary. The study has surveyed 30 urban poor settlements in different slums of 14 wards and tried to give a scenario of existing water supply provisions in Chittagong City. For having insufficient budget or for CWASA water service limitation, the poor have to buy water from vendors more than 8 times higher than the usual water price level. The expense for water is set higher percentage of their income. As CWASA is not directly involved with the poor, public participation in decision-making is not encouraging and politicians do not care about this urban poor settlements because it is regarded as an informal settlement and thus no efforts for basic services are made. It is the time to work together for the urban poor only for giving their basic needs such as water supply provisions. CWASA, City Corporations, Department of Public Health Engineering (DPHE) etc. and private organizations like operational and campaigning NGOs and CBOs can work parallel for the water service delivery in urban poor settlements.

References

- Banglapedia, (2014). National Encyclopedia of Bangladesh. Retrieved on 02-09-2019 from http://en.banglapedia.org/index.php?title=Chittagong_City_Corporation.
- Islam, N. (1996). The Urban Poor in Bangladesh, Center for Urban Studies (CUS), Dhaka.
- UPPR (2011). Mapping Urban Poor Settlements and Vacant Lands in UPPR Project Towns, Urban Partnerships for Poverty Reduction Project, UNDP, Chittagong City Corporation, Chittagong.
- WARPO (1999). National Water Policy, Ministry of Water Resources, Government of Bangladesh, Dhaka.
- WATSAN (1998). National Policy for Safe Water Supply & Sanitation, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.
- World Bank (2010). Project Appraisal Document, People's Republic of Bangladesh for a Chittagong Water Supply Improvement and Sanitation Project, Report No: 54697-BD, Washington, D.C: The World Bank.

People's Participation in Physical Planning Process: A Case Study of Detailed Area Plan Preparation for Dhaka City

Dr. Adil Mohammed Khan*
Farsia Naznin**

Abstract: People's participation in planning process and decision making procedures plays a key and supportive role in urban planning leading to sustainable development. This paper intends to measure the state of people's participation in the physical planning process for Dhaka city as well as to identify the factors impacting the level of people's participation in planning. Basically, this paper focuses on examining past and present scenario of people's participation as well as community engagement in physical planning preparations at the local level regarding Detail Area Plan Preparation for Dhaka city. This paper reveals that level of people's participation in planning process is currently very minimum as well as very formal in nature. People mostly do not have the required understanding about plan preparation processes as well as they are not quite aware about their appropriate role in these processes. Proper participation of people and community in the physical planning processes is indispensable for success of a physical plan however it has been revealed that physical plan preparation process for Dhaka city mainly involves elite stakeholders in decision-making processes such as representatives from different public departments and local governments, professional groups, civil society organizations, business groups, media, elected political leaders, and academics. Hence peoples participation at its real sense is quite absent in current planning practices in Dhaka city. This paper recommends that urban authorities should be more dynamic in ensuring peoples participation in planning if they really wish to prepare plans for the development and betterment of people.

Key words: People's Participation, Community Participation, Detail Area Plan (DAP), Participatory Rapid Appraisal (PRA), Focus Group Discussion (FGD),

Background of the Study

In contemporary world, people's participation in development process is considered as the prerequisite for sustainable urban development (Ahmed and Swapan, 2009). People's participation is regarded as one of the cornerstone for good governance and helps to enhance accountability, transparency and ensure sustainability of development initiatives (Mwiru, 2015). Mansuri & Rao (2004) explained in "Community-based and community-driven development: A critical review" that involvement of members of defined community in at least some aspects of project design and implementation is the cornerstone of community based development. Marsland (2005) finds that participation empowers the developers and citizens to achieve something themselves and gives them the confidence to continue independently.

* Associate Professor, Department of Urban and Regional Planning,, Jahangirnagar University,
Email: adilmkhan@gmail.com

** Urban Planner, Email: farsianaznin11@gmail.com

There are great benefits of participation in development plans, programs and projects. It is also assumed that participation is able to improve the quality and increase the efficiency, effectiveness, sustainability and coverage of projects and programs. Promotion of participation is also expected to benefit primary stakeholders, building their capacity and leading to self-reliance and empowerment (Alam, 2008).

Participation, as a principle, is now commonly accepted to be an important component of successful development programs (Mitlin and Thompson, 1995). Such broad participation is built on freedom of association and speech, as well as capacities to participate constructively. Beneficiary contributions of stakeholders to development projects, informal processes of service improvement and service delivery management are all forms of user participation (Keishnamurthy, & De Wit, 2000).

In developing countries, participatory planning approaches are not integral part of planning processes. Planning is mainly a top-down approach in developing countries which has not been successful in the past years (Kaiser, 2012). Dhaka is the capital city of Bangladesh with huge population experiencing a lot of stress on infrastructural services and facilities (Begum, 2015). In order to manage the growth of Dhaka city as well as ensuring proper services and facilities, various types of physical plans have been made over the years – namely Structure Plan, Urban Area Plan and Detail Area Plan (Rajuk, 2016). Rajdhani Unnayan Kartipakkha (RAJUK) – Capital Development Authority for Dhaka city – prepared Dhaka Structure Plan and Urban Area Plan for a time period of 1995-2015 and later prepared a Detail Area Plan for these plans for a jurisdictional area of 1528 sq-km. However it is perceived that peoples participation in planning preparation processes of those plan especially for detail area plans were bare minimum, thereby questioning validity of these plans to common people. RAJUK is currently preparing Detailed Area Plan (2016-35) for Dhaka City and people's participation in planning processes has been emphasized by the Plan Preparation Cell of RAJUK through conducting different Participatory Rapid Appraisal (PRA) with different stakeholders and community people across its coverage areas. This paper evaluates the people's participation processes in physical plan preparation in drafting Detail Area Plan (DAP) for Dhaka city and analyzes the challenges of community participation in decision making processes concerning DAP preparation.

Objective and Methodology of the Study

This study aims to examine the state of people's participation in physical plan preparation processes for Dhaka city and tries to find out the challenges of community participation in decision making process concerning Detailed Area Plan (DAP). In addition, this study attempts to identify the factors that influences the community involvement in the physical planning preparation processes regarding Detailed Area Plan for Dhaka city and finally recommends some measures to increase the level of community participation in physical plan preparation in the context of urban areas in Bangladesh. This study mainly adopts qualitative approach and in order to fulfill the objectives of the study, primary and secondary data for this study have been collected.

Primary Data Collection

For the purpose of this research, primary data have been collected from focus group discussion, key informant interview and direct observation method.

Focus Group Discussion (FGD)

Ten FGDs were carried out among cross section of population in order to reveal various aspects on people's participation in physical plan process. The FGD sessions were aimed to discuss the key questions in order to get interpretations regarding the factors affecting participation, participation in PRA meeting, involvement with development activities as well as physical planning process and so on. There was also the opportunity to collect data on personal or collective experiences regarding community participation. Each session included 5-7 persons who were randomly invited through open invitation. Each discussion has taken around 20-30 minutes.

Table 1: Locations and number of FGD in DAP areas

Location	Number of FGD	Total number of individuals
Savar	4	$7+5+5+6=23$
Tongi	3	$5+7+6=18$
Narayanganj	1	7
DSCC ward no 18	2	$6+7=13$

Source: Prepared by author, 2018.

Key informant's interview (KII)

To determine the factors affecting the level of people's participation in the planning process, planning practitioners and key players who are actively involved in preparing Detailed Area Plan has been interviewed. Detail discussions on key research issues and questions have been asked in this process in order to get in-depth knowledge and practitioners' perspectives. An open-ended questionnaire has been applied for these interviews along with informal conversation. 11 key informants have been selected using purposive sampling method for the interview. The respondents were planners of city development authorities and consultancy firms, project director and project managers of DAP, town planners and sub-assistant engineer of the municipalities and ward commissioners.

Direct Observation Method

Direct observation in Participatory Rapid Appraisal (PRA) Sessions for DAP was done which was held on Tarabo Paurashava.

Secondary data collection

Secondary data have been collected from the RAJUK office, Savar, Tarabo and Tongi municipality, Narayanganj City Corporation, various Ward offices, regarding PRA and other participatory approaches in plan preparations. In addition, related books,

publications, reports, articles, newspaper, journals, websites, were analyzed and examined through desk research regarding people's participation as well as community engagement in Detailed Area Plan preparation and plan implementation process. The relevant information have been triangulated and analyzed in the light of the objectives of the study.

Peoples Participation in Contemporary Planning Theories

People's participation in planning process has been viewed differently by various planners and social thinkers over the years since the emergence of urban planning ideas. 'Rational comprehensive planning theory' developed by Auguste Comte (1798-1857), regards planner as neutral observer of urban life and its various problems (Mantysalo, 2005). In comprehensive-rationalist planning the 'public interest' as the goal of planning is defined within the context of planning expertise and ideas of public participation as well as its impact on planning were considered to be bare minimum.

In his classic article "Advocacy and Pluralism in Planning", Davidoff claims that "determinations of what serves the public interest, in a society containing many diverse interest groups, are almost always of a highly contentious nature" (Davidoff, 1973). Davidoff argued that public sector planning needed genuine alternatives based on different value considerations. According to Davidoff, by taking the role as an advocate, analogous to the legal advisors in courts, the planner aids democracy in public planning not only by permitting the citizen to be heard: "It also means that he, be able to become well informed about the underlying reasons for planning proposals, and be able to respond to them in the technical language of professional planners".

Charles E. Lindblom, published his book "The Intelligence of Democracy" (Lindblom, 1965), introducing the theory of "partisan mutual adjustment" as a model of decision-making in public planning. Lindblom was not only concerned with how to bring the interests of different groups into the agenda of public planning, but, furthermore how agreement could be reached between these diverse and conflicting interests. According to Lindblom, "partisan mutual adjustment" is a method of bargaining and compromise-seeking between the interest groups concerned with a planning issue.

'Communicative planning as consensus-seeking' theory explains communicatively rational argumentation between the different interest groups. According to Habermas, there are three life-worldly criteria upon which we should base our arguments and test them, when attempting at communicative rationality. These criteria are: propositional truth, normative rightness, and subjective truthfulness (Habermas, 1984)

The possibility of communicative rationality is based on the assertion that a shared context of life-worldly values and understandings is achievable as soon as each participant withdraws from the use of power. 'Forester' has introduced the concept of 'designing as making sense together', which refers to the notion of designing as a shared interpretive sense-making process between participants engaged in practical conversation in their institutional and historical settings (Forester, 1989).

A planning decision which serves everyone's interests, or is generally accepted as a good decision, may indeed be hard, or sometimes even impossible to find in real life scenarios. Hillier notes', building mutual respect does not necessarily mean building consensus. But "mutual respect can help domesticate antagonism into agonism in which participants recognize the boundaries of what is and is not possible" (Hillier, 2002).

Through the 1970s and 1980s, therefore, a tradition of planning theory emerged which viewed the town planner's role - and hence his or her 'professional' expertise - as one of identifying and mediating between different interest groups involved in, or affected by, physical development processes (Taylor, 1999). In this backdrop, people's participation and community engagement in planning processes have been highly recognized in contemporary planning ideas and thoughts.

Past scenario of People's Participation in Detailed Area Plan Preparation (1995-2015) for Dhaka city

People's participation in planning process has not been widely recognized in earlier planning practices in Bangladesh. However this scenario has been changing in recent times. RAJUK is responsible for preparing physical plans and development guidelines for its jurisdictional area of 1528 sq-km. RAJUK prepared Dhaka Metropolitan Development Plan (DMDP) for Metro-Dhaka city with effects from 1995-2015. DMDP comprises of Structure Plan, Urban Area Plan and Detail Area Plan (DAP). Due to various reasons, RAJUK prepared its DAP in 2010 which was expected to be effective to 2015 and it has been argued that level of people's participation or involvement of communities in the plan preparation process was bare minimum. However, RAJUK initiated public hearing of Draft Detail Area Plan (2010) for common people to provide their comments on the draft proposals of DAP, though it was not easy for a common people to comment on the draft plan due to cumbersome procedures.

According to Swapan (2013), a survey was conducted on 290 households in Tejgaon, Dhanmondi, Mirpur, Kollyanpur (Mirpur), Mohammadpur, Choukbazar (Lalbagh), Uttara, Gazipur and Keranigonj within DAP areas in order to examine the level of peoples participation in DAP (2010) preparation process. The summary of the survey is given below.

Table 2: Scenario of People's Participation in Previous Detail Area Plan, 2010

Respondent	Male	88%
	Female	12%
Idea about the plan	Did not have a proper idea about the plan	50%
	Respondents had perceived understandings	41%
	Perceived that they would be benefited from the Project	10%
	Confirmed that they would be affected negatively by the plan	3%

Informed about the Plan by	Newspaper	20-25%
	DAP, TV/Radio coverage	15%
	Informed by neighbors or relatives	22.40%
	RAJUK officials	18.30%
Involvement in the Planning Process	Did not involve	50%
	Formal involvement	21%
	Self-motivated informal involvement	23%
Participation in preparing DAP	Not informed	57%
	indirect/passive participation	13%
	not interested in taking part	23%
Willingness to Contribute	Conditional	35%
	Agreement	
	Agreement	28%
	Disagreement	28%
	Agreement in principle	9%
Citizens' aspiration Towards Participation	Prefer formal participation	48%
	Prefer indirect/passive participation	36%
	Not interested	16%

Source: Swapan, 2013.

Analysis of the previous experiences regarding people's participation in planning process as revealed by Swapan unveils that dominant perception among all the groups has been the ignorance due to incomplete understandings of the planning process that was perpetuated by the planning systems. There was a general consensus among the survey respondents and FGD participants that people were poorly informed about the location and plan of the public hearing, resulting in low presences at the event. However the gradual higher attendance in PRA sessions resulted from the fact that the news of the public hearings increasingly disseminated within the communities over their socio-political networks.

The dissemination tools applied by RAJUK to notify citizens about DAP were found ineffective in this respect. Nonetheless the communities were not informed whether their

complaints and proposals were integrated in the final version of DAP. It has been found that public hearings drew attention mainly to those respondents who saw themselves as being perhaps negatively impacted by the future plan. Furthermore, people were much concerned to know if they are going to be adversely affected by the upcoming DAP (sense of urgency) rather than if any meaningful proposals or observations to progress the plan for the betterment of community. The results indicate RAJUK's limitations in building public awareness of the planning process as well as lack of sincere effort in consulting local residents to minimize possible conflicts from physical plans and maximizing community welfare.

Present scenario of Community Participation in Detailed Area Plan preparation (2016-2035)

RAJUK prepared Draft Structure Plan (2016-35) for Dhaka city in 2016 and thereafter initiated the Project for Revision of Detailed Area Plan for 2016 to 2035 for management of development of Metro-Dhaka city, which have an area of 1528 sq-km. Nevertheless, in the process of drafting the DAP (2016-35), RAJUK conducted several Participatory Rapid Appraisal (PRA) sessions with various stakeholders at different locations within its jurisdictional area across various communities and people in order to accommodate the ideas and thoughts of people, thereby ensuring community participation in planning process, which has been regarded an indispensable part of plan preparation process in contemporary urban planning. The major aims of these PRA sessions were involving communities and deriving opinions as well as taking proper feedback from people in terms of major planning decisions while preparing the plans.

Table 3: Conducted PRA sessions for DAP for Dhaka city

Type of Stakeholder	No. of PRA Organized	No. of Units Covered
City Corporation and Paurashava	3	3
City Corporation and Paurashava Wards	7	13
Union Parishad	16	16
Agency/organization	3	3

Source: RAJUK, 2017. (Note: PRA Meetings up to May, 2017 have been included)

For better understanding of peoples participation in planning process, PRA session held in Tarabo Paurashava of Narayanganj on 1 February 2018, was attended by the authors. Mayor, Chief Executive Officer, Town Planner, other officers, ward councilors, TLCC¹ members of the Paurashava, and political persons of that area and DAP practitioners and some journalists were present at that public hearing meeting. But level of public participation of general people in that public hearing program was bare minimum. Some members of the TLCC have not any idea about the purpose of the meeting, or even about Detail Area Plan of RAJUK.

Ward members of the Paurashava have presented their existing problems and some other problems related to DAP. Town planner of the Paurashava has also revealed problems

¹ TLCC means Thana Level Coordination Committee for a Municipality

relating to proposed DAP map. After hearing the speech of mayor, CEO, TLCC member, and political leaders, Project Director of DAP has committed that DAP will address the issues that have been discussed in the public hearing meeting by different stakeholders.



Source: Field Survey, 2018.

Figure : PRA session in Tarabo Paurashava.

Peoples Participation in Plan Making Process: Major findings from Detailed Area Plan (2016-2035) Preparations

Various attempts have been made by the development authority of Dhaka city, RAJUK in order to involve common people and community in plan preparation processes in the form of public consultations or PRA sessions. This study finds that there is still very low level of awareness and understanding about urban planning and its role towards common people and even the community representatives. Mainly people in the more outlying areas of the metro region are not fully aware about the importance of detail area plan for their locality and community.

Many local government members and significant citizens of the community are not even conscious that their area falls under the jurisdiction of RAJUK and therefore within DAP. At many places, a large number of people are not aware about the role of RAJUK as a development authority and particularly its special roles and responsibilities regarding planning and development.

There is considerable antipathy and even agitation against RAJUK at some places as people generally believe that it is an organization that only takes away people's property, land and houses. People mostly do not have prior understanding about DAP as an urban plan or development control regulation. The survey findings reveal that most of the respondents do not have a proper idea about various levels of plan.

Where people have some understanding or have at least heard about DAP, they usually have a very different idea than what it really is. Almost in every case, this existing idea or perception has extremely negative associations. People believe DAP is a scheme where people's households and other properties would be acquired and changed to large-scale housing projects. Another popular notion as revealed from the study is that DAP is an outright restriction on development and in areas under the jurisdiction of DAP, no development work is permitted for common people.

Many people have negative previous knowledge or experiences about this kind of development project, to the point that some are even outspoken to express their expectations and apprehensions because they believe this will be of no use. Their former experience with project operation is unpleasant and unsatisfactory. They have expressed that there had been many discussions and promises from concerned authorities in the past but very few of those promises turned into reality. So they are apathetic about the value of such meetings.

The authority related to DAP generally communicates with the local people through their representative, such as ward commissioner, political leader, and the elite person of the community. But it is quite necessary to communicate directly with local people for successful implementation of any development project. Without incorporating the sincere opinion of common people in the planning process, the plan will fail and the development will not sustain in the long run.

Project Manager of DAP has asserted that level of community participation in physical planning process has been increased through PRA meeting in ongoing DAP project compared to previous master plans and detail area plans. However this claim is not supported by the common people of ward No. 18 of DSCC as per the findings of FGD conducted for this study. In this case, community people have complained that they are not even well informed about the PRA meeting which was held in the ward office of that zone. Only ward officials, political leaders and selected individuals mostly from privileged classes of the society have attended the PRA meeting for that zone.

Project Manager of DAP has also emphasized that they are trying their best to incorporate the demands of the community people in DAP. For example, as recommended by stakeholders presented in the PRA meeting held for DSCC ward No. 18, DAP consultants and planning officials have assured to include their proposals regarding their locality in the DAP which will be implemented by RAJUK. However primary survey for this study reveals that most of the community people are quite unaware about the proposed changes and they are not holding the same views about the proposed changes. They even have the opinion that these demands are only from the ward commissioners and his political partners for attaining their personal interests for being financially benefitted due to the proposed changes in the DAP.

Some community people have claimed that they were not informed about the meetings regarding planning and decisions related to DAP. On the other hand, some people of Savar municipality engaged in businesses have said that they usually attend the meeting if it is related to their stakes only – community interests are not their priorities, and thereby they do not attend these types of meetings where physical planning issues have the priorities.

Tongi, Savar municipality, and Narayanganj City Corporation (NCC) usually do not follow the rules and regulations of RAJUK as well as they do not comply with the proposals of DAP or other physical plans as revealed from official survey for this study. In this regard, the town planner of Savar asserted that *“Municipality is under the Ministry of Local Government, Rural Development and Cooperatives (LGRDC) and RAJUK is under the Ministry of Housing and Public Works. According to our law, we do not take*

decisions in coordination with RAJUK. If our ministry permits us then we will follow their rules”.

Town planner of Narayanganj City Corporation does not think that currently physical planning is being done with true participation and so he argued that *“PRA is not being conducted in a proper way. All classes of people should be included in this meeting and level of participation should be increased”*. Mayor of Narayanganj City Corporation arranges a community meeting named *“Jonotar Mukhomukhi”²* in which future development projects are showcased and discussed with the common people of the municipality.

Town Planner of Tongi Municipality has said that as they do not follow DAP strictly, so PRA meeting has not been organized by DAP consultants in Tongi area. He has also emphasized that they arrange community meeting after 2-3 months, where Mayor do reply to all the questions from the people. Here new project ideas are shared with common people. But from FGD it is revealed that the statement of the Town Planner is not absolute true. General people are not informed about this type of meeting within their locality.

Some respondents of Tongi has claimed that they had reported on several incidents regarding significant corruption associated with housing projects, plot distribution, and development control issues. Few people complained that they did not even receive proper compensations for their lands taken by the planning agency for development activities.

Challenges of Community Participation in the Planning Process

This study reveals that common people are not generally aware of the public hearing or PRA sessions of physical plan preparation processes. In addition, few persons of the community have idea of physical plans like DAP. The citizens’ lack of understandings and awareness of DAP have been surfaced in FGD’s and moreover general people are unknown about any community meeting in case of any development activities. Urban planner of DAP has claimed that community people are attending the community meeting more than the past. But field survey for this study did not find this claim to be right. People of ward No. 18 of DSCC has said that they do not attend in PRA meeting conducted by RAJUK for the purpose of DAP and even they are unaware about that meeting which was held in the ward office of that area. Only ward commissioners, political leaders and elite persons of the community usually attend this type of meeting. The authority related to DAP communicates with the local people through their representatives such as ward commissioner, political leader, and the elite person of the community. But communication with cross sections of local people is absolutely necessary for successful plan preparation which is not currently absent in planning process.

As revealed in this study, challenges of ensuring proper participation of community in physical planning processes in Bangladesh are manifold. Various internal and external

² ‘Jonotar Mukhomukhi’ means ‘Conversation with common people’

factors from citizen's perspectives and urban planner's perspectives have been identified from FGD and key informants interview which are summarized here.

Internal factors

Citizen's perspective

The major factors that have profound impact on level of people's participation in plan making processes as revealed from FGD's are – economic issues, awareness of the planning process, effectiveness of communication strategies taken by the planning agency, trust of common people in planning agency, dependency on neighbors' initiatives, sense of urgency (i.e. whether or not people were personally affected by the plan) and status of social capital.

According to FGD, it can be seen that 'trust in local planning agencies' has the highest influence upon the respondents' attitude towards participation. It creates the fact that diminishing level of trust in planning agencies discourages citizens from taking part in the participatory process. Evidence from other sources also claims that lack of trust in planning agencies is a significant factor regarding the decisions to participate in participatory process.

Urban planner's perspective

The planning practitioners identified several factors regarding public participation in planning process as revealed from KII. Planners observed that traditional beliefs of the citizens have a significant impact on their choice to participate. Traditional beliefs are developed from the socio-economic situation of the community which largely effects to form an attitude or behavior. The practitioners are apprehensive that most of the communities felt easy to rely on chief or elders and community leaders. Common citizens like to provision them and hence restrain themselves from direct participation.

The study findings expose that practitioner perceive 'awareness of planning process' has the maximum impact upon the respondents' approach towards participation. Basic education and planning knowledge of community members, as well as their sense of urgency and involvement in informal networks, are seen as important factors, as identified by planning officials. Other factors such as the status of social capital and trust in planning agency are considered relatively less important from planners, as practitioners did not regard this factor as significant in influencing individual's inclination for participation.

External factors

Citizen's perspective

Major external factors that influences the level of people's participation are – political instability, lack of good governance, capacity of RAJUK, role of political representatives, role of planners, legislative framework, planning approach of RAJUK, corruption in planning etc. FGD respondents have also noted that these issues are closely interrelated

and might together create an atmosphere that is accountable for public indifference and subsequently led to a lower level of participation.

FGD survey has perceived a number of reasons are equally responsible for public indifference including lack of good governance, financial and technical capacity of RAJUK and non-participatory planning approach. Political instability and lack of genuine political commitments are selected as factors having a medium magnitude of impacts. It is clear that the procedure adopted by the master plan approach to planning by RAJUK remains plagued by bureaucratic control, political bias and averse to community engagement and consultation. They are also aware that participation could be enhanced through relevant legislation and sincere efforts of planners.

Urban planner's perspective

Planning practitioners, on the other hand are relatively specific in defining external realities that affect citizens' participation in the planning process. They have recognized the factors such as – legislative framework, political instability, role of planners, good governance, influence of patron-client network, role of donor agencies or NGOs – which influences public participatory process in planning. Urban planners' have indicated three key factors in this regard including political instability, lack of good governance and role of international donor agencies who fund major development projects in Bangladesh. They acknowledged that participation should be emphasized through a strong and clear legislative framework and by defining a participatory role of the planners.

However, they also mentioned that citizen participation often makes the planning process complex. It is reported that the citizens without having a proper orientation about the project and technical variability of planning issues, often made undue and impractical proposals to incorporate in the plan.

Recommendations for engaging people in plan making processes

Peoples participation in the planning processes are very much important in drafting plans for community development. Without the appropriate engagement of community as well as common people in the plan making process, planning decisions might be wrongly directed and implementation of the decisions would become harder for development authorities. From the survey findings of this study, it can be stated that a significant number of respondents either have a negative attitude towards participation or a preference to rely on indirect or passive participation by community leaders or political patrons. A proportion of respondents believes that their interests are best served by involving local leaders and thus do not pursue their own rights of participation. Such prevailing perceptions lead to a higher tendency of relying on the prevalent socio-political network.

Some respondents have reported a desire to engage with the formal system representing various levels of participation. This has included acquiring information regarding the plans and processes personally; attending consultation meetings to express their needs, or being consulted. Lot of people desired to get feedback on the proposals they have submitted while some showed a higher tendency towards participation by taking part in the layout plans or land use planning. Based on the findings of the study and suggestions

from Key Informant Interviews, following recommendations have been provided for ensuring proper participation of people and community in the plan making process while preparing physical plans for urban areas in Bangladesh.

Recommendation for encouraging community involvement

There are various ways to engage community people in plan preparation process in order to ensure that planning will ensure the overall betterment of the community and people.

- **Community workshops**

Community workshops offer opportunities for education and brainstorming in cooperating settings. Workshops can be planned as events and inventive participation methods should be introduced.

- **Training session on public meeting facilitation techniques**

A training session on public meeting facilitation techniques can be directed by the consultants directing on the challenges of facing public involvement in planning process.

- **Monthly community meeting**

In every month, there should be a community meeting with the community leader. This process includes the gathering of interested and diverse people in the community and subsequent discussion of problems and solutions regarding community planning and development management issues at ward levels in urban area.

- **Community trips**

Community trips as field visits can be arranged for increasing the understanding and coordination with practitioners for better understanding of the problems and the plan related to DAP.

Recommendations regarding dissemination of planning information

Planning information is very important while making major planning and development decisions, therefore it is important to disseminate planning and development related information to common people.

- **Measures to empower citizens**

The planning agency should take proper measures to empower citizens on planning matters, to realize and prioritizing local problems and to establish collective actions for community development.

- **Newsletter**

A newsletter can present timetables, information about community workshops, key issues, and policy recommendations. The newsletters may highlight graphics, photos, and illustrations in order to be eye-catching and make the development models easily understood.

- **FGD by urban planners or ward commissioners**

Urban planners or ward commissioners can organize FGD through which they can reach to the common people. Following this procedure they can inform people about the

proposal of DAP, its usefulness on their improvement, the benefit of involvement in plan preparation, their role in any plan and their rights in the planning. Through this method, they can invite them to attend the PRA session which will be held on their neighborhood.

- **Involvement of local schools**

Involvement of local schools is one of the best effective publicity methods. Students can either participate directly or they can work as a media to pass information to their parents. They can influence their parents to attend the community meeting.

- **Arranging program regarding the students' perception on community planning issues**

Urban planners or ward commissioners can organize a program regarding the students' perception of community issues and their dream about the future. Drawing pictures and identifying their favorite and least favorite places, making plans for neighborhoods and districts; writing essays about community issues and their visions for the future of the city and answering to questionnaires – using these techniques can be helpful for youth in order to communicate with planning officials of development authority regarding their choices and preferences on various community planning issues.

- **Establish educational programs**

Establish educational programs or a source to access data (such as a public library), or both, so that groups or individuals can find timely, accurate information that facilitates them to have a meaningful influence in decision making. To increase readability, prolonged documents should be concise into fact sheets and kept at the repository along with the full-length documents. If needed, fact sheets should be modified for community groups according to the demand of the local people.

- **Organizing a program of a photo exhibition by DAP practitioners**

DAP practitioners can organize a program of a photo exhibition in each locality within DAP area in which existing and proposed map of the area, proposed infrastructures and possible changes in the locality will be placed. Through this endeavor, local people can be informed about the future plan of DAP with regard to the concerned area. A comment collection process about the proposed map from the people should be conducted by the organizer or the planning authority.

- **Disseminate the information using various techniques**

Practitioners can disseminate the information by using various techniques as advertisements that include (1) Leaflets and books, (2) Noticeboard displays, Bulletins, (4) Brochures, (5) Information sheet and technical materials, (6) Postures, (7) Expert technical reports.

- **Preparing a presentation**

Urban planners can prepare a presentation about the plan of DAP so that common people can easily understand the planning proposals that will have social, economic, environment and physical impact on their locality.

Recommendation regarding responsibilities of Government and local leaders

- **Training programs or workshops**

In order to enhance degree of faith of citizens to local representatives, the government officials must carry out all activities in an equitable manner to all beneficiaries and there should be no political biasness or favoritism regarding planning decisions.

- **Establishment of active local civil society organizations**

Active civil society organizations are important for ensuring the common benefits over personal interests regarding various planning decisions. This will also benefit to remove misuse of public funds for local projects since societies as the main beneficiaries have a strong role to ensure accountability and transparency.

- **Involvement of voluntary associations**

Involvement of voluntary associations (NGOs and CBOs) stimulate individuals to become politically active for ensuring proper rights of commons while shaping the future of community through planning decisions.

- **Responsibilities of community leaders**

Community leaders can assist in the communication of information by suggesting proper means of updating the community, talking to their respective residents, publicizing meetings timely; developing notices that are concise, clear, and accessible to the communities involved; mapping the abilities and assets of individuals, citizen associations, and local foundations; building relationships and associations to respond to the challenges due to physical changes through various plans and development schemes.

Concluding Remarks

People's participation in physical plan preparation and decision making process plays a key and supportive role in urban planning leading to sustainable development of cities and settlements. This paper reveals that most of the community people do not get the proper opportunity to get involved in physical planning process. People mostly do not have the previous understanding about Detail Area Plan as an urban plan or development control regulation. Though Detail Area Plan was primarily designed to develop plans through ensuring local and community participation, in reality it only ensured involvement of selected stakeholders in decision-making process including representatives from different public departments and local governments, professional groups, civil society organizations, business groups, media, elected political leaders, and academics. Hence the idea of public participation has not been achieved in the current processes of PRA that have been practiced in DAP preparation process. In this backdrop urban authorities should be more dynamic in ensuring peoples participation in planning if they really wish to prepare plans for the development and betterment of people and the community.

References

- Ahmed, S., & Swapan, M. (2009). *Peoples' Participation in the Physical Planning Activities: A Case Study of Khulna Development Authority*. Journal of Bangladesh Institute of Planners, Vol. 2, December 2009 (ISSN 2075-9363).
- Alam, M. (2008). *People's Participation as a Tool for Improving Urban Basic service Provision of Two Selected Paurashavas* (Masters). Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh.
- Begum, H. (2015). *Improving access to housing for low-income communities in Dhaka: From rhetoric to reality in community participation*. PhD Thesis, School of Civil Engineering and Built Environment, Science and Engineering Faculty, Queensland University of Technology.
- Davidoff, P. (1973). "Advocacy and Pluralism in Planning", in A Reader in Planning Theory, edited by Andreas Faludi. Pergamon, Oxford, pp. 277-96.
- Forester, J. (1989). *Planning in the Face of Power*. University of California Press, Berkeley, Los Angeles.
- Habermas, J. (1987). *The Theory of Communicative Action*. Volume 2 - Lifeworld and System. Polity Press, Cambridge, U.K.
- Hillier, J. (2002). *Shadows of Power. An Allegory of Prudence in Land-Use Planning*. Routledge, London and New York.
- Kaiser, S. (2012). *Development Approaches: Bottom UP vs Top Down*. The Daily Star Report on 4 October, 2012.
- Keishnamurthy, A.N. and De Wit, W.J. (2000). *Learning Lesson from the Bangalore Urban Poverty Alleviation Programme Participatory Approaches to Urban Development*. Institute for Housing and Urban Development Studies, Rotterdam, Netherlands.
- Lindblom, C. E. (1965). *The Intelligence of Democracy*. The Free Press, New York.
- Mansuri, G., & Rao, V. (2004). *Community-based and-driven development: A critical review*. The World Bank Research Observer, 19(1), 1-39.
- Mantysalo, R. 2005. 'Approaches to Participation in Urban Planning Theories' available at '[https://www.semanticscholar.org/paper/Approaches-to-Participation-in-Urban Planning-M%C3%A4ntysalo/6483258d052f65c5b12e5e575c094070ffaa3a76](https://www.semanticscholar.org/paper/Approaches-to-Participation-in-Urban-Planning-M%C3%A4ntysalo/6483258d052f65c5b12e5e575c094070ffaa3a76)'
- Marsland, R. (2005). *Community Participation the Tanzanian Way: Conceptual Contiguity or Power Struggle? Oxford Development Studies*, 34.
- Mitlin, D., & Thompson, J. (1995). *Participatory approaches in urban areas: strengthening civil society or reinforcing the status quo?* SAGE Journals.
- Mwiru, M. (2015). *The importance of community participation in development projects at local level: A case of Dodoma Municipal Council*. Local Government and Management (LGM) of Mzumbe University.
- RAJUK. 2016, Dhaka Structure Plan (2016-2035). Rajdhani Unnayan Kartipakkha, Dhaka.
- Swapan, M. (2013). *The Realities of Participation in Planning in Bangladesh: The Role of Institutional and Socio-political Factors in Shaping Participatory Planning in Developing Countries* (Degree of Doctor of Philosophy). Curtin University.
- Taylor, N. (1999) 'Anglo-American town planning theory since 1945: three significant developments but no paradigm shifts', *Planning Perspectives*, 14:4, 327 – 345

Education for Visually Impaired: Congeniality Study of Digital Talking Book

Dr. Rasheda Akhtar*

Md Sazzadul Alam**

Noor Kutubul Alam Siddiquee***

Abstract: Globally, Information Technology is being leveraged to empower people and improve the quality of life of the citizens regardless of their age, sex, race, social status and physical ability. The innovation of Digital Talking Book (DTB) is the contribution of that Information Technology. Digital Talking Book brings a significant advancement in favour of people who are blind or have a print disability like reduce dependency on Braille books, save time and energy, increase interest for going to school, boost up their confident etc.

Key words: Digital Talking Book, visually impaired, technology

Introduction

In Bangladesh, more than 9.1% of the total population have been suffering from various types of disabilities (HIES, 2010). In addition, about 2.5 million people are visually challenged in this country¹ and a large number of visually impaired students are now studying at various educational institutions. There are an estimated 50,000 blind children (0-15 years of age) and approximately 90,000 to 120,000 children with low vision²(Samaddar,2014). These people do not have better access to information and study materials suitable for them in Bangladesh.

Albeit, education is considered one of the key components of overall human development. It is one of the basic human rights as well. According to the Convention on the Rights of the Child, “States Parties recognize the right of the child to education, and with a view to achieving this right progressively and on the basis of equal opportunity, and that they recognize that a mentally or physically disabled child should enjoy a full and decent life”³. Unfortunately, proper access into books as well as education is one of the major problems for visually impaired children.

Considering these limitations, many technologies and innovations have come into practice to overcome these limitations. Digital talking book (DTB) is one of the major inventions in this regard. Since the advent of digital talking books in 1994, when the first Digital Accessible Information System (DAISY) prototype was launched, people with print disabilities have been able to access previously elusive text features (Petri, 2012). In

* Professor, Department of Anthropology, Jahangirnagar University, Savar, Dhaka.

** Assistant Professor, Department of Anthropology, Jahangirnagar University, Savar, Dhaka.

*** FK Exchange Fellow, Ministry of Health and Population, Nepal.

¹ According to National Forum of Organizations Working with Disabilities (NFOWD) and Handicap International (HI), 2005.

² <https://www.globalgiving.org/projects/education-for-blind-children/>

³. <https://www.ohchr.org/documents/professionalinterest/crc.pdf>

addition to different previously popular systems like Braille books and screen magnifiers, the digital talking book is a form of assistive technology for print-disabled readers (Petri, 2012). Still, there is a huge gap in understanding the usefulness and benefits of DTB. Because Literature regarding talking books appears to be primarily a concern for professional stakeholders and non-profit organizations for the print disabled, and often from a technology perspective rather than from a user perspective (Lundh, 2013)

In Bangladesh, some initiatives have already begun to address integrating blind and/or visually impaired schoolchildren into regular government and nongovernment schools. One of the most popular solutions is Digital Talking Book (DAISY, 2014)^{4,5}. Globally, ICT systems are providing the print disabled and visually impaired people with Digital accessible information systems (DAISY) and study information materials; which allow them more equitable access to educational opportunities.

In this article we will elaborate an educational medium through the Digital taking book which is only advantageous for visually impaired students. Through this discussion we will demonstrate how Digital taking book unveil the new way of education component for visually impaired. New way means we will stress it's (Digital taking book) affordability, longevity, user friendliness etc. We also represent the adoption mechanism of Digital taking book like how visually impaired come to know about this, how they use it or realization as Digital taking book user. Moreover we will mark a point that how the educational process of visually impaired is changing gradually.

For this, we will divide our discussion into four parts except introduction and conclusion. In the second portion we bring some contemporary writing about Digital taking book, next we will discuss our research methodology, then we will present a argument regarding amalgamation between Visual impaired students and Digital Taking Book and lastly we will discuss about Consequence of Digital Taking Book acquirement discourse.

Literature review

Education is the way toward encouraging learning, or the obtaining of information, aptitudes, qualities, convictions, and propensities. Educational methods incorporate narrating, exchange, educating, preparing, and coordinated research. Training regularly happens under the direction of teachers, anyway students may likewise instruct themselves (John, 1944). So to understand the process and structure of education we need to perceive the marginalized education system also.

In educational anthropology, anthropologists try to focus on education and multiculturalism, educational pluralism, culturally relevant pedagogy and native methods of learning and socializing. Educational anthropologists also interest in education of marginal and peripheral communities within large nation states (Dar & Najar, 2018). Education is a basic human right and is necessary for sustainable social and economic development. But the system or methods of teaching are different for disable persons.

⁴ "DAISY Digital Talking Books (DTBs)", Available: <https://www.gh-accessibility.com/services/daisy>. [Accessed: 2014.01.02]

⁵ http://workshop.sciaccess.net/DEIMS2016/articles/p12_Vashkar.pdf

They need Special education and it was established officially in the United States in 1818. The complex of establishments that quickly emerged originated before instruction for regularly creating understudies by decades and developed as basically a double framework, very independent from the general stream. Nonetheless, the frameworks of administration conveyance delivered by a custom curriculum from 1817 onwards were not fleeting or static; they developed and changed, creating new occasions and activities (Winzer; 2006). In this context, Louis Braille, who wanted to squeeze the critical gap in communication between the sighted and the blind and that led him to introduce Braille system for blind education (Nasrain, 2017). But now Digital taking book is very accessible, approachable and also unrestricted for visually impaired.

Now we will discuss the introduction of Digital taking book. In 1930, Digital taking books were introduced in England among soldiers who lost their sight. Then, the talking books were used as tapes played on recorders form. But continuous development of technology, these turned into electronic books (e-books) and digital talking textbooks (Coard, 2002; Philips, 2007). Basically, Digital Talking Book is an audio representation of a print publication which is planned to further enable people with print impairments⁶. A DTB is intended to provide enhanced access to documents above and beyond the standard audio book. DTBs have all the benefits of regular audio books, but they are superior when it totals up to navigating the content and displaying synchronized text⁷. DTB has some unique feather which has made this workable for visually impaired. Duarte and Carrico (2007) listed this features of the DTBs, which include: (a) a visual display is not needed, (b) multiple playback speeds, (c) content accessible at a fine level of detail, (d) usable table of contents, (e) easy skips, (f) ability to manage notes, (g) setting and labeling bookmarks, (h) fast forward and reverse, and (i) presentation of visual contents in alternative formats. On the contrary, Borg, Lindstrom, & Larsson (2009) described this technology as a assistive technology. They said that there is no authoritative definition for assistive technology. But The United Nations label assistive technology as “technology adapted or specially designed to improve the functioning of people with disabilities”. It refers to “any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities” (The Assistive Technology Act, 2004).

There are many scholars confer about the utmost of DTB. Leporini (2007) showed that the DTBs offer numerous advantages to students with visual impairments. The gadgets allow students to easily access lessons by locating a specific topics or chapters quickly, placing bookmarks for future reference, adjusting text size, changing the font, and listening to audio. DTBs researchers also believed that these learning materials could overcome most problems derived from printed textbooks, as DTTs offer interactive materials, allow locating specific contents, and skipping and returning to the content easily (Duarte & Carrico, 2007; Moreno & Mayer, 2000).

⁶ "Print Impairments", Available: http://www.ifla.org/files/assets/hq/officers/documents/wb_u-visual-presentations-guidelines-summary.pdf [Accessed: 2014.06.30].

⁷ "Synchronized Text", Available: <http://www.fcla.edu/FloridaVoices/SynchronizingTranscriptsAndAudio.shtml> [Accessed: 2014.07.20].

In many writing scholars emphasized on social inclusion process. They argued that all people have need the same education and information. In this context Adetoro (2010) argued that visually impaired people have the same information needs as sighted people, and that it is mainly the need for alternative formats that is specific for visually impaired users. He also highlights the fact that the younger study participants prefer the talking book format to Braille books.

Research methodology

This was a mix method research. For this research, Chittagong district was selected as data collection field. In this research for data collection, qualitative survey⁸, In-Depth Interview (IDI) and case study methods were used. Qualitative survey and Case Studies were conducted with Talking Book users. IDIs were conducted with officials (who are involved with visually impaired children programme) and teachers who were working for the visually impaired. For calculating our survey sample, following formula has been used.

$$Sample\ Size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + (\frac{z^2 \times p(1-p)}{e^2 N})}$$

In this formula,

Population Size = N, Margin of error = e, z-score = z and e is percentage.

Amalgamation between Visually impaired students and Digital Taking Book

Visually impaired students treat DTB as a flashy invention for them. But obviously it is a new educational method for our students. So in this section we will give out the interrelation between visually impaired students and DTB. Though it is a new technology for visually impaired but their backwash wasn't gracious. Despite some puisne incoherence, DTB conjoined with visually impaired students. So now we will address how visually impaired students came to know about DTB, training process, positive or negative aspect of DTB etc. Before the era of DTB, Braille book was the only reliable source of study for the visually impaired people. Although there were tape recorders and cassette players before DTB, it was difficult to forward and backward. One of the schoolteachers of the visually impaired students said that, *"there was cassette player once. Then CD player came into market. Now we are using mobile phone. Lessons can be learnt through mobile phone. We never thought of such feasible facility while we were students."* Basically, not everyone could afford the tape recorders or cassette players as it

⁸ In short, the qualitative survey is the study of diversity (not distribution) in a population. Surprisingly, the term *qualitative survey* (and/or the alternative diversity survey) is almost non-existent both in textbooks on general social research methodology (e.g. BABBIE, 1989; ALASUUTARI, BICKMAN & BRENNAN, 2008; LEWIS-BECK, BRYMAN & LIAO, 2004) and in textbooks on qualitative research methods (CRESWELL, 1998; SCHWANDT, 1997; SEALE, GOBO, GUBRIUM & SILVERMAN, 2004). One significant exception is the paragraph on "Analysis of Qualitative Surveys" in FINK's book entitled *The Survey Handbook* (2003, pp.61ff.).

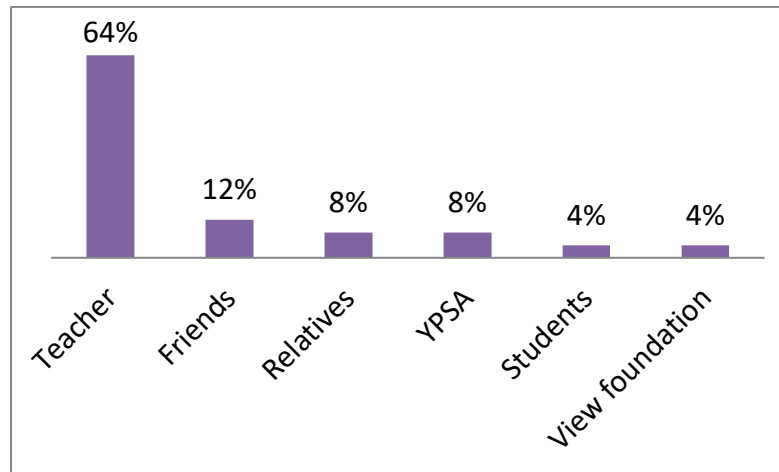
was costly. As a result, most of the visually impaired students had to rely on Braille books.

Moreover, it is a life changing technology for most of the visual impaired students. One of the respondent told his own story where he perceived that it has created plenty of opportunities for visual impaired students. That case is elaborate here.

Mr. Maruf (Pseudo name) is a teacher at school for visually impaired students. He is also visually impaired person and has been teaching visually impaired students for around 15 years. He was one of the first visually impaired students admitted into Chittagong University. When he started his university life, there was no single system or facility for the visually impaired students in Chittagong University. He had to continue studying in the same manner and same curriculum with other students. This was difficult for him. He started talking with his teachers. He was only oriented in Braille system. One day he was taking note in the class in his Braille book. The teacher called him and rebuked him for drawing in the classroom. He was completely astonished to listen to the teacher's perception about him. He went to the teacher after class and explained everything to him. The teacher had no idea about Braille system or the method how visually impaired students study. The situation has changed now. Visually impaired children can use DTB or other recording option as a potential supplement of Braille. Government is developing all the academic books in DTB version. This digitized version can also be run in mp3 players. MP3 player and multimedia phones have become cheap. As a result, students do not have concern in terms of following teacher's lesson. The inauguration of DTB has enabled them to better prepare themselves. On the other hand, many teachers are trained on the method of teaching visually impaired students. Many other have been sensitized. DTB and other digital device has opened enormous doors for the visually impaired students.

In our research we found that most of the students first came to know about DTB from their teachers, which is 64%. Apart from this, 12% and 8% participants came to know about DTB respectively from friends and YPSA⁹. Braille book was not sufficient and students were being more and more dependent on DTB. 96% participants were somehow using DTB and 88% of them was found regular user of DTB. Study also found that 88% participants had more than 6 DTB.

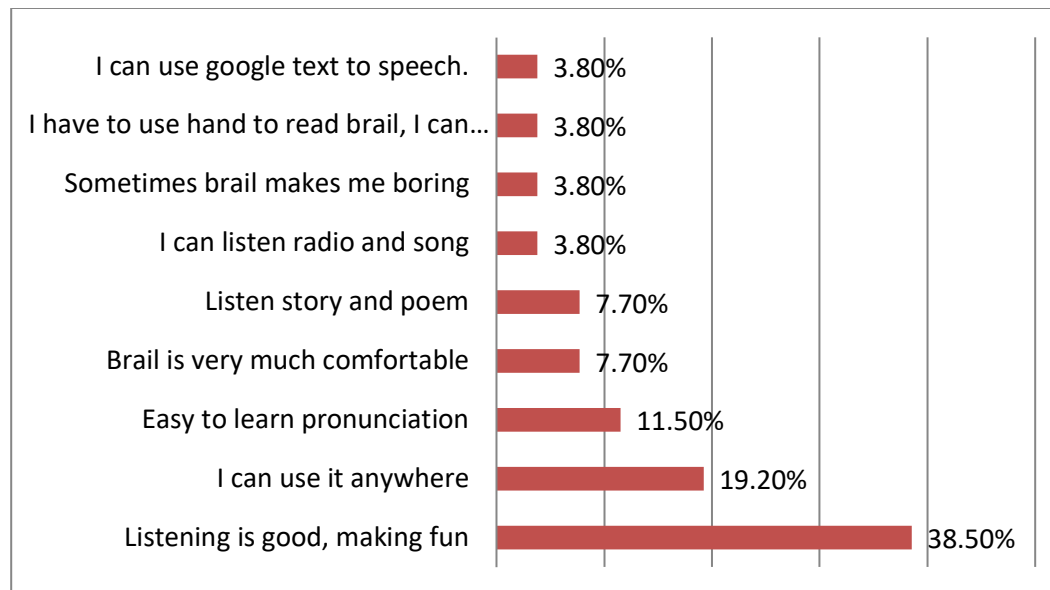
⁹. In 20th May 1985 by active initiation of the socially conscious youth, a social development organization called YPSA (Young Power in Social Action) began its course of participation in the development process. YPSA is registered with the different departments of the people's republic of Bangladesh including NGO Affairs Bureau, Department of Social welfare, Department of Youth Development, Health and Family Welfare, Copyright office, Register of Joint Stock Companies and Firms and Micro Credit Regulatory Authority.



Source of Information about DTB

DTB is a new thing in Bangladesh. Although there were mp3 and other recordings before, education through digital way was not a familiar method. As a new method, we asked the participants whether they received any training or orientation about how to operate DTB. Only 12% participants said that they received training on DTB before using it. 60% participants did not answer to this question. 28% participants said that, they did not receive any training or orientation. On the other hand, for orientation of the teachers on DTB; the response showed similar result to students. We also asked them whether their teacher received any training or orientation. Similar response came to this question as well. That means, 60% participants did not response and 28% said no. Only 12% said that, their teacher received training on DTB.

Forasmuch as, DTB is exclusively designed for people with printing disability and visual impairment, so, we asked respondents whether they are getting fun out of it. 96% participants said that they were getting fun from DTB while learning. Previously they had to deal only with Braille which was not a fun like thing. So study tried to identify some of the features which had made DTB a pleasant learning material. 38.50% participants mentioned the benefit of listening which was completely new to them. 19.20% mentioned about DTB's feasibility and 11.50% mentioned about the facility of learning pronunciation. Braille just taught them to read and spell. Learning pronunciation was a difficult part for them. DTB has made this easy and fun.



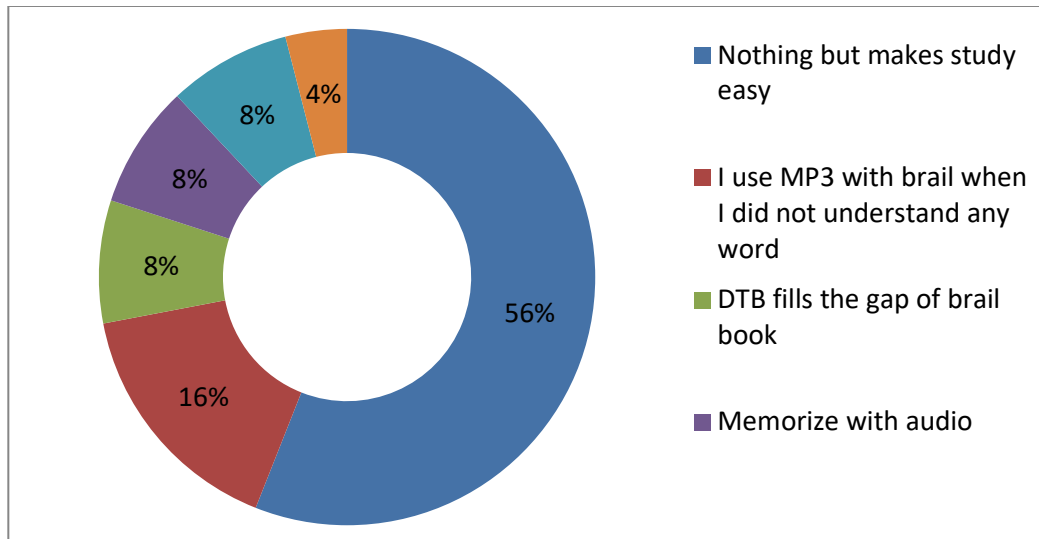
Reason of Being a Fun Learning Material

In this research we also wanted to know about technical issues regarding DTB like internet connection, charging and sound problem. 92% respondents said that DTB did not require internet connection, whereas 8% participants said that they had no idea about the need of internet connection to run DTB. On the other hand, 84% participants said that DTB needed continuous charging. 84% participants managed to charge the device by themselves. Participants did not mention about any sound related problem.

Contrariwise research participants said a lot of good things about DTB. Still, the study tried to find out some loopholes and legacy of DTB. When the participants were asked whether there was any negative thing that came because of DTB; 28% said yes. The rest of the 72% did not mention any negative outcomes of DTB. These 28% participants were asked about the negative things that came because of DTB. 58% participants mentioned about ear problem and lack of headphones as DTB requires headphones and speaker. 14% mentioned about English pronunciation as a legacy of DTB, which need to be addressed.

Consequence of Digital Talking Book acquirement discourse

DTB is not an alternative educational system of Braille. Moreover it is an auxiliary system which helping the visually impaired. There is no disharmony between Braille and DTB. The study wanted to locate and analyze the broader change in order to measure the impact. We asked for participants' opinion about some broader changes that came because of DTB. 56% participants said that, DTB did nothing but making the study easy and comfortable. 16% described DTB as a supplementary material besides Braille. Usually they used Braille books. When they could not carry Braille books, then they used DTB. 8% opined that, Braille books had some serious limitations and DTB fulfilled those gaps.



Broader Change

We found in our research that DTB has retreated some problems for visually impaired students. One of the respondents said that *I became familiar with DTB during 2013-2014 from one of the visually impaired students living near to my house. Initially I collected the digitized version of few books and started listening to it through mp3 player. Before that, I used only Braille books. Unfortunately, Braille books were not sufficient considering the number of visually impaired students. Besides, Braille books are good to remember or spell anything. But, students could not have much progress in terms of speaking or utterance. On the other hand, I had very few personal Braille books of my own provide by NCTB. I had to rely on school provided books. Sometimes, school couldn't provide books according to demand. On the other hand, one of the teachers said, "suppose there are just three sets of Braille books for class 8. We cannot lend the book to the students whenever they wish. DTB has brought revolution in this regard. Students do not need to depend on the limited sets of books. They can prepare themselves according to their own pace using DTB. On the other hand, we the teachers also need the books to prepare ourselves. Unfortunately, we cannot use the book all the time. Then we also make preparation using DTB"*.

Digital Talking Book is very significant when there is shortage of Braille books. There was a time when integrated schools and visually impaired students did not get Braille books in time. Moreover, the number of books was insufficient considering the demand. NCTB is primarily responsible for developing and distributing Braille books. On the other hand, all types of service for disable people are run under the Department of Social Service. NCTB used to divert their responsibilities to the Department of Social Service. Unfortunately, Department of Social Service had no copy to develop and print Braille books. As a result, students and teachers had to use old books, which sometimes could not match with the new syllabus.

However, most of the students did not consider DTB as an alternative of Braille book but as a supplementary material. Braille book is very important to learn studying and spelling. The problem is one Braille book cannot be used more than three years. Because it loses its sharpness. Combination of Braille and various forms of DTB is important to learn both pronunciation and spelling together. Students can study with the DTB from the very beginning of the education year, whereas Braille books do not come in time.

DTB has some contribution in increasing enrolment. There was a time when visually impaired students had least options to study. Now government has set up many institutions for the disabled children. Enrolment of students has increased. One of the visual impaired school teachers said, *“no seats are empty in our school. Sometimes, we cannot admit all the children due to our seat limitation. Enrolment has been increased. Parents are being more and more aware. They used to complain that, we had not enough Braille books. Now, they do not complain because their children can learn from DTB. They can also help their children to learn. Few days ago, one of the guardians called us for DTBs”*. As there were not enough Braille books, students were frustrated. The frustration went away with the inauguration of DTB. Students had the option to choose. If they did not feel good with Braille, they could use DTB. One of the visual impaired school Head teacher said, *“initially guardians got confused when their children started using DTB. They were not convinced about this method. Now they understand. No one now complains that their children’s education is going to be off due to lack of study materials.”* In addition, one of the guardians of a visually impaired student said that, *“DTB is easy to read and comfortable. It takes less time and does not create extra pressure on the students. On the other hand, Braille books take comparatively more time.”*

Conclusion

Digital Talking Book brings a significant advancement in favour of people who are blind or have a print disability. The standard and the new technology provide a better reading experience and have the potential to encourage both visually impaired students and the guardians to get education. This trend is already visible in Bangladesh, although DTB is very new. Year wise statistics of enrolment of students also indicates the potential of DTB.

Still, students use Braille books as the primary material of study. DTB is comparatively new in our country. Although there were mp3 players and cassette players prior to DTB, but DTB is different from them. DTB has specific contents. Users can chose what to listen/learn. In cassette player/mp3 player, there was a huge problem in terms of backward and forward. DTB has solved that limitation. In reality, the existing education system for the visually impaired was never comfortable. Those who have overcome the boundary had to struggle a lot. DTB has brought hope in this regard.

Reference

- Adetoro, N. (2010), “Reading interest and information needs of persons with visual impairment in Nigeria”, South African Journal of Libraries and Information Science, Vol. 76, No. 1, pp. 49-56.

- Adetoro, N. (2012), "Alternative format preferences among secondary school visually impaired students in Nigeria", *Journal of Librarianship and Information Science*, Vol. 44, No. 2, pp. 90-96.
- Assistive Technology Act of 2004. Retrieved from <http://www.gpo.gov/fdsys/pkg/STATUTE118/pdf/STATUTE-118-Pg1707.pdf>
- Borg, J., Lindstrom, A., & Larsson, S. (2009). Assistive technology in developing countries: National and international responsibilities to implement the convention on the rights of persons with disabilities. *Lancet*, 374(28), 1863-1865.
- Coard, P. (2002). The impact of assistive technology on visually impaired computer users accessing the Internet. *Proceedings of the 15th Annual NACCQ*, Hamilton, New Zealand, July, 202-210. Retrieved from www.naccq.ac.nz
- Dar, W. A., & Najar, I. A. (2018). Educational Anthropology, Tribal Education and Responsible Citizenship in India. *South Asia Research*, 38(3), 327-346.
- Dewey, J. (1944), *Democracy and Education*, The Free Press.
- Duarte, C., & Carrico, L. (2007). Developing an adaptive digital talking book player with FAME. *Journal of Digital Information*, 8(3). Retrieved from <http://journals.tdl.org/jodi/article/view/236/193>
- Household Income and Expenditure Survey (HIES) (2010), Bangladesh Bureau of Statistics, <http://203.112.218.65:8008/WebTestApplication/userfiles/Image/LatestReports/HIES-10.pdf>
- Leporini, B. (2007, August). An accessible and useable e-book as educational tool: How to get it? Paper presented at the Conference & Workshop on Assistive Technologies for People with Vision & Hearing Impairment (CVHI 2007), Granada, Spain. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.142.8348>
- Lundh, A.H. (2013), *Talking Books and Reading Children: Children Describing Their Use of Talking Books*, Swedish Agency for Accessible Media, MTM, Johannesshov.
- Moreno, R., & Mayer, R. E. (2000). A coherence effect in multimedia learning. *Journal of Educational Psychology*, 97, 117-125.
- Nasmith, W. and Parkinson, M. (2008). "Senior citizens embrace change and make a new technology work for them", *The Electronic Library*, Vol. 26, No. 5, pp. 673-682.
- Nasrain S. M. (2017), *Special Education for the Visually Impaired Children in Bangladesh*, IOSR Journal Of Humanities And Social Science (IOSR-JHSS), Volume 22, Issue 8, Ver. 14, PP 30-34.
- Philips, D. (2007). Talking books: The encounter of literature and technology in the audio book. *The International Journal of Research into New Media Technologies*, 13(3), 293-306.
- Petri, K. (2012), Accessibility issues in e-books and e-book readers, in Polanka, S. (Ed.), *No Shelf Required 2: Use and Management of Electronic Books*, American Library Association, Chicago, IL, pp. 35-60.
- Samaddar Manju (2014) *Strengthening Integrated Education Programs for Blind and Visually Impaired Children in Bangladesh*, Baptist Sangha School for Blind Girl.
- Winzer M. (2006), *Confronting difference: an excursion through the history of special education*. The sage handbook of special Education, SAGE publication.

The Bipolar of Politics: The Role of Political Parties in the Post Peace Accord Context of Chittagong Hill Tracts

Ranjan Saha Partha*

Introduction

This paper addresses the major challenges faced by political parties in Bangladesh in promoting 'peace' by means of political negotiations, and also questions the importance of the political process as the means of conflict resolution in the present context of the Chittagong Hill Tracts (CHT). Several major challenges of the political process of the CHT Peace Accord in Bangladesh will be discussed. These challenges include the bipolarity of key political actors, the role of international organizations and civil society, and the political process's connection with the daily life experiences of the grassroots Jumma people along with those of the Bengali settlers. I argue that there are differences in the real-life experiences of the CHT people. Thus, I aim to show that, even with what the determining political dialogue has tried to establish, the whole phenomenon is neither homogeneous nor historically the same. Through this, I want to establish that, along with development/political/governmental interventions; the real story of the grassroots people is often different and carries multiple layers of understanding and realization.

Politically and historically, the Jumma people's struggle for self-determination and regional autonomy goes back to the early 1970s, and involves a series of political histories and armed conflicts. The struggle in the CHT region has had a long history of conflict and fighting from 1973 to December 1997 (24 years or almost a quarter of a century), comprising the insurgencies of Shanti Bahini ("Peace Force"), counter-insurgent measures by militarization, the Bengali resettlement project, massive human rights violations, bloodshed, loss of thousands of lives, etc. To end the killing and the attacks, the 12-member National Committee of CHT Affairs was formed. After seven rounds of negotiations, the Peace Accord was signed between the PCJSS and the government. In this respect, the main objective of this article is to examine how the political parties and non-political actors have been involved in the post peace accord context.

Theoretical Discussions

While most of the mainstream literature has focused on the political solution as a method of peace building, my argument is that the negotiation between political leaders creates little space for the local people. My current understandings of the critique of political organizations have been profoundly influenced by a variety of intellectual debates¹. In

* Associate Professor, Department of Anthropology, Jahangirnagar University

¹ I borrowed this argument from Islam (2012) who draws on the case of Bangladesh. According to Islam, "the neopatrimonial Bangladesh state has a lack of administrative capacity, effective institutions and

recent years, several attempts by social scientists have sought to question the role of political leaders in the social sectors. However, globally, it is not a new argument to point out that the “monopoly of state politics” is a consequence of the adverse role of political leaders. As noted by Weber: “[a] compulsory political organization with continuous operations will be called a ‘state’ insofar as its administrative staff successfully upholds the claim to the monopoly of the legitimate use of physical force in the enforcement of its order” (1978:54).

Drawing on Weber’s idea, many academics have tended to analyze the state’s institutional character as an organization or set of organizations, its functions especially regarding the making of rules, and its recourse to the coercion “monopoly of the legitimate use of physical force” (Migdal, 1994, cited in Mohammad, 2012). In this view, Reuschmeyer and Evans claimed “the state to be a set of organizations invested with authority to make binding decisions for people and organizations juridically located in a particular territory and to implement these decisions using, if necessary, force” (1985:46-47).

Acemoglu and Robinson (2012) have provided a number of interesting examples which include North and South Korea. For instance, they claimed that Korea is one of the most homogeneous nations in the world, yet the people of South Korea are among the richest while the people of North Korea are among the poorest. It is political management that has created completely different institutions that promote development in South Korea. In the context of South Asia, social scientists have increasingly questioned the role of political leader in the social context. Particularly in Bangladesh, many key concepts have been used by scholars in explaining the polity, which include: criminalization of politics, confrontational politics, eroded governance, massive corruption, lack of accountability and transparency, and the absence of the rule of law (Islam, 2012). Sobhan’s work can be seen as a contribution to a better understanding of the operations of political supremacy on the ordinary people (Sobhan, 2000). In this sense, he showed how political leaders, political parties, and political culture systematically criminalize politics in Bangladesh. He claimed that political activists now increasingly use *mastaans* or hoodlums as a political resource in their contention for party office and use state patronage to access public assets. Politically-patronized *mastaan* culture has institutionalized itself over successive regimes. This extra-legal activity is now turning into a basic part of the election system used in securing a support base in particular areas (Sobhan, 2000). The consequences of *mastaan* culture on Bangladesh society are live and substantial in manipulating and determining the functioning of the country’s key political organizations as well as the behavior of the major actors. Successive governments have failed to execute the very basic functions of a polity,

coherent ideology, and thus, is unable to carry out developmental as well as economic goals. In other words, as a consequence of loss of state capacity, the state’s ability to define and pursue basic services has declined over the years and been rendered incapable or rarely capable to provide basic services to its citizens. Most importantly, the neopatrimonial regimes of Bangladesh survive based on patronage politics, where personalized exchanges are the mechanisms of the government. Thus, the neopatrimonial regime is the antithesis of good governance as well as the antithesis of development” (2012: 8).

that is, ensuring law and order, establishing justice, and collecting revenue from citizens (Sobhan, 2004). Ordinary people, at present, are confused with the law of democratically elected governments and their shameless politicization of everything in the society and their incapability to govern. As a result, the state is now caught in a large economic trap of corruption (Barakat, 2003; Siddiki, 2011, as cited in Islam, 2012).

As in the national politics of Bangladesh, a strong bipolar system of polity exists in the Chittagong Hill Tracts (CHT). Since the Peace Accord in 1997, the almost equal strength of the two major political parties' duopoly has existed not only in the national political system, but also in the regional political structure (for the role of the UPDF and the PCJSS).² The ordinary Jumma people are now caught in a political trap of criminalization. In order to provide legal security to the local Jumma people, the state institutions need to be effective. In this study, by employing the framework of political bipolarity as presented in this section, I therefore particularly focus on the underlying limitations of the unregulated peace process in the CHT and the resultant need to protect the ordinary people.

Peace Accord 1997: Some Historical Issues

The politics of identity of CHT people originated in the British colonial period, when it was adopted in the state apparatus as part of Britain's tribalism policy in dealing with the region. The colonial government at first used sub-names, such as 'tribe' or 'hill men', to distinguish the Jummas from the majority of Bengalis in the country. The notion of 'tribal' was related not only to the identity issue, but also to the governing policy through which the colonial administrator began to control the whole political economy of the local people. The colonial administrator documented several aspects of tribalism, such as having religious beliefs perceived as primitive, i.e. animism and 'heathenism' (Marriott, 2003:146; Xaxa, 1999); ape-like physical features (Marriott, 2003) and sexuality of an immoral and exotic nature (van Schendel, 1992). In the CHT, the Jumma people, for the first time, came to experience a different kind of political economy, which caused changes in their own culture and society. The colonial administration started the process of land alienation by taking over the ownership of land rights in the CHT through the creation of reserved forests (Dewan, 1990).

The serious problems in the CHT began with the building of the Kaptai hydroelectric dam between 1957 and 1963, when the territory was part of Pakistan. This dam flooded at least 54,000 acres of settled cultivable land farmed by the Jumma people (Nasreen, 2002), permanently displacing thousands of indigenous people without any compensation (Jenneke, 1997). This policy of exclusion from decision making, adopted by both the British and Pakistani governments, has continued to dictate the development of identity

2 In this paper, I have termed the conflict between the UPDF and the PCJSS as "in-group feuds". However many of the ordinary people of Jumma society have termed the conflict as a "brotherhood conflict", as the conflict has arisen between the Jumma communities. I have discussed this situation in detail in Chapters 7 and 8, with ethnographic evidence.

and the livelihood policy of the CHT people since the creation of Bangladesh.

After Bangladesh gained its independence in 1971, a group of indigenous people formally expressed their demands for autonomy to maintain their self-identity. However, the Prime Minister of Bangladesh, Sheikh Mujibur Rahman, rejected the Jumma people's demands, advising them 'to forget ethnic identities' and 'to be Bengalis' (Al-Ahsan and Chakma, 1989:967). This denial of constitutional recognition of the Jumma people's diverse ethnic identity and regional autonomy by the independent state of Bangladesh brought social, political and cultural chaos to the CHT. A portion of the Jummas initiated a strong resistance movement by forming the political party PCJSS, with its armed wing Shanti Bahini ('Peace Force'). From 1976, the CHT became an area under military occupation and a training ground for counter-insurgency. Moreover, approximately 400,000 Bengalis moved into the region between 1979 and 1987 under a government transmigration program which had several sociocultural consequences for the indigenous Jummas: destruction of the agricultural system, changes in the names of indigenous localities, attacks on indigenous religious institutions and, above all, forced eviction from their land. The indigenous Jummas now risk being outnumbered by Bengali settlers who have continued taking over their land and attacking their religious and cultural values. Under these circumstances of conflict and violence, the Jumma women have often been the most vulnerable victims. The civil administration and the military have appeared to be concerned bystanders at best or, in some instances, the direct patrons and protectors of the Bengali settlers (Mohsin, 1997). Since 1980, 13 major cases of sectarian attacks by Bengali settlers on the Jumma have been reported (International Work Group for Indigenous Affairs, 2012; Amnesty International, 2013).

During the period of counter-insurgency, almost a hundred thousand Jumma have been forced to cross the border into India or have become internally displaced as a result of the armed conflict (Jenneke, 1997; Barua, 2001). Around 8,000 people,⁵ including security forces, from the two communities have been killed. After a long process of political negotiation, a major turning point occurred when the Bangladesh government and the PCJSS signed a Peace Accord in 1997. However, the Accord has not settled the situation: rather, several new issues have arisen in the CHT region.

Political Consequences of the Peace Accord: The Role of National Political Parties:

On 2 Dec 1997, CHT Peace Accord was signed between Government of Bangladesh (GoB) and Parbatya Chattagram Jana Samhati Samiti (PCJSS) ending two era-long insurgency formally. The opposition within Bangladesh's national parliament, with its radical Islamic parties such as Jamat-e-Islam, opposed the Peace Accord when it was signed. Immediately after the signing of the Peace Accord, when the Awami League and PCJSS activists held a march in Khagrachari district to celebrate the signing ceremony, the BNP and seven other opposition parties held four days of protests and strikes. The perceptions of the BNP

leadership had been shaped by the past experience of its predecessor, President Zia, who was persuaded that militarization of the CHT was needed to solve the problem of insurgency. The BNP, while in opposition, vehemently opposed the Accord, terming it a “black agreement” and declaring that it would amend some of the provisions on assuming power. The BNP claimed that, as per the Peace Accord, one-tenth of Bangladesh had been surrendered to the ‘tribal’ leadership of the Regional Council, which was against the unitary nature of the state and would encourage secessionist movements in other parts of the country.

After coming to power in 2001, the new BNP government kept silent about the Peace Accord; in addition, it ordered the cessation of all developmental initiatives undertaken by the previous Sheikh Hasina government in the Chittagong Hill Tracts (CHT). Consequently, the Jumma people were very much in doubt about the policy and program of the new government toward the Peace Accord. For the entire duration of its regime (its five-year rule from 2001–2006), the BNP government did not hold any meetings of the Peace Accord advisory committee. The BNP government did not appoint a fully-fledged Minister to the CHT Affairs portfolio, with Moni Sawpon Dewan appointed as state minister, but not as cabinet minister. The BNP government also violated many provisions of the Accord, including: giving permanent resident status to 26,000 Bengali settler families (i.e., more than 0.1million [10,000]) living in the CHT cluster villages; appointing the chairmen of the HDC based on political considerations; acquiring land without consulting the Regional Council; and delaying the framing of rules and regulations, etc., thus indicating its lack of positive attitude towards the Accord (PCJSS, 2010).

On the other hand, although the Awami League government, during its regime from 1996–2001, undertook some institutional policies in accordance with the Peace Accord, these policies have not yet been fully implemented. For example, as per the Peace Accord, the district councils were formed on January 25, 1998; however, they have not yet been given full power. Similarly, as per the Accord clause, the Regional Council was formally established in Rangamati on 1999 (Chowdhury, 2008); however, the Regional Council bodies were supposed to be elected bodies but, to date, the elections have not been held. After the general election in 2008, when Awami League government again came to state power, it did not create any effective policies to implement the Peace Accord. Implementation of one of the key agenda items of the Peace Accord, the demilitarization process, was severely violated. The government decided to only withdraw one brigade and 35 temporary army camps by September 2009. According to the government, of the 500 security camps, 200 have to date been withdrawn in phases since the Accord was signed (PCJSS, 2010 cited in Partha, 2015)..

The Regional Politics

It is worthy mention that, the Jumma people are not homogeneous in terms of their

religious and ethnic backgrounds. Hierarchical relationships exist within the 12 ethnic communities among the Jumma, and the identity of the Jumma people is dominated by the one of these 12, the Chakma population. Although the Jumma people have several ethnic factions, politically they function in a more collective fashion in pursuing their rights in the region. The notion of 'Jumma' has a strong political meaning (van Schendel, 1992). The PCJSS was formed as a political party by activists who came from different ethnic groups of the Jumma people. The activists were unified under the umbrella of Jumma nationalism, and the establishment of constitutional recognition of the Jumma people was their main demand.

However, in the regional political context of the CHT, when the chair of the PCJSS signed on behalf of the Jumma people, other local political parties such as the Hill People's Federation, Hill Students' Federation, and Hill Women's Federation refuted the treaty by arguing that it had failed to endorse many of the Hill people's important demands. They established an organization called the United People's Democratic Front (UPDF), declaring the formation of a movement that would work to achieve full autonomy for the CHT's Hill people. In recent years, since the signing of the Peace Accord, the number of in-group feuds between the PCJSS and the UPDF has gradually increased. The ideological differences between the PCJSS and the UPDF have turned into armed conflict with the consequent effect being deterioration in the law and order conditions within the Hill region. From 1997 to the current time, some 300–500 people have been killed, with an even larger number injured, and more than 2,000 people have been abducted as a result of the in-group feud conflict (PCJSS, 2010 cited in Partha, 2015).

Furthermore, critics queried why a census was conducted in Bangladesh if the number of ethnic groups had already been determined and if individuals of more than 40 ethnicities would not have the ability to categorize themselves in accordance with their respective ethnicity. A parliamentary committee agreed that the Jumma people should be recognized as 'tribal' or from small national minorities; however, it refused to recognize them as indigenous people. The PCJSS rejected proposals for amending the Constitution of Bangladesh as they did not recognize the indigenous people of Bangladesh. It demanded that the proposed amendment provide constitutional recognition of the indigenous or *adivasi* people. However, the 15th Amendment to the Constitution of Bangladesh was passed in which every citizen of Bangladesh was deemed to be a 'Bengali'. The PCJSS has called upon all regional political parties to form a united movement to ensure the rights of the indigenous peoples of the Chittagong Hill Tracts (CHT).

The Jumma people, under the leadership of the PCJSS, have launched many protest activities against the 15th Amendment to the Bangladesh Constitution. Similarly, the UPDF has demanded the cancellation of the 15th Amendment to the Constitution, as it has brought the Jumma people in under the definition of 'tribal', including them with those of minor races or ethnic sects. Regardless of whether the goals of both political parties (the PCJSS

and the UPDF) in recent years have been almost same, they have not been unified when seeking to achieve their demands. Not only has the problem of political leadership created new forms of ‘brotherhood conflict’ between them, they are even unwilling to negotiate. As stated by the PCJSS chair, Shantu Larma:

The UPDF was never a political organization. It has no history; it has no ethical values or organizational structure. They demand autonomous governance in the CHT region which will never be materialized. There is no one in the UPDF who was involved with the PCJSS earlier. We have no interest to make a negotiation with them.³

On the other hand, the UPDF has claimed that Larma is simply a puppet of the Awami League government, which, for a long time, has appointed the chair of the Regional Council in order to establish the government agenda in the CHT region. This kind of in-group feud has also hampered the peace process over the past decade. The fear of losing its dominant position under the emergence of strong Jumma political groups has made the government apathetic to the peace process. Both the UPDF and the PCJSS have blamed each other, claiming that the other party has been receiving privileges from the army in order to crush them.

The In-group Feuds in Local Context

Although the Peace Accord disarmed the Shanti Bahini rebels, the dissatisfaction of different stakeholders has increased with conflict distributed in multiple layers. More specifically, conflict between the UPDF and the PCJSS has seriously affected the livelihood of the ordinary Jumma people. It is noteworthy that, as claimed by the UPDF, the Accord has failed to address the basic demands of the Jumma people. These demands have actually been articulated by the PCJSS and are as follows: regional autonomy, constitutional recognition of the indigenous Jumma people of the CHT, restoration of land rights, withdrawal of the military, and withdrawal of the settlers from the CHT. Moreover, in the accord, there is no reference to accountability for the human rights abuses that have bordered on genocide. The UPDF has argued that, without fulfillment of these basic demands and accountability for human rights abuses, a genuine and permanent peace cannot be established in the Chittagong Hill Tracts (CHT). The UPDF was born as a result of this perception.

In recent decades, by showing their armed power, both of these groups have illustrated their desperation to control the Hill region. According to the villagers of Mahajan and Lamuchari *Paras*, to maintain their parties, the activists and leaders of these groups have collected money through extortion under the name of “protection money” from the ordinary Jumma people. This scenario is prominent in the whole CHT region. When a

³ *Dhaka Tribune*, August 18, 2014

village is dominated by the UPDF, UPDF activists forcefully squeeze money from the inhabitants. Similar practices can be seen in the PCJSS-dominated areas. Moreover, when a person refuses to pay the extortion money, they face torture or abduction by the party activists.

In the CHT, it is hard to find a village where the people are not dominated either by UPDF members or PCJSS members. However, their dominated areas are not the same areas. If a village is captured by the PCJSS, the UPDF workers are not able to collect extortion money from the PCJSS-controlled area. Moreover, opposition workers have no scope to go into the village for any ordinary purpose. The dominant activists are on patrol all the time searching for opposition workers in the respective villages. In the case of ordinary people who do not belong to either side, they cannot go to other villages at night due to the patrolling activities of the activists or their leaders. The situation in the CHT has become tense as the UPDF and the PCJSS are locked in a long-standing clash and have turned the total Hill region into a “valley of death”.⁴ Nobody comes forward to file any police cases after these murders or illegal tolls.

In the realm of UPDF and PCJSS politics, the strong bipolar system of the polity is extremely confrontational in nature. Since 1997, the almost equal strength of the two major local political parties has contributed to the emergence of a duopoly over the regional political system of the Chittagong Hill Tracts (CHT). This ‘winner-take-all’ power game in the CHT is not the outcome of ethnic difference nor is it based on class difference but rather it is based on “power sharing”⁵ of resources. This “power sharing” is concerned with the acquisition of land and business licenses and tenders, the collection of extortion money, the gaining of power in institutional bodies, etc. The nature of this takeover of power, in Bengali words, looks like the politics of *char dokhol*⁶ (the occupation of *char* lands) which is more typical of a thriving peasantry than a burgeoning bourgeois democratic movement or activities. In the case of Regional Councils, to date, these have continued to be highly political, dominated by the PCJSS and government-nominated members. When the chair of the PCJSS is selected as the head of the Regional Council, this selection violates the clauses of the Peace Accord which state that this post is to remain unelected. The signed CHT Peace Accord could not satisfy other ordinary people in the CHT due to the domination of the PCJSS in the Regional Council (RC) and Hill District Councils (HDCs). The Jumma people, who were not actively involved in regional politics, felt deprived and

⁴ When I talked with a retired schoolteacher from Mahajan *Para*, he used the term “valley of death”. According to him “the brotherhood conflict between UPDF and PCJSS is increasing day by day and the CHT region is turning into a valley of death”.

⁵ The term “power sharing” usually means a policy agreed between political parties or within a coalition to share responsibility for decision making and political action. It is true that the CHT Peace Accord is a “power sharing” process between the government and the PCJSS. However, the local people reported this event as a power-sharing process between elite political stakeholders, where other groups and ordinary people have been considered marginal.

⁶ Mohsin and Guhathakurta (2007:50) used the term *char dokhol* to discuss the bipolar political system of Bangladesh (Mohsin and Guhathakurta, 2007, cited in the PhD thesis of Mohammad, 2012)

betrayed due to their poor representation on the Regional Council (Partha, 2016).

Similarly, the stakes of the competition between the PCJSS and the UPDF have helped to institutionalize political violence as an instrument of political pursuits. In this political culture, the rest of society is forced to go with the more powerful party if they wish to participate in and receive benefits from the system. The constant support of the extended process of elitism and the related political beneficiary group have made the ground-level reality an unbreakable cycle which only brings suffering to the Jumma people.

Conclusion

As discussed above, the peace process in the CHT has been disrupted by different political parties in several ways. The political conflict among the Jumma people as well as distrust between the state and the Jumma people have escalated into further conflict in the CHT region. The elites, that is, administrative, military, and political leaders have been taking advantage of the Bengali–Jumma relationship through their manipulation of political support in favor of Bengali settlers' organizations. In addition, the elites have exploited the conflict between Jumma organizations. These influential factors have created an insecure policy environment and have made the Accord implementation ineffective in different layers. Thus, the role of political parties, such as the Awami League and the BNP, or the PCJSS and the UPDF, in seeking to establish their own political agendas, have only translated into the cycle of suffering of the Jumma people as well as of the Bengali settlers. From an outsider's point of view, it would be easy to recognize the structural manipulation by different stakeholders to which I referred earlier. However, in order to realize the grassroots practices and their meaning, it is necessary to explore the experience and narratives of the local people. In the following chapters, based on my experience as a participant observer, I explain the institutional practices and people's negotiation with those practices.

The constant reinforcement of the prolonged process of local elitism and its related beneficiary group has made the ground-level reality an unbreakable cycle of suffering for the Jumma people. While the nature of different governments' policies toward the CHT is not homogeneous, and is much dependent on Bengali nationalist discourse, the role of Shanti Bahini has also reinforced the conflict in several ways. As I have observed, after the signing of the Peace Accord, many Jumma people, and even some Jumma political parties, have criticized the perceived role of the PCJSS as having sole authority for the Jumma people of the Chittagong Hill Tracts (CHT). In this context, and to sum up, the ground-level reality of the CHT peace process is that it has been interrupted by different political stakeholders.

References

- Acemoglu, D. and Robinson, J. (2012), *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*, New York: Crown Business.

- Barakat, A. (2003), 'Political and Economic Scenario of Bangladesh: Where to Go, Where are we Going?', paper presented to the *National Seminar on Economic, Social and Political Situation in Bangladesh*, organized by the Bangladesh Federation of Chambers of Commerce and Industry, Dhaka, 2003.
- Guhathakurta, M. (2001), 'Women's Narratives from the Chittagong Hill Tracts', in Rita Manchanda (ed.), *Women, War and Peace in South Asia: Beyond Victimhood to Agency*, Sage Publications, India Pvt. Ltd: New Delhi.
- Guhathakurta, M. (2003), 'Minorities, Women and Peace', *Journal of Social Studies*, Vol. 100 (June), 88-99: Dhaka.
- Guhathakurta, M. (2004), 'Ethnic Conflict in a Post-Accord Situation: The Mahalcchari Incident in the CHT', paper presented at *international seminar on "Ethnic Identity and Ethnic Conflict in Multicultural Societies"* organized by the Dept of Sociology, University of Mumbai, India, March 3-5.
- Islam, M. (2012), *The Politics of Food Security in Bangladesh*, unpublished PhD thesis, School of Social Sciences, University of New South Wales.
- Islam, M. (2013), 'The Toxic Politics of Bangladesh: A Bipolar Competitive Neopatrimonial State?' *Asian Journal of Political Science*, Vol. 21, No. 2, 148-168. DOI: 10.1080/02185377.2013.823799I
- Migdal, J. S. (1988), *Strong Societies and Weak States*, Princeton, New Jersey: Princeton University Press.
- Migdal, J. S. (1994), 'The state in society: an approach to struggles for domination', in J. S. Migdal, A. Kohli, and V. Shue (eds.), *State Power and Social Forces: Domination and Transformation in the Third World*, New York: Cambridge University Press.
- Mohsin, A. (1997), *The Politics of Nationalism: The Case of the Chittagong Hill Tracts, Bangladesh*, Dhaka: University Press Limited.
- Mohsin, A. (2003), 'Women, Peace and Justice: A Chronology of Denial', *Journal of Social Studies*, Vol. 100, June, 58-71, Dhaka.
- Partha, R.S. (2016) "Discursive formation of Peace Practice: Chittagong Hill Tracts Peace Accord and Village Society of Bangladesh". *International Journal of SouthasianStudies*, Monohar.
- PCJSS, 2005- 2010, Report on Present Status of Implementation of the Chittagong Hill Tracts Accord and Overall Situation in the Chittagong Hill Tracts, The PCJSS, Chittagong Hill Tracts, Bangladesh.
- Reuschmeyer, D. and Evans, P. B. (1985), 'The State and Economic Transformation: Toward an Analysis of the Conditions Underlying Effective Intervention', in P. B. Evans, D. Reuschmeyer, and T. Skocpol (eds.), *Bringing the State Back*, Cambridge: Cambridge University Press.
- Sobhan, R. (2000), 'Governance and development in South Asia', in P. Panandiker (ed.), *Problems of Governance in South Asia*, Dhaka: University Press Limited.
- Weber, M. (1978), *Economics and Society: An Outline of Interpretive Sociology*, vol. II, Berkeley, CA: University of California Press.

A Review of the Development of Online Environmental Impact Assessment Process in Bangladesh

Md Mossabber Hossain*

Abstract: Bangladesh is a low-lying riverine country, particularly vulnerable to environmental change. Since independence in 1971, environmental suitability is a primary concern for any developmental initiatives in Bangladesh, and it is also prominent in the global push for sustainable development goals nowadays. Environmental impact assessment (EIA) has a crucial role in achieving this goal. Although evidence from Bangladesh shows, it is a complicated system, a rigorous administrative procedure of submission and approval of necessary environmental documents are in place for having an environment clearance certificate, which was failing to deliver quality services on time. However, The Department of Environment (DOE), Bangladesh initiated Digital services in 2013 at pilot basis to make it more public-friendly and hassle-free. This paper critically evaluates the impact of the new Digital EIA system based on the institutional structures supporting it, case studies of EIA in practice, and compared it with the old manual EIA system. An established set of evaluation criteria has been applied to evaluate the process and make a few recommendations for improvement.

Introduction

Environmental impact assessment (EIA), is a planning and management tool for sustainable development that seeks to identify the type, magnitude and probability of social and ecological changes likely to occur as direct or indirect result of a project or policy and to design the possible mitigation procedure (Vanclay and Bronstein, 1995; Harvey, 1998; Thomas, 1998; Momtaz, 2002). It emphasizes that all public and private enterprises should consider the environmental consequences of their actions. By the 1990s, this practice gain popularity within the developing countries in Asia emerged at the forefront of EIA practice in the developing world (Gilpin, 1995; Momtaz, 2002). For Bangladesh, EIA has been practiced since the late 1980s. Still, it is through the enactment of the Environment Conservation Act, 1995 and the Environment Conservation Rules, 1997 EIA gained formal status in the country. For EIA to be effective, a sound legal basis and established institutional framework are required for EIA review and approval, Bangladesh has a systematic mechanism in place for examining the environmental consequences of development initiatives. But evidence suggests that EIA has not yet evolved satisfactorily in Bangladesh in several aspects (Kabir and Momtaz, 2013; Momtaz, 2002). It is widely speculated that in Bangladesh EIA still had many complexities due to the rigorous administrative procedure of submission and approval of necessary environmental documents are in place and only remains as an instrument for project approval and not a tool that can promote the environmental sustainability of the project. This failure could put the potentials of meeting primary sustainable development goals (SDGs 9 and 13) at risk. It was because of this realization that the Department of Environment (DOE), Bangladesh conceived a pilot project 'Web-based one-click service

* Assistant Professor, Department of Anthropology, Jahangirnagar University

for application and Environmental Clearance Certificates(online ECC)' for digitalization of the process and applied for a funding support from the access to information (a2i) program, Prime Minister Office, Bangladesh. Under service innovation fund (SIF), DOE was successful in getting financial support to set-up local area network (LAN) in five regional (divisional) offices of DOE, and to develop and maintain software that enables end-users to apply for and get online ECC. The project started on a pilot basis in October 2013 and completed in June 2015. Software development and LAN establishment were completed in five divisions – Chittagong, Sylhet, Khulna, Rajshahi (in Bogra district under the division), and Barisal. The automation process, thus developed by DOE, allows the applicants to get ECC by making registration and submitting application and relevant documents online to make it more user-friendly and hassle-free.

After completion of the project, the writer (Md. Mossabber Hossain), conducted an impact assessment study under the Memorandum of understanding (MoU) between the Anthropology department, Jahangirnagar University, and a2i program. The objective of this assessment is to assess the success and credibility of the project as well as to identify the challenges that it faces. This assessment also has an aim to find out the areas and ways in which the service delivery might be improved. The study is basically based on the experiences of relevant stakeholders that include beneficiaries, environment experts, DOE officials, and project focal persons. The study carefully taken these comments and observations into consideration and verified the situation on the ground. It also has examined project significance and future relevance as it has analyzed the opinions of both service providers and beneficiaries extensively. This paper shows the evolution and present status of EIA in Bangladesh based on the study report identifies the constraints and includes some specific recommendations that can make the whole process more suitable and sustainable in the future.

Methodology

A qualitative-quantitative mixed methodology was used to evaluate the impact of the online ECC project. The study site was Narajanganj District; because of time and resource constraints, the study was restricted to one project location of Bangladesh- a renowned industrial zone, and convenient to commute for the researchers. The study is basically based on the experiences of relevant stakeholders that include beneficiaries, environment experts, DOE officials, and project focal persons. The techniques of data collection included a questionnaire survey, focus group discussions (FGD), in-depth interviews (IDI), and visits to the industries. A2i helped to choose these industries. They provided a full list of ECC clients in the district that contained ECC applicants belonging to categories. The assessment team randomly selected 20 Industries, five from each ECC category (Green, Orange-A, Orange-D, and Red). In each industry, the samples were selected independently, including 40 questionnaire-based interviews from industries and seven from the DOE officials, thus making up a total of 47 interviews. A total of 2 FGDs was conducted with trade union leaders and local journalists.

The research team consists of four Anthropologists who have outstanding expertise in project evaluation, along with the writer, Professor Mohammad Nasir Uddin, Fazal Haque, and Mustafa Babu worked in the evaluation team. The interviews and discussions

were conducted in the local language, audio-recorded, transcribed, and translated by a professional translator. Field notes provide additional detail.

The author analyzed the data thematically, reading the entire transcript along with field notes to identify and juxtapose salient themes in their narrative contexts. The field research team reviewed the findings and discussed them with the author.

Environmental impact assessment and International contexts

The term “environmental impact assessment” can refer to any actions that aim to evaluate the effects of development on the environment and human beings. EIA is normally applied to large development projects, which may have significant environmental impacts; it can be used for any other project if it is considered likely to have significant environmental consequences. The objective of EIA is to help tackle environmental problems before they occur (Jalava, 2014). It is also suggested that EIA should be a tool used not just to avoid problems but also to promote more sustainable forms of development (Jalava, 2014). In any case, the primary purpose of EIA is to consider the probable environmental consequences of planned actions in advance. Globally, EIA regulations are typically procedural (Sadler, 1996; Wood, 2003; Pölönen, 2007). EIA consists of steps and tasks that are considered to be useful in achieving EIA's abovementioned purpose, i.e., to ensure the appropriateness and environmental feasibility of a planned project. Each national EIA system is specifically suited to its context (Sadler 1996, Wood 2003). Despite the variation among systems, it can be argued that the principles and procedural needs regarding assessments are usually quite similar (Wathern 1988, Wood 2003, Glasson et al. 2012).

In Bangladesh, the main environmental initiatives were the enactment of the Water Pollution Control Act 1973, and the Environmental Pollution Control Ordinance 1977 (Ahamed, 2004). The United Nations World Commission on Environment and Development (UNWCED, 1987) and its Brundtland Report, had a strong influence in shaping the development and environmental activities in Bangladesh (GOB, 1991, page 112). In the late 1980s, the Government started to attach increased importance to environmental issues. Creation of a separate ministry, the Ministry of Environment and Forest (MOEF), in 1989 and the restructuring and expansion of the Department of Environment are major Government initiatives (Ahamed, 2004). It issued environment clearance certificate after assessing the potential environmental impact. The mechanism of the certificate issuance has been introduced in compliance with the Environment Conservation Act, 1995, and Environment Conservation Rules 1997 (ESR, 1997). The process is as follow-

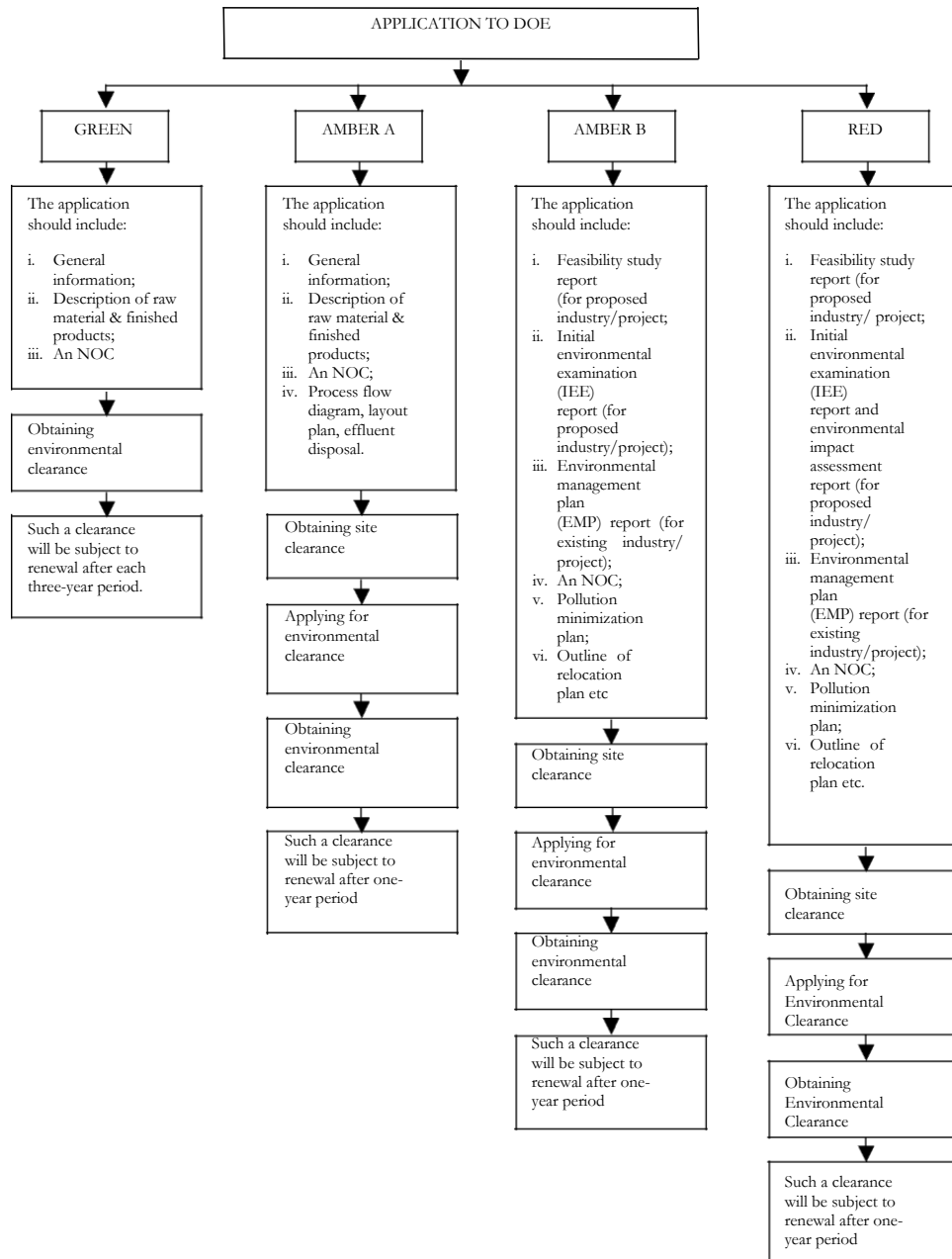


Figure 1. Steps involved in the environmental clearance in Bangladesh

Source: DOE (1997, page 7)

Fig. 1 shows the various phases in environmental clearance; this certificate is provided to the new industries or projects after assessing the project area and pollutants to be emitted or discharged by the enterprises or plans to be set up. For highly polluting industries,

environmental clearance is given after making sure that necessary measures have been put in place to combat the pollution potential. Rule 7 of ECR 1997 classifies industrial units and projects into four categories depending on environmental impact and location for issuance of ECC. These categories are Green, Amber A, Amber B, and Red. All existing industrial units and projects, as well as proposed industrial units and projects that are considered to be low polluting, are categorized under "Green" and are accordingly granted Environment Clearance. For proposed industrial units and projects falling in the categories Amber-A, Amber- B and Red, firstly, they will be given a site clearance certificate, and after that, an Environmental clearance certificate will be issued. A detailed description of those four Categories of industries is provided in Schedule-1 of ECR'97. Apart from meeting the general requirements, for every Red category proposed industrial unit or project, the application must be accompanied by a feasibility report on Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) based on approved TOR by DOE, Environmental Management Plan (EMP), etc. The ECR of 1997 also contains the procedures as to how to obtain Environmental Clearance Certificates (ECC) from the Department of Environment for different types of proposed units or projects.

Any person or organization wishing to establish an industrial unit or project must obtain ECC from the Director-General. Such certificates remain valid for three years for the green category and one year for other groups. There is a compulsory requirement that the document should be renewed at least thirty days before the expiry of its validity. The manual system takes a lot of time to process and issue Environmental Clearance Certificates (ECC). Prompt information distribution in times of need is also not possible. In this context, the online initiative taken under SIF of a2i was expected to make DOE's website into a dynamic website that would become a data center along with having a system to enable anyone to apply online from anywhere for ECC, check their status through SMS and email, and get online feedback on queries. Within this digitalization process, the certificates are generated digitally, and they are distributed online.

Governance of the online ECC activity and its impact

The findings of this study show that beneficiaries appreciate the right sides of the online application system. Informants were candid in their opinion that the overall application process is quite easy, and that they did not face any problems while applying. Required documents may vary for different categories of certificates. The authority provides information about the current status of the application from time to time through text messages and emails. There also is a system for responding to the queries. Besides, a client can also get information through an online account in which he already signed up. So, it makes the process more comfortable than before, and it ensures greater transparency than the previous system. DOE provides two categories of certificates for Industrial operation. These are:

- I. Site clearance certificate
- II. Environmental clearance certificate

Time requirement varies depending on which group of the industry is making the application.

However, in practice, this timeframe is not maintained. According to the respondents' view, the actual time required is far longer than what is officially indicated. With regards to 'site clearance certificate,' 25 respondents said they were yet to get the certificate although they apply 15 -20 days earlier. They hoped that they would get it within one month. Ten of the respondents have obtained their certificates within 3-4 months after they had applied.

Now, if it takes around four months to have an ECC, then it is difficult to say that the system is efficient or as less time-consuming as it was expected to be

Therefore, more focused efforts would be needed to curtail the steps of the application process so that an applicant can quickly get ECC.

Since one of the objectives of this automation system is to ensure hassle-free services to be provided by DOE, it is vital to reduce the number of steps involved in delivering the certificate.

Concerning this, Saiful Islam, one of the informants, said that the inadequacy of the number of DOE staff involved in processing the applications makes the process more time consuming than expected. However, they recognize that the current online system is still far more accelerated than the previous manual system. It has reduced the time of application and reduced the time of getting a certificate except for the fact that the onsite practical inspection issue still makes the process complex. It needs additional time that contributes to the process of becoming lengthy. If DOE had recruited the required number of officials to carry on these duties, the purpose of the project would be more effectively fulfilled.

This new system is far better than the previous one. For the site clearance certificate, many of the respondents said that they had to wait more than 90 days under the previous system. They had to collect and submit hard copies of all the necessary documents; one would require more than four visits to DOE offices to fill up an application form. Certificates were issued from the head office, and the applicants had to collect it from the local office of DOE. It was a very lengthy process that involved protracted stages of information checking and validation work as it was outlined in the procedures of ECC application.

The main reason for the lengthy processing time of the ECC application was the inadequacy of DoE officials engaged in the job. Additionally, online sampling made the ECC process lengthy.

While talking about this comparison between past and present systems, an informant, who is an AGM of an apparel factory, said this: "Getting certificate timely was a tough job within a manual system. In many cases, we would get it in hand only after the expiry

of the renewal period. One had to have a good connection in the DOE head office to get an ECC in time."

In the current system, a beneficiary can apply online and can also upload necessary documents. DOE officials from any office can inspect this application through the one-click method. However, there are still some manual activities that one has to carry out as part of the ECC application. A client has to submit one set of necessary documents and forms as a printed copy. Such submission of hard copy contributes to ease the workload of DOE officials; however, it acts as a burden to the applicant. Moreover, many of the applicants still need to seek 'technical assistance' from others while finishing the application. The finding of the survey also is in line with this qualitative finding. 85.11% of the respondents think that the application process is not manageable without expert help.

Kazi Sazedur Rahman, Chairman of KPC Industry, while talking to this team, said that DOE should take initiatives to make the process fully online-based. He said, "After submission of the application online, it is unnecessary to submit a hardcopy. If we are allowed to upload all the documents, then the DOE officials can check them online. They can then issue the certificate and send it to the email of the institution or industry. If such simplification is ensured, then, he says, it will be more user-friendly and hassle-free. Apart from this shortcoming, the project has been running smoothly.

The survey showed that 85.11% of the respondents confirmed that the overall outcome of the

project was satisfactory; 87.23% pointed out that DOE staffs were capable of handling with queries from the clients; 55.32% thinks that ECC is now readily available and accessible. 65.96% of the respondents are of the view that the process is clear enough to work with; 74.47% marked that the overall level of corruption has reduced. 61.6% and 70.21% of respondents respectively confirmed that the application process and certificate getting process had become less time-consuming.

Respondents are of the view that the project has been playing a valuable role in having a positive impact on the proper administration of ECC. 82.98% of the respondents confirmed the belief that this project has made the overall ECC process easier.

Respondents view about new ECC application process

The benefit of having a service center not far away

The members of this assessment team have worked to select respondents from industries that are situated in different Upazillas of Narayangonj district: Narayangonj Sadar, Araihaazar, Sonargaon, Bondor, Rupgonj. Respondents indicated the advantages that they were getting from the new digital system compared to the previous manual system. One thing they highlighted is that whereas in the past, they needed to apply to the zonal office at Dhaka, now they can get things done at the district DOE office at Narayangonj Sadar. This is being possible, particularly for the fact that a district office has to be set up here.

The Challenges of handling computer and internet

The digital system makes the process easier; now, the entrepreneurs can submit their applications from anywhere. However, they said that they faced some problems too. A few of the entrepreneurs have encountered issues in filling up the form, and as they applied for the certificate online. They had to seek 'expert help' relating to this task. In most of the cases, they went to the local Union Parisad (UP) digital center. Some entrepreneurs also went to the district DOE office to fill up the application, which is situated 30-35 kilometers away from their home. Awareness, training, and proper technical support is still needed to make sure that citizens can submit the online application properly, and they are not scared of using computer and internet. If this 'uneasiness' as regards technology use persists, it will be difficult to the proper value of digitalization. Still, the new online system is more user-friendly than the previous manual one.

The study findings show that the view of 95.74% of the respondents is that only 1-2 visits are required to get ECC in the current digitized system, whereas in the manual mode, they would require a higher number of visits. 93.62% of the respondents stated that they would need more than two trips to get the desired service as a manual system involved more complex work. This comparison shows it clearly that the digitized system is more user-friendly than the manual mode.

DOE's capacity to handle error

The study found entrepreneurs' opinions in terms of mistakes for getting ECC. It is seen that the digital process is more error-free. The applicant got proper information and technical assistance from DOE designated experts, most of the beneficiaries fill up the application with the help of district DOE staffs, and the teams are cordial for providing this service. 97.87% of respondents confirm the current digital process is errorless.

If an error occurred, they got technical support. One beneficiary faced server problems during the application process; he had to spend a day on that. After that, the respected officer corrected it by resubmitting the application. Big industries hired an expert for handling environmental issues (applying for ECC, water report, ETP report, etc.). They are capable enough to fill up the application and manage other procedures by their own afford. In contrast, the Manual system is an error full, but at that time, they can correct it also manually by their hand. Now they had to seek expert support for that reason.

Anxiety regarding delayed service delivery

It is revealed in this study that this online procedure is user-friendly but creates stress. DOE still delayed ECC delivery from their expected time. The survey result exhibits their anxiety level. 53% of the respondents feel somewhat anxious that the ECC would not be delivered within the stipulated time, whereas for 14%, the level of anxiety is considerably high.

Online ECC is more user-friendly than the manual system

This is an overwhelming view that the digital system is more satisfactory contrary to the manual mode. According to 31.91% of respondents, they find the system very satisfying,

whereas 48.94 find it 'somewhat satisfactory'. On the other hand, 44.68% of respondents found the manual system 'somewhat dissatisfactory,' and 17% found that the system very dissatisfied.

The general view of the respondents is that the current digitalized process is more effective in terms of saving time and ensuring transparency. After signing up with the DOE website, they get the short message (SMS) and email notification, this means that they can be assured of their application status, and this ensures less bureaucratic hassle. The beneficiaries also think this: whereas the online system is friendlier for the well-established industries, it is a bit difficult for small and informal sectors.

In terms of DOE officials' support and cooperation, the view of the respondents is: officials are generally supportive and friendly. They give support in this current system – they were almost similarly supportive in the case of the previous manual system.

The above discussion shows the project has been running quite effectively. The major shortcoming is the lack of technical knowledge and experts, which can be solved with awareness-building activities. Many respondents expressed this opinion that the inclusion of other institutions is necessary for making the process digital. A large number of beneficiaries think that if all the interconnected institutions transform their service systems from manual to online, ECC automation will be much more convenient.

Conclusions and Recommendations

Annandale (2001) suggested that a set of 'core' criteria should be met for EIA effectiveness which are: Dedicated legal and administrative system, scoping guidelines, transparent government decision-making and approval process. Bangladesh is on track in its effort to develop environmental guidelines based on this- online ECC process exhibit it clearly. DOE has the potential to establish and strengthen the system for guiding the nation towards environmental sustainability. The precise finding of our evaluation shows the implementation process of online ECC project going very well, and it has already proved its effectiveness in providing services in a more user-friendly and time-saving way. Through a survey, field visit, and interviews, we get this clear impression that the automation of ECC application submission has made the process more comfortable than before. One of the significant achievements of this digitalization initiative is that it maintains more transparency than the previous manual system. A client can get a certificate once the investigation of data and document is carried out by the field inspector of DOE. DOE, with support from A2i, launched this online application procedure for the first time in 2015. As a pilot project, the system was successful; this present study has been conducted to assess the impact of this project.

Previous records and this study findings show that beneficiaries are fully appreciative of what this online application system means for them. This online system has reduced the time of getting the certificate. It also has reduced the frequency of visits to the DOE office. Usually, it is supposed to take one week for the Green category, 15 days for Orange category, one month or above for the Red category – however, in reality, a far longer time is still needed for the processing of an ECC.

The developed automation process allows one to get an environmental clearance certificate by making registration and applying online. S/He has to fill-up specific information and upload some required documents. Required documents may vary for different categories of certificates. The authority provides information about the current status of the application from time to time through SMS and email. There is an opportunity to give a reply through email if the client has any queries. The applicant can also get information through an online account in which he already signed up. So it makes the process more comfortable than before, and it maintains more transparency than the previous system.

The introduction of this current system indeed saves time; however, official procedures and necessary official works remain the same as before. It only saves communication time (for example, sending a letter, etc.). Moreover, the certificate is not yet delivered in any digitalized form; therefore, it has to be collected from the office (The authority told us that there is no adequate funding to do so).

An applicant needs internet and scanned documents, so the cost of application is not high. An applicant has to come only to get a certificate, so the number of visits has decreased. On the whole, it appears that the developed automation process is almost user-friendly. The authority already received more than 1200 applications online. An applicant has to visit once to get a certificate, so the number of visits decreased. There is a toll-free number at DOE to get information without any cost.

However, the system needs further improvement to ensure fuller digitalization. Although the application submission process has been automated, the other process remains manual. A requirement of Field inspection makes the process lengthy. The integrated procedure can be introduced to carry out onsite inspection and generate a report. Other internal office procedures can also be automated so that applicants can get ECC in a more hassle-free way. The significant weaknesses relate to the lack of DOE Staffs, inadequacy of resources; failure to make the EC findings a key aspect of future environmental decision-making; and failure to make a country level industrial mapping. To strengthen the current ECC system in the country, therefore, investment in training and continuing professional development in ECC for different stakeholders is needed. The most urgent priority is the establishment of a fully automated ECC process. DOE aims to improve the quality of their service and make an online database. They agree that as a new service, the system has got some critical challenges. DOE officials say that they are working to overcome these challenges. The DOE can take the initiative to make the process friendlier by taking further funding support from A2i or other sources. In this way, the automation will become more sustainable.

Specific Recommendations are listed below:

1. Implement a fully functioning online procedure for ECC:

The DOE should consider making the whole process digital and online-based to reduce hassles and sufferings of beneficiaries. This is a potential threat to making the system sustainable. □

2. Need workforce and sufficiently skilled technical experts:

A shortage of technical experts (service provider, onsite field inspector) was noticed during the assessment period. It is essential to have enough skilled human resources, to implement this system on a large scale.

3. Reducing time between ECC application and Delivery:

Most of the cases, the client gets ECC after 4-6 months of application submission, which is a reasonably long time. This process needs to be reduced with greater efficiency. Otherwise, the objectives of the automation process will not be achieved.

4. Establishing an online monitoring and complain response system:

The proper monitoring system is essential for large scale implementation of the system.

There needs to have a team that will provide periodic reports to the Ministry of Environment and Forest and DOE. The project team also take the initiative to encourage stakeholders to use toll-free cell number and leave their opinion on different aspects of the one-click system.

5. Improving awareness about the new system:

The initiative needed for proper orientation and integration of different dimensions of environmental awareness issues among various stakeholders. To raise awareness about this new system for ECC, the DOE should take necessary steps like advertised at the TV, radio, and local cable TV, as well as organized several social programs to inform the client about how to complete the entire procedure and its benefits and social impact respectively.

6. Make it more inclusive:

Need Proper orientation and integration of different related institutions in this process. To ensure the validity of necessary information- the establishment of an online data checking system is essential. For this, other institutions like the Ministry of ICT and Ministry of Information, Ministry of Public Administration, Bangladesh Computer Council (BCC), and any other relevant institutions should be integrated.

Finally, it should be noted that the task of improving the online ECC process after in Bangladesh will require significant effort due to the population density, unplanned development pressures and environmental vulnerability of the country. However, for these reasons EIA should be well placed, and a coordinated effort between all agencies involved would assist the country in moving toward a sustainable development.

References

- Access to Information (2017). Retrieved from
http://a2i.pmo.gov.bd/sites/default/files/resource_docs/a2i%20Evaluation%20Report.pdf
(Accessed 18th December 2017)
- Ahammed, R., & Harvey, N. (2004). Evaluation of environmental impact assessment procedures and practice in Bangladesh. *Impact Assessment and Project Appraisal*, 22(1), 63-78.

- Annandale, D. (2001). Developing-country EIA: Developing and evaluating environmental impact assessment systems for small developing countries, *Impact Assessment and Project Appraisal*, 19(3):187-193
- DOE, (1997). EIA Guideline for Industries, Department of Environment, Ministry of Environment and Forest, Govt. of the People's Republic of Bangladesh.
- ECA, (1995). The Bangladesh Environment Conservation Act 1995, (Act no. 1 of 1995) Department of Environment, Ministry of Environment and Forest, Govt. of the People's Republic of Bangladesh.
- ECR, (1997). The Environment Conservation Rules 1997, Department of Environment, Ministry of Environment and Forest, Govt. of the People's Republic of Bangladesh.
- Jalava, K., Pasanen, S., Saalasti, M., & Kuitunen, M. (2010). Quality of Environmental Impact Assessment: Finnish EISs and the opinions of EIA professionals. *Impact Assessment and Project Appraisal*, 28(1), 15-27.
- Kabir, S.M.Z., and Momtaz, S. (2013). Fifteen years of the environmental impact assessment system in Bangladesh: current practice, challenges and future directions, *Journal of Environmental Assessment Policy and Management*, 15(4):1-30. □
- Momtaz, S. (2002). Environmental impact assessment in Bangladesh: a critical review, *Environmental Impact Assessment Review*, 22:163-179.
- Sadler, B. (1996). *International Study of the Effectiveness of Environmental Assessment. Environmental Assessment in a Changing World: Evaluating Practice to Improve Performance.* National government publication, Canada.
- Service Innovation Fund (2017). retrieved from <http://a2i.pmo.gov.bd/service-innovation-fund-sif> (Accessed 18th December 2017)
- Wood, C 2003. *Environmental Impact Assessment. A Comparative Review*, 2nd edition. Essex: Pearson Education Ltd.

Regional Conflicts and Conventional security in South Asia: Is Human Security Overlooked?

Kamrul Hasan*

Abstract: South Asia is the most complex, volatile and divided – socially and politically – region in the world. It is a region which has witnessed five full-scale inter-state conflicts, where adversaries are nuclear-armed and no country has been free from insurgencies and separatist movements. Although, direct conflict or potential of direct faceoff lies only between India and Pakistan, other South Asian nations are suffering from internal strife such as separatism, extremism and ethnic tensions. With the accession of BJP as central authority in India, high potential of ethnic and communal violence has been risen which will eventually spillover national borders. The study attempts to examine the costs of regional conflicts and conventional security spending in terms of human security. Upon evaluating conflicts – national and transnational - it finds that due to the high scale of multifaceted conflict, the region is suffering from severe human security crisis. Strife – prevailing and probable - largely drives the attention of South Asian Governments in maintaining conventional security bypassing human security agenda which results in food insecurity, illiteracy, internal displacement, loss of lives and poor health.

Introduction

When it comes to security, South Asian governments take a traditional view – focusing on securing national boundaries and amassing military power. South Asia is one of the most conflict prone areas in the world. While conflicts in Afghanistan and Pakistan have attracted global attention, parts of India, Sri Lanka, and Nepal have also experienced long-running conflict. Although after kargil war of 1999 there has been no direct warfare in the region, the tension among the states are prevailing in the region in general and between India and Pakistan in particular. The rivals are about to another round of war when India invaded to Jammu & Kashmir scraping article 370 (a) in the constitution on August 5, 2019. Civil wars and ethnic conflicts – Tamil conflict of Sri Lanka, CHT conflict of Bangladesh, Northeastern secessionist violent movements and religious extremism of BJP centering cow politics in India, separatist movements of Baluchistan and religious extremism in Pakistan – are constant in South Asia. Ethnic cleansing of Rohingya minority by Myanmar government adds more pressure to the old and ongoing tensions in the area. National Register for Citizen (NRC) issue of Assam, in India which excluded over 1.9 million people claiming them as intruders from Bangladesh after 25 March, 1971 – a communal trump card of fundamentalist BJP aimed at winning elections – threatens the security of South Asia. NRC between India and Bangladesh, Rohingya involving Myanmar and Bangladesh and Kashmir crisis connecting India and Pakistan directly are the most pressing interstate face-off. Clearly, the region is likely to wage lots of interstate and intra-state clashes. The region currently spends roughly \$ 30.9 billion a year on the military competition (Berry & Desai, 2009). The big two players of the region

* Assistant Professor, Department of Government and Politics, Jahangirnagar University, E-mail: k.hasan@juniv.edu

fought four wars – first Kashmir war of 1947, 1965 war, 1971 war over the then East Pakistan and Kargil war of 1999. It has also experienced another warfare in 1962 between India and China – an extra regional but highly involved actor and one of the major rivals of India in the region. India's military spending rose in 2018 for the fifth consecutive year, and was 3.1 per cent higher than in 2017. At \$66.5 billion, India's spending was 29 per cent higher than in 2009. Increases in Indian military expenditure are largely motivated by tensions and rivalry with Pakistan and China. Spending 2.4 % of GDP (2018) it has been one of the five biggest military payers in the world (World Bank, 2019). On the other hand, Pakistan's military spending in 2018 was \$11.4 billion, making it the 20th-largest spender globally. Pakistan's military spending has increased every year since 2009. It rose by 73 per cent between 2009 and 2018 and by 11 per cent between 2017 and 2018. Pakistan's military burden in 2018 was 4.0 per cent of GDP—the highest level since 2004 (Sipri, 2019).

The result of these conflicts and military expenditure are human misery, destruction of infrastructure and social cohesion, and death. The knock-on effects of these confrontations are huge: illiteracy, underdevelopment, human insecurity, food crisis, poor healthcare, malnutrition and extreme poverty etc. As the supply of resources is limited while demand is paramount, the excessive disbursement for conventional security items – buying arms, ammunition, employing more and more security personnel and maintain nuclear weapons – is definitely shrinks the allocation of budget for human development. While elites in the corridors of power celebrate missile tests and military hardware purchases, little or no attention seems to be given to human development. The social, political and economic development of South Asia has been seriously hindered by interstate and intra-state conflicts. The aim of this paper, however, is to measure the impacts of conflicts – interstate and intra-state – on human security. It does so with reference to the most populous region of the world, namely South Asia.

In this study, the content analysis of credible secondary sources have been used. The content analysis—a robust examination of relevant materials—includes credible journal articles, books, newspaper articles, and Internet documents. Content analysis is significant because there is an enormous body of literature dealing with conflict, politics, and human security in South Asia. To thoroughly understand the subject matters, it needs to make a robust historical survey of this literature.

The paper is organized into five sections. Following this brief introduction, the paper in the second section highlights the typology of conflicts with a flexible definition. Section three provides an overview of the current status of conflicts both interstate and intra-state in the region, and attempts to identify broad patterns and themes that might provide insight into prospects for conflict management. The impact of conflicts upon human security has been discussed in the section four while the final section summarizes the arguments and presents concluding remarks.

Conflicts in South Asia: Search for definition and taxonomy

A conflict can be said a clash of interest among groups of people. It refers to a serious disagreement or argument, typically a protracted one. It might happen between

individuals, groups of individuals, organizations or states. Conflict is constant in the human society although genesis of conflict may be diversified. It can be racial, political, ethnic, and economic and so forth. It as an activity which takes place when conscious beings (individuals or groups) wish to carry out mutually inconsistent acts concerning their wants, needs or obligations (Nicholson, 1992). Conflict is a collision of opposing interest. Collision may be mild or exceedingly violent in nature. Conflict occurs when the interests of one party come by accident or design into engagement with those of others. The collision can be tangible or intangible, direct or indirect (Cooper, 2003).

Conflict can be internal or external. Internal conflict may arise within a country between two or more ethnic or religious groups such as Tamil conflict in Sri Lanka, Maoist insurgency in Nepal and separatist movement in Northeast in India. There are two types of internal conflict. The first is conflict against the state or civil war, for instance, terrorism which is an extreme manifestation of conflict and reflects a certain degree of organization of conflict. It is carried out by a relatively organized group of non-state actors, and directed against the state. The second category includes people-to-people conflict, or ethnic conflict. Example of such type includes localized land conflicts, religious and ethnic riots, homicides or other crimes (Ghani & Iyer, 2010). Exterior war are those that engage two states in combat, say, India-Pakistan war of 1965. When in clash individuals or groups try to damage the opponent's strength, position and power.

Conflict in South Asia varies by nature and forms. They can be broadly categorized as intra-state and inter-state. Muni (2003) classified conflicts in following fashion: first, those enforced and rocketed by the global political, strategic and developmental dynamics, including the role of great powers. External actors are involved in this type of clash. For instance, battle spawned in or between the South Asian states as a consequence of the United States' post 9/11 intervention in Afghanistan to wage a "global war on terrorism", and the Soviet military intervention in Afghanistan in 1979-80 and the US-led resistance to this intervention during 1980-89 falls under this category. 1962 war of China and India can be considered as this type. Second kind of conflict is inter-state engagements, say for example, India-Pakistan conflicts or India-Sri Lanka strife. Inter-state conflicts in South Asia have been triggered by territorial disputes, disagreements on access to or sharing of resources of the region like water, energy, fisheries as also by disputes and disagreements on issues related to trade, transit and investments, migration of people across the borders etc. Third category of conflict is intra-state conflict that include the insurgencies and ethnic/sectarian conflicts, say, Tamil insurgency in Sri Lanka and Tribal Movements in Northeast India. The fourth category of conflicts is related to the operations of non-state actors or terrorist group which come under attention recently such as Al Qaeda or ISIS attacks. These conflicts never remained confined to a single category rather they can overlap when in real manifestations, therefore, sometimes categories of conflict might be inextricable and interlocked. Thus, new kind of strife is likely to engender out of erstwhile clash. A global trending is noticeable that the interstate conflicts is gradually replacing by intra-state conflicts (Large & Timothy, 2006).

Through this brief discussion it has been clear that conflict, in South Asia, can be, largely, categorized in two types. One is intra-state conflicts and other is inter-state conflict. Intra-

state conflicts are these conflicts which occurs within the state. Whereas Inter-State conflicts are those conflicts which occurs between the two or more than two states. Intra-state conflicts are the main reasons behind the Inter-state Conflicts. In this study, categories of conflict are flexibly used. It includes interstate, intra-state, ethnic, religious and people to people strife.

Dynamics of intra and inter-state conflicts in South Asia

Causes of conflict in South Asia are multiple and compound. Conflict traces its root to the history, geography, and cross cultural landscape. South Asia is a region of tremendous political complexities. The politics of the area is shaped by narrow consideration of religion, caste, ethnicity, language, community, and the like. Arms race between two nuclear powers makes the atmosphere more perilous and conflict prone. It spawns a sense of insecurity and anxiety amongst the small states like Nepal, Bhutan, Bangladesh and Maldives. Border disputes, ethnic conflicts, communal politics seriously disturbs India. India has border disputes along with Pakistan, China, and Bangladesh. Border killing between in India and Bangladesh borderland is contentious issue between the two nations. Religious extremism in Bangladesh, India and Pakistan also threatens the security of the region. For example, Nepal has been enlisted in a failed state due to decade long Maoist insurgency. Successive governments have failed in the efforts to establish and regulate everyday governance and regular life. Ordinary lives have been collapsed for years due to the severe political violence among leftist and centrist political parties. Political and constitutional institutions proved dysfunctional. Human rights situation went deteriorated. Additionally, religious violence has appeared as serious threat to civilian security in India. BJP's cow vigilantes in India have killed at least 44 people from 2014 to till now (Marlow, 2019). Mob lynching has emerged as dominant civil unrest. Separatist movements in Assam, Mizoram and in Kashmir are also pressing threat to South Asian security.

Sri Lanka have been in civil war for decades. Although, the LTTE has been defeated in 2009 by Sri Lankan military, the probability of the revival of conflict is still alive unless the normalcy returns in the life of ordinary people. Thousands of Tamil people are imprisoned and tortured in detention camp, movements of civilian people are restricted, normal life is disrupted, fear feeling is haunting them as large number of security personnel are present in Jaffna. Before, final defeat of LTTE, Sri Lankan government had to wage prolonged expensive civil strife. Due to the civil war the successive governments have been characterized by military preponderance, this is why democracy has been undermined in the country. Being civil war in prime concern, the successive governments are greatly failed to address the human development in conflict prone area. The conflict was mainly between majoritarian Buddhist Sinhala and predominantly Hindu Tamil. In government, Sinhala people are powerful, decision maker, and ultimate driver of the executive. As a result they formulated discriminatory laws and regulations undermining civil and citizen's rights of Tamil people.

Pakistan is crisscrossed by sectarian, ethnic and religious fundamentalism. Conflict between muhajeers who migrated from India during partition and local Sindhis in Sind province is one of the remarkable turmoil in Pakistan. Separatist movements in

Baluchistan is also hampering the stability and peace in Pakistan. The following section will discuss inter-state conflict first, and then internal conflict.

Inter-state conflicts

The inter-state contentious issues in South Asia are of a varied and diverse nature. They can be categorized into following manner: India factor, conflict arising from legacy of partition, religious fanaticism and escalating arms race etc.

Big India factor and Small neighbors' apprehension

The "India factor" has persuasively shaped the regional interaction among South Asian states. The small states, except Pakistan, are accusing India's "big brother attitude" to other neighbors. Being geographically positioned in center and having large territory India has taken role as big fish of South Asia. In multinational forum like, SAARC, India is not interested to solve the lingered issues in multilateral fashion, rather it shows interest in bi-lateral approach. Because it is easier for India to take the small states under control in bi-lateral platform. That results in apprehension of interference of India in domestic matter of small states which ultimately stains the sovereign status of these nations. Weaker neighbor like, Bangladesh, Maldives, Nepal, Sri Lanka and Bhutan are, by and large, keener in multilateral way of determining regional issues avoiding unilateral or bi-lateral style. This big brother attitude gravely affects bilateral and multilateral relationship between Indian and her neighbors. Although governments of smaller neighbors, say, Bangladesh government, are enthusiastic to keep relationship with the party in power in India, the mass people of those country are remarkably anti-Indian.

With India, every South Asian country has conflict over bilateral issues. Between India and Sri Lanka major conflicting issue is Sri Lankan Tamil and LTTE. During the 1970s, India's external intelligence agency, the Research and Analysis Wing (RAW), helped to train and arm the LTTE, but after the group's terrorist activities grew in the 1980s--including its alliances with separatist groups in the southern Indian state of Tamil Nadu--RAW withdrew this support.

Conflict originates from legacy of partition

In South Asia, one of the biggest case of interstate conflicts is India Pakistan strife which is largely emanates from partition of India in 1947. Partition does not only divided the territory into two parts but also immediately left a great number of people stateless. The stateless people migrated, sometimes forcibly, from India to Pakistan and vice versa. It was the greatest political and international migration of the twenty first century. Some seven million people migrated to Pakistan and around five and a half million Hindus and Sikhs crossed the new international boundary in the opposite direction. In Bengal, despite government efforts to assure minority populations, waves of migration continued throughout the opening decades of Independence whenever there were outbreaks of violence or rumors of communal conflict. The number of casualties has been estimated around 200,000 by a colonial official, Pendrel Moon, while Muhajir Qaumi Mahaz (MQM) claimed that it was roughly two million. Upwards of 100,000 women were

kidnapped on both sides of the border (Talbot, 2010). Bengal and Punjab were the main epicenter of migration but casualties happened in all other parts of undivided India. This massive scale dislocation and migration inevitably influenced political developments within India and Pakistan as well as affecting deeply their relations. This trauma of partition imprinted a long lasting hostility among the neighbors. Resentment transmit from intergovernmental to mass people. The partition also left questions of bureaucracy, property, security personnel and borders. Among the disputes, border has been one of the most contentious issues. International border along India-Pakistan and India-Bangladesh causes conflict and claims lives. Bangladesh and India border bring the infamy of the most dangerous border in the world leaving 1144 killed, 1078 injured, 1367 abducted, 111 missing and 15 raped in last eighteen years (Odhikar, 2018).

Another notorious legacy of partition is Kashmir issue over which India and Pakistan fought three wars namely: First Kashmir war 1947-48, war of 1965 and Kargil war 1999. Of late, again, Kashmir issue has become the headlines in the world media and provokes the dormant clash among the antagonistic neighbors when fundamentalist BJP government scrapped the 370 article of constitution on August 09, 2019. The antagonism continues and both the neighbors are about to a war. Kashmir conflict arises the resentment among the mass people of Bangladesh as the majority people of Kashmir are Muslims they show their solidarity to Kashmiri people. Many sections of the people under the name of different banners and platforms, for example, leftist student in Dhaka University, some Islamic organization, brought protest program and condemned BJP's decision. People show their favor for Kashmiri Muslims and simultaneously denounce BJP government in the social media. Being the situation went gradually chaotic, Bangladesh government warned stern action against those who tried to unrest and provoke the people. This might have turned communal riots between Hindu and Muslims in the country as the BJP's communal behavior aggravated Muslim sentiment in Bangladesh. Once communal antipathy ensues in Bangladesh it remains strong probability to spillover the neighboring India affecting minority Muslims which might ultimately turn into interstate conflict.

India-Pakistan Conflict

India-Pakistan and conflicts were born together. By birth they are enemy to each other. Even, conflict originates long before birth of these two nation states. Two major ethnic groups, Hindu and Muslim, in undivided India, have had many fights in terms of deadly communal riots. Thus, it become clear to the then political leaders from both community that Muslim and Hindus are not fit to live in a single state. In 1947, partitioning Indian Territory tow states have come into being as India, a Hindu majority country, and Pakistan, a Muslim majority state. Merely over Kashmir, Delhi and Islamabad waged four wars. Soon after the partition the neighbors fought first war to keep control on Kashmir.

First Kashmir War, started in October 1947 when Pakistan comprehend that the Maharaja Hari Singh of the princely state of Jammu and Kashmir would join Indian dominion. The state had a majority Muslim population and significant fraction of Hindu population. Tribal Islamic forces with support from the Pakistan Army attacked and occupied parts of

the princely state. Being a Hindu by religion Maharaja was inclined to accede India. To receive support from the Indian army Maharaja had signed the Instrument of Accession and joined Indian republic. Following the accession of the state to India on October 26, 1947, Indian troops airlifted to Srinagar, the state capital. Later in 1948, they relented and the Pakistani armies entered the war after this. The fronts solidified gradually along what came to be known as the Line of Control. A formal cease-fire was declared on 31 December, 1948 and became effective on the night of 1 January 1949.

The nations again involved in a war in 1965 on the same issue - Kashmir. The war started following Pakistan's Operation Gibraltar, which was designed to infiltrate forces into Jammu and Kashmir to precipitate an insurgency against India. Indian army retaliated by launching a full-scale military attack on the then West Pakistan. The seventeen-day war caused thousands of casualties on both sides and witnessed the largest engagement of armored vehicles and the largest tank battle since World War II (Higgins, 2016; Rawat, 2015). The hostilities between the two countries ended after a ceasefire was declared following diplomatic intervention by the Soviet Union and USA and the subsequent issuance of the Tashkent Declaration (Lyon, 2008). India had the upper hand over Pakistan when the ceasefire was declared.

Third Indo-Pakistan war was in 1971 which was unique in that sense that it did not involve Kashmir. Bangladesh, the erstwhile East Pakistan has been the epicenter of this war. This was a kind of spillover conflict between the neighbors. The source of conflict was originated in East Pakistan while central leader of Pakistan launched a full fledged military strike on Dhaka denying transfer of power to Sheikh Mujibur Rahman and Awami League – the party won a decisive victory in the historic 1970 general election. Following the “operation searchlight”, a military crackdown on Dhaka by Pakistan army on 25 March, 1971, 10 million people mainly Hindu community crossed the border and took refuge in neighboring India (Jaffrelot, 2004). Immediately after the refugees took shelter in India Border States, West Bengal, Assam and Tripura, the Indian army invaded in East Pakistan on December 3, 1971. Hostile relations in the past between India and Pakistan added to India's decision to intervene in Pakistan's civil war. Two adversaries fought for 13 days leaving Indian force as conclusively victor in the war on 16 December, 1971.

Kashmir became the birthplace of 4th India and Pakistan war in 1999 which was commonly known as Kargil war. During early 1999, Pakistani troops infiltrated across the Line of Control (LoC) and occupied Indian territory mostly in the Kargil district. India responded by launching a major military strike to drive out the Pakistani infiltrators (Wolpert, 2010). The conflict last for two months and India had slowly retaken most of the occupied areas that were trespassed by the Pakistani army. An estimation says that nearly 80 % of the encroached land was taken back under Indian control (Dettman, 2001). Apprehending a massive destructive armed conflict, the outer world, led by the USA pressurized Pakistan to withdraw forces from battle field. Pakistan initially did not acknowledge many of its casualties, but Nawaz Sharif later said that over 4,000 Pakistani troops were killed in the operation and that Pakistan had lost the conflict (Kapur, 2007). By the end of July 1999, organized hostilities in the Kargil district had ceased. The war was a major military defeat for the Pakistani Army (Dettman, 2001).

Apart from the aforementioned wars, there have been skirmishes between the two nations from time to time. Some have bordered on all-out war, while others were limited in scope. Some of the conflicts are namely: Siachen conflict, Sir Creek disputes, India–Pakistan maritime trespassing, and Insurgency in Baluchistan (Lyon, 2008). Recently, tension grows as India grabs Jammu and Kashmir abrogating the article 370 (a) of constitution. Pakistan retaliates to India's activity and warns the worst for India. Perhaps, another round of all-out war is likely to happen.

India-Bangladesh contentions

Historically Bangladesh has a closer relation with India which have been cemented in 1971 during the liberation war. India has contributed to the liberation of Bangladesh defeating Pakistani occupational force and drawing external support for newly liberated nation. This relation goes, usually, exclusively warmer when Awami League (AL) – the party which led the liberation war – is in the office. Even though government to government relations is special and deeper, a strong anti-Indian sentiment among the mass people of Bangladesh remarkably is evident which sometimes determines and shapes the nature of relations. This is because of India's hegemonic presence and influence in country's politics, economy and administration – civil and military. Consequently, despite having good relation between the nations, there are some issues of contentions.

Major conflict or confrontation happens in border area. Bangladesh India border has been cited as one of the most dangerous border line in the world. Now and often, Bangladeshi civilian are shot to death by Indian Border Security Force (BSF). This is not happened in accident, rather it is the policy of BSF. Surprisingly, Bangladesh government has taken the issue as fair, the authority thought that it is not unfair when a smuggler or an illegal cow trader is shot to death (Adams, 211). However, civilian killing in border by BSF ignited the people's psyche in Bangladesh and eventually made them anti-Indian. During last two decades, 1144 civilians were shot to death by BSF (Odhikar, 2018). One example of excruciating inhumane border killing is Felani murder – an adolescent Bangladeshi girl who was shot dead by BSF on January 7, 2011 while crossing the Indo-Bangla border into Bangladesh. After shooting she was hung upside-down on the barbed wire fence along border. This tragic incident has triggered the outcry in the international media and been denounced by rights body.

Fresh conflict is provoked by Assam government's National Register for Citizen (NRC) project which expels 1.9 million Bengalese – roughly 1.2 Hindu and .6 million Muslim – from the list citing them as invader or intruder from Bangladesh after 1971 (BBC, 2019). Identifying as "foreigner" Assam is building detention camp to confine them. Apprehension and resentment are getting stronger in both sides of border. There is strong a trepidation among Bangladeshi people that India want to change the demographic character of Bangladesh through which it will control politics, economy and administration in future. Delhi will probably push back NRC excluded Hindu community to Bangladesh to increase the percentage of Hindu in Bangladeshi demography.

Although Awami League government is historically pro-Indian, recently, more specifically after 2018 election, the party is inclining to pro-Chinese policy to draw development fund from China. It is noteworthy that although Bangladesh India relations is in the highest level, but being the third ultra-poor countries in the world Delhi convincingly unable to disburse fund for Bangladesh Mega projects. Rather China is capable and fervent to supply fund for projects. Already, China has financed in five big projects: the Padma Bridge rail link, Karnaphuli river tunnel, phase III of the Info-Sarkar project, installation of a single-point mooring with double pipeline in Maheshkhali and modernization of telecommunication network for digital connectivity. Beijing is supposed to disburse \$20 billion to 27 projects which have been agreed during the President Xi Jinping's Dhaka visit in October, 2016 (Chakma, 2019). BJP government already declared that they will initiate NRC project in other states and west Bengal would be second state after Assam. In his speech, President Ram Nath Kovind said, "my Government has decided to implement the process of 'National Register of Citizens' on priority basis in areas affected by infiltration" (Livemint, 2019). When the project be completed a large number of Indian citizen would be stateless. They might be pushed neighboring Bangladesh to bridge the gulf of difference between Muslim and Hindu community. It will, then, be easier for Delhi to keep control on Bangladesh. This might have a substantial link to India's *Akhand Bharat* (Undivided India) plan and policy of expansionism. Currently, in Bangladesh Hindus are approximately 10% of the total population (BBS Census, 2011). However, percentage in the government job of Hindu community is more or less 25% (The News.com, 2017).

Apprehension among majority Muslim grows further when Priya Shaha – organizational secretary of Hindu Buddha Cristian Oikya Parishad – complained against Bangladeshi Muslims to US president Donald Trump in Washington DC, on July 16, 2019. She said that 37 million minority people – Hindus, Buddhists, and Christians – have been disappeared from the country. In the meantime Govinda Chandra Paramanik, Secretary General of Bangladesh Jatiya Hindu Mohajote, and Rana Dasgupta – Secretary General of Hindu Buddha Christian Oikya Parishad urged Delhi to push back Hindu community who are excluded from NRC to Bangladesh (Bangladesh Pratidin, 2019). It is emphatically professed that communal riots or even civil war is likely to happen If India tries to push back NRC excluded Hindu community to Bangladesh.

Another major area of contention is water sharing of common rivers – mainly Ganges and Tista river water. Conflict for water between the nations is prolonged one. From Bangladesh part it is complained that India does not give the due share to Bangladesh although a treaty has been signed in 1996 for sharing water fairly that results in the decrease of navigability and drying out of Padma. Bangladesh is urging a treaty for sharing water of Tista River while Delhi expresses its inability to sign a treaty as West Bengal forcibly denied.

India-Nepal Disagreements

It is widely understood in India and Nepal that the two countries are more than just neighbors; the relationship is "special." One aspect of this is that the Indian establishment has always viewed Nepal as being within India's larger security envelope in relation to

China. Some observers see Nepal as not landlocked but “India-landlocked.” Unsurprisingly, then, India has always held sway over Nepal, but what is noteworthy is that India’s influence in Nepali politics has intensified over the past few decades, especially after the advent of multi-party democracy in 1990, when Nepal’s monarchy ceded power to party leaders. Indeed, Nepal’s relationship with India is strongly tinged by the British colonial era, although Nepal never became a formal colony (Ojha, 2015). But relations in the post-1990 era have shown a consistent trend of increasing and mostly unwarranted Indian interference in Nepal’s affairs. However, there are some disagreements or conflicting issues between the neighbors. With India, Nepal has multiple conflicts or differences. One of the major disputes is border row. Two border areas in particular a chord in Nepal: Kalapani and Susta, which lie on the western and eastern border of Nepal, respectively. Kalapani, which is where India, China, and Nepal meet, has a strategic military position and has been held by India’s Indo-Tibetan border security forces since the 1962 war with China. The Mahakali River defines the border in Kalapani, but India and Nepal each claim the river originates in different places, thus the conflict. In eastern Susta, the Narayani river forms the Indian-Nepali border. But several large floods have re-shaped the river, causing a 14,500 hectare Indian encroachment into Nepal (Groves, S. 2014). Here, again, Nepalese are sensitive to the perceived threat to their sovereignty. Land disputes among locals are usually won by Indian nationals who have the support for the armed Indian Border Police Force.

India and Nepal share 1,758 km long border includes the Himalayan territories as well as Indo-Gangetic Plain. Unlike other borders of India with neighbors, it is an open border which is governed by Indo-Nepal treaty of 1950 and it provides free movement of citizens of both the countries across the border. This open border has been used for supply of goods and items imported from India in Nepal which provides comfort and hardship for both the neighbor. Being a small state and heavily dependent on India for imports, Nepal, sometimes, has been victim of India’s ill diplomacy to keep influence alive which brings both the nations in the brink of contention and conflict. For example, unofficial economic blockade 2015 of India using open border on Nepal which leads to serious humanitarian crisis. Although India denied any official blockade, the tiny nation accused India of unofficial blockade inciting Madeshi people who are culturally, ethnically and linguistically closer to the people of India’s border states Uttarpradesh, Bihar and Uttarkhand. Claiming that they are marginalized in Nepal’s new constitution Madeshi people demanded proportional representation in the constitution and re-demarcation of provinces: revision of the state boundaries in such a way that Tharu community in southwestern Nepal and Madhesi in the south east of the country get separate provinces. Demanding constitutional revision, although it has been passed by 90% majority in constituent assembly, Madeshi launched a *bandh* (a general strike) and halted the traffics – which carry import goods mainly petroleum, vegetables, medicine and relief good for earthquake – in open border area. India has pressurized the Nepali authority to meet the demand of ethnic people constitutionally. Therefore, India is accused of backing the ethnic group’ months long protest. This deadlocked leads to a strife in the relationship of the neighbors.

The differences between Delhi and Kathmandu grew more noticeable when Kathmandu began to act on its own. After the constituent assembly election in 2008, when India's direct political engagement in Nepal became unnecessary, the perception emerged among the Nepalese that India was bullying Nepal in order to secure its own interests over hydropower energy, development projects, business, and trade. India continued to tell Nepal what it should and should not do. This led to a cooling of relations between the Indian establishment and Nepali leaders. Tensions then ratcheted up in June, when Nepal's leaders, challenged by the devastating earthquake, decided to expedite the process of promulgating the new constitution, after five years of delay (Ojha, 2015). This was a collective decision by Nepal's major parties, although it was not free from contention within Nepal.

Sino-Indo Rivalry and External linkage of Conflicts in South Asia

The involvement of three super powers, namely China, USA and Russia, in South Asia has become crucial to the conflicts related to terrorism, Kashmir and maritime disputes. The super powers particularly the USA and China have geostrategic and economic interest in South Asia. South Asia is home to 1.6 billion people—or 27% of the global population. Such a concentration of population will always be important, whatever its circumstances. It means a giant consumer market and at the same time a cheap labor reservoir for industrialized nations for instances China, The USA etc. It is a gateway to Bay of Bengal and Indian Ocean which is the largest route of oil supply from Persian Gulf to Southeast Asian nations more specifically energy thirst super power China. India and China rivalry has been overtly manifested first in 1962 when two adversaries have fought an all-out war over land along boundary. The cause of the war was a dispute over the sovereignty of the widely separated Aksai Chin and Arunachal Pradesh border regions. Aksai Chin, claimed by India belong to Kashmir and by China to be part of Xinjiang, contains an important road link that connects the Chinese regions of Tibet and Xinjiang (Gurung, 2018). China's construction of this road was one of the triggers of the conflict. Both country come to conflict again in 1987 for Sumdorong Chu Valley.

Apart from these timeworn military warfare between the neighbors, the military standoff and skirmish are evident. To increase influence and to halt India's supremacy on Indian Ocean Beijing ties South Asian nations in its belt and road initiative which is an ambitious strategic and political program in disguise of economic development and achievement. Using this program, Asian super power already has knotted the tie with Pakistan, Bangladesh and Sri Lanka through huge development projects. For example, China have built Hambantota sea port in Sri Lanka, Gwadar deep sea port in Pakistan under CPEC. These developments projects in South Asia lie in China's 'String of Pearls Policy' – a policy which extend from the Chinese mainland to Port Sudan in the Horn of Africa. China has a historic friendship with Pakistan from late sixty while the then Pakistani President Ayub Khan shifted its foreign policy from the USA to China. Since then relationship went dipper and stronger among the neighbors. Recently, after the 2018 general election in Bangladesh, Awami League (AL) government – convicted for its excessive pro-Indian character – government have approached towards China. In the current cabinet, pro-Indian politicians have been excluded to make China happy. Awami

League government have done it because it needs huge credit for development politics. After the mostly end of war crime trial which was Awami League's one of the major political agendas in 2008 general election, it moved to 'development politics' – more development less democracy or alternatively development first democracy later – for what AL government requires huge soft loan. Accordingly duo have signed 27 development projects during Chinese President Xi Jinping's Dhaka visit in 2016 which needs \$ 21.5 soft loan to implement the projects (Byron, 2019). In the meantime, Bangladesh has bought two submarines from China in 2016 which cost \$203m (Dhaka Tribune, 2016). Unsurprisingly, Dhaka's growing economic and military ties with Beijing pushed Delhi in new dimension of anxiety. Expectedly, India gets angry over the developments and starts retaliation fashioning trouble along border killing. To contain the Chinese influence on Dhaka, Delhi have set new trap for its historic friend: National Citizen Register (NRC) in state of Assam through which 1.9 million people, roughly 1.1 million Hindu and .8 million Muslim and others, have been excommunicated stating them as 'foreigner' (Banglanews24.com, 2019). Now, India is likely to pressurize Bangladesh to take back its people or as can be assumed that detained peoples will be, unofficially, pushed back in Bangladesh. China and India's geopolitical "tug of war" for Bangladesh might escalate further tension and even humanitarian crisis in South Asia.

To deter the Chinese mastery in South Asia USA and India become strategic partner. Before India Pakistan war of 1965 the USA was the main strategic partner of Pakistan. During this war Ayub Khan's administration sought help from China which annoyed Washington. After the dismemberment of Pakistan in 1971 Washington's illusions on Pakistan continued to wane and it tagged India as its new partner in South Asia. Since then, on the one hand, USA's reliance on Islamabad have been fading, relationship between USA and India have been warmer, on the other hand. USA wants to counter balance Beijing's hegemony over South Asia and Asia Pacific through strengthening India's military capacity. Delhi and Washington, in the meantime, have signed several civil and strategic treaties which rocket the tautness further. For example, India and USA have signed nuclear treaty for peaceful use of nuclear energy. However, the observers viewed these treaties as more strategic than civil one.

India USA partnership have been more marked during so called "war on terror". To combat militancy in Afghanistan, although, USA used Pakistan the relationship between countries have been continued to diminish more and more. On the other hand, relationship between India and USA have been deeper. For example, from 2006/7 political turmoil to present day political developments in Bangladesh, India have been playing unilaterally. It is widely perceived that USA has transferred its power of attorney to India as key decider on Bangladesh in particular and South Asian issues in general. Having license from USA as key player, India is unilaterally shaping Dhaka's polity especially politics and economy. 2014 general election – a poll without voter and opponent candidates where 153 seats were declared uncontested because of the boycott of polls by major oppositions party led by BNP – and 2018 general elections which is widely perceived that approximately half of the vote have been cast at night of polling day, for instances, India alone backed up Awami League to form government and to continue.

Russia's engagement in South Asia is not as overt as that of USA and China. However, it maintains smooth relations with India since long ago. Russia becomes the friend of Bangladesh since her birth in 1971 as it was one of the major players in the global arena for liberating Bangladesh. However, the footprint of Russia does not heighten skirmish in South Asia except intervention in Afghanistan during late eighties.

Escalating arms race in South Asia

Since its disintegration in 1947 and the following tensions were escalating over a disputed territory in Jammu and Kashmir, India and Pakistan conflict has never been resolved until today. In terms of military capability, both countries have developed their capacities to contest other states at the demise of Soviet Union in 1991. Recent studies found evidence that India and Pakistan are actually increasing the trend of developing Weapon of Mass Destruction (WMD) particularly nuclear weapons (Sudirman, 2010). India first successfully tested nuclear bomb on May 18, 1974. The code name for the bomb was Smiling Buddha which was detonated on the army base Pokhran Test Range (PTR), in Rajasthan, by the Indian Army under the supervision of several key Indian generals¹. Officially, test has been named after the place 'Pokhran' where it has been exploded. Although, officially, the Indian Ministry of External Affairs claimed that this test as a "peaceful nuclear explosion", it is widely perceived that the program has been aimed at military purpose not for civilian one. The country has gone for second time nuclear bomb test in 1998. Presently, India has 140 nuclear warheads (AAC, 2019). Total military personnel is 3462500, active force 1362500, reserved force 2100000, total aircraft strength 2082, combat tanks 4184, submarine 16. Spending 2.4% of GDP the nation of India is ranked 4th out of 137 country in 2018. India's military spending rose in 2018 for the fifth consecutive year, and was 3.1 per cent higher than in 2017. At \$66.5 billion, India's spending was 29 per cent higher than in 2009. Despite this rise, India's military burden in 2018 was at one of its lowest levels since the early 1960s: 2.4 per cent of GDP compared with 2.9 per cent in 2009 (SIPRI, 2019). Increases in Indian military expenditure are largely motivated by tensions and rivalry with Pakistan and China. Neighboring two nuclear power – China and Pakistan – India waged a total of five wars four with Pakistan and one with China.

Pakistan has been one of the nine nuclear powers in the world having 160 warheads and has longer-range nuclear weapons, such as the Shaheen 3 missile that can reach India's Andaman Islands near Southeast Asia (AAC, 2019). The nation has been under military rule for a long period of time, therefore, despite partaking some democratic regimes still now military has considerable influence on politics and economy. Thus, whatever the government, be it military or democratic, armed force has been the key decision maker both in domestic and international affairs. When armed force is the driver of a nation its prime job is to bring the military interest forefront in policy making process. The country has ranked 15th out 137 countries with 1204000 total military personnel, 654000 active force and 550000 reserved force. It has a total of 1342 aircraft, 2200 combat tanks and 5 submarines. Pakistan has spent 4.0% of GDP which equals \$ 11.4 billion in 2018.

¹ <http://nuclearweaponarchive.org/India/IndiaSmiling.html>

Pakistan have fought four fight with India which have resulted in security threat in the region. Arms race has been intensified in South Asia as both country amassing arms and increasing military strength. It seems a legacy of the Cold War still competing in India and Pakistan relations and it could be considered as a flashpoint in South Asia's security aspect to stabilize the adverse region (Sudirman, 2010). As a result, international community (particularly the US) fears that if the escalation of hostility is getting worse then the nuclear war would be imminent due to the distribution of nuclear powers in Asia.

Conflict arises from religious fanaticism

It is claimed that India is "the largest secular democracy" in the world (BBC, 2019; Economic Times, 2019). However, recently, India's secular entity – for which many Indians be proud once – is awfully smashed by Hindu extremist politics. Mob lynching by "cow vigilant" are commonplace in present India in which minority Muslims are mostly affected. For example, Pehlu Khan's murder in the broad day light undermines loudly the so called Indian "secular" identity. Hindu religious militancy is not new in India. It traces back to the rise of Hindutva in early twentieth century. The term "Hindutva" is coined first by Vinayak Damodar Savarkar in his book *Hindutva* published in 1923. It is championed by the Hindu nationalist volunteer organization Rashtriya Swayamsevak Sangh (RSS), Vishva Hindu Parishad (VHP), Shiv Sena, Hindu Mahashova, and Hindu Sena. The Hindutva movement has been described as "almost fascist in the classical sense", adhering to a disputed concept of homogenised majority and cultural hegemony (Patnaik, 1993). Decade before, Hindu Mahashova – a right wing Hindu nationalist political party – was founded (1915) by Madan Mohan Malaviya in the reaction of British Indian government's decision of separate Muslim electorate under the Morley-Minto reforms of 1909 (Bapu, 2013). This Hindutva politics leads to a large number of notorious communal riots which claims Innumerable lives both from Hindu and Muslim community. Religious violence in India has been predominantly marked as Hindu-Muslim conflicts because the riots has been recurrent between the two major ethnic groups. As the Muslims are minority in India, large part of responsibility for clash shoulders to Majoritarian Hindu. Notorious pogroms are Ranchi-Hatia riots (1967), Gujarat riots (1969, 1985 and 2002), Mumbai violence (1992/3), Nellie massacre (1983), Bhagalpur violence (1989), Muzaffarnagar riots (2013) and Kaliachak riots (2016). These massacres and exterminations stridently voices about Hindu religious fanaticism against minority Muslims in India.

Fright covers the mind of Muslim minority again in 2014 with the rise of BJP as central government in India. Hindu extremist groups – Bajrang Dal, RSS, Shiv Sena etc. – established reign of terror across thorough India. The "Cow Vigilant" launched attacks across the country that have targeted Muslim and Dalit communities. The frequency and severity of cow vigilante violence has been described as "unprecedented" (Sarkar & Sarkar, 2016). International Rights body has reported that there has been a surge in cow vigilante violence since 2015 (HRW, 2017). The surge is attributed to the recent rise in Hindu nationalism in India. Many vigilante groups say they feel "empowered" by the victory of the Hindu nationalist BJP in the 2014 election (Marlow & Pradhan, 2017). Cow protection vigilante groups were estimated to have sprung up in "hundreds, perhaps

thousands" of towns and villages in northern India (Jha, 2016). There were an estimated 200 such groups in Delhi – National Capital Region alone. Some of the larger groups claim up to 5,000 members (Safi, 2016). A great number of violence have occurred since 2014. As of 2019 44 people killed by radical cow protectors since Modi assumed power in 2014. Most surprising about the mob lynching of Muslim minority is that perpetrators get shelter from police and BJP government, and culture of impunity is terribly growing. For example, all 6 out of 9 accused of Pehlu Khan lynching case are acquitted by a local court in Rajasthan on August 14, 2019. Pathetically, cows are protecting in the cost of human lives.

At the forefront of hundreds of cow vigilante outfits active across India is the The Bhartiya Gau Raksha Dal (BGRD), "a non-profit, tax-exempt organization" that was set up in 2012 and registered as a company by the Union Ministry of Corporate Affairs. Although there are no organizational links between the BGRD and the Sangh Parivar, many activists are members of Parivar constituencies such as the VHP and the Bajrang Dal or in close touch with them. They are fierce supporters of Hindutva. According to Pawan Pandit, the BGRD's chairman, India is divided in two, one part that includes "the so-called *kattar* [Hindi for radical] Hindutva people" like himself and the other comprising people who don't share this ideology (Ramachandran, 2017). India's communal harmony and secular entity has been acutely damaged by Bajrang Dal (BD), the young militant wing of Vishva Hindu Parishad (VHP). It is a member of the RSS family of organizations (Jaffrelet, 2010). The ideology of the organization is based on Hindutva or Hindu nationalism (Deshpande, 2008). Founded on 1 October 1984 in Uttar Pradesh, it has since spread throughout India, although its most significant base remains the northern and central portions of the country. The group runs about 2,500 akhadas, similar to the shakhas (branches) of the Rashtriya Swayamsevak Sangh.

Undertakings of these communal bodies disrupt the shared harmony, on the one hand, instigate militancy among minority people, on the other hand. Clearly, attacks on Muslim minority in India by Hindu Militant groups, say VHP or BD, become the source of antipathy among Muslims in the neighboring Bangladesh, Pakistan and Maldives which might result interstate and spillover conflict.

Intra State Conflict: Human costs and escalating cycles of conflict

There is not a single country in the region today, except perhaps for Maldives that is unaffected by national strife and violence. Nor are there any signs of abatement in the number of casualties. Furthermore, recurring cycles of violence erode the political legitimacy of political leaders and national as well as local governments (Dahal et. al. 2003). Every single state is suffering from either of the strife be it ethnic clash, insurgency or political conflicts.

Looking across the countries of South Asia, we see somewhat different trends. In India, we see a steady rise in conflict incidents after 2001, with a dramatic increase after 2004 (Iyer, 2009). This is mainly due to an increase in incidents of left-wing extremism, concentrated in central India, and an increase in terrorist incidents in India's cities. Regarding the other South Asian countries, an increase in conflict incidents is apparent

for Afghanistan, Pakistan and Nepal after 2001. While the conflicts in the first two countries are linked to each other and to the U.S. military action in Afghanistan, the violence in Nepal developed in an entirely separate fashion. A “People’s War” was initiated by Maoist rebels in 1996, which escalated strongly in 2002 after the deployment of the Royal Nepal Army.

Violence in Sri Lanka remained low till 2004, due to a cease-fire negotiated between the government and the Liberation Tigers of Tamil Eelam (LTTE), the major rebel group in the country. The conflict intensified after the government began a military campaign against the rebels in 2006. Bangladesh witnessed a sharp rise in terrorist incidents in 2005, but a decline in later years following strong government action. The sources of conflict in each country are discussed in detail below.

Afghanistan

Afghanistan is one of the most violent places not only in South Asia but also in the world since 2001. The life in Afghanistan has been shaped by marked violence, ethnic conflict and terrorist attacks. Conflict has been a feature of life in Afghanistan since the Soviet Union invaded the country in 1979 in an attempt to help the Communist movement in Afghanistan. In a decade long fighting the Soviet army have been defeated by *Mujahideen* – which have been heavily financed and armed by the USA, China Pakistan and Saudi Arabia jointly to deter Soviet influence in the region – and withdrawn in 1989 (BBC, 2019) which militarized the polity leaving country with huge arms and ammunition for future conflict. Later, for another decade Afghanistan have been beset with conflict of ethnic militias leading to the rise of Taliban (Students), a group of young fighters belonging to the Pashtun ethnic group and espousing hardline version of Islam, in 1997. On September 11, 2001, al-Qaeda allegedly launched a terrorist attack against the USA leaving 2977 people killed (Moghadam, 2008).

Accusing the group of providing sanctuary and support for al-Qaeda and its leader Osama Bin Laden, the USA and NATO jointly propelled military operation in Afghanistan on 7 October 2001. Since then Afghanistan has been a home of deadliest violence, suicide attack, bombing, gun fight between Taliban and US military. Ordinary life has been completely collapsed for almost two decades. Although number of casualties since the begging of war is practically unlikely to track, however, it has been traced that an average of 74 men, women and children were killed every day in Afghanistan (BBC, 2019). This prolonged war leads Afghanistan to the index of failed states ranking it 9th out of 178 countries in the world. Perceiving the consequence of a protracted gory war, both rivals were likely to reach a peace deal in September, 2019. Regrettably, Trump has dismissed the probability of peace accord in the lieu of a fresh attacks, just before few days of agreement, on Afghanistan by Taliban. Despite the initial failure of the dialogues the adversaries are attempting another round talks to reach a settlement. However, the battle continues and uncertainty in life is mounting.

Bangladesh

Bangladesh has been dreadfully shaken by unprecedented political turmoil. Political conflict or scuffle for power is marked the history of the country since the inception (1971) of its journey as sovereign state. First regime of the country, which was led by founding leader of the nation - Sheikh Mujibur Rahman – is torn down by vehement political crusade conducted by erstwhile major opposition, Jatiya Samajtantrik Dal (JSD). The battle was so fervent that the sovereign entity of the state was about to disappear. Government retaliated to opposition's struggle with harsh measures. It is extensively perceived that 40,000 opposition's activists including civilians were killed by Rakshi Bahini – a para military security force from 1972 to 1975 (Uddin, 2018). In 1975, founder president was killed along with his family members that followed a political tranquility up to mid-eighties. From mid-eighties to late eighties or early nineties, the country experienced another round of intense political clash between military dictator H.M. Ershad regime and mass people that led to the fall of Ershad. After 1990 mass upsurge, bi-party system has been established and two rivals – Bangladesh Nationalist Party (BNP) and Bangladesh Awami League (BAL) – fiercely competed for leading Bangladesh to politically a stalemated country. During the 1990s movement Non Party Caretaker Government (NCTG) has been installed in the constitution through thirteenth amendment (1996) for smooth power transition. Despite the instatement of NCTG, both competitors while in power tried to use NCTG for retaining power and thus fighting continued. Struggle for power have been intensified more in 2006 which led country to a state of emergency in 2007. Then a military backed caretaker government has assumed power to hold a free, fair and credible election. Through the 9th parliamentary election (2008) Awami League has come to office and fighting stopped for short period of time.

Fresh violence again started with the abolishment of caretaker government by Grand Alliance government through 15th amendment in the constitution in 2011. Since then political violence continues to happen. It seems that this is an unending combat. In political violence 4929 people killed, 204069 injured from 2001 to 2018 while another account found a total of 4580 intra party clashes in Bangladesh (Odhikar, 2018).

India

There are four main sources of internal conflict in India: insurgency in Northeast, Communal and Caste conflict, left extremism and terrorist attacks. In the northeastern states, Indian nation and state building have been bitterly contested since Partition. After 50 years of independence, the region is still tormented by separatist insurrection, guerrilla warfare, and terrorism, with some of the movements having been campaigning for independence since before 1947. To contain insurgency India have initiated three dimensional approaches – constitutional, say providing special status or creating autonomous zone and district, political, declaring elections, rendering power to the insurgents, and military tactics (Brass, 2010). Although, the separatist movement have been subsided remarkably in the Northeast, insurgents are active in some of the states of seven sisters – namely Assam, Manipur, Tripura and Nagaland. Even few years back, Indian central authorities had to take it seriously. As of October, 2019 from 2000, the

number of militant incidents 6315 where 11689 lives have been lost including civilian (South Asian Terrorism Portal, 2019).

India is suffering from another trauma, although the country have achieved considerable success in combating insurgency, which can be categorized as caste and communal conflict and typically unending and deeply rooted in Indian society. There has been a creeping communalization in many state administrations, with the growing display of Hindu symbols and fraternization of state servants with members of Hindu nationalist organizations such as the RSS and VHP. School texts have been rewrite to accentuate the conflicting and anti-Muslim strands of Indian history rather than its more hopeful aspects, for example, more about Aurangzeb and temple destruction and much less about Akbar and other rulers who employed many non-Muslims in their administrations and endowed temples across the land. Communal conflict or violence, in post-Independence India, is the outcome of political decisions. Riots have been fomented and capitalized for political purposes, for example Gujarat riot of 2002 and Babri Masque demolition in 1992, from which state BJP has been benefited in the next election. Social and physical segregation are still realities in many places across India, with anti-Muslim prejudice and fears preventing many upwardly mobile members of the Muslim minority from obtaining housing outside of recognizable “ghetto” areas in the major cities (Wilkinson, 2010). Rise of BJP as a ruling party in 2014 election, communal violence in India is consistently happening. Hindu militant political parties like Bajrang Dal (BD), Bhartiya Gau Raksha Dal (GRD), Vishva Hindu Parishad (VHP) and other extremist organizations that were spawned by Rashtriya Swayamsevak Sangh (RSS) are hold responsible for commuting communal violence. People, mainly Muslim minority, are beaten to death by these groups simply in the name of protecting cows. It, therefore, can be ardently supposed that communal relation in India is not reached at satisfactory level yet.

Third source of internal violence in India comes from incidents perpetrated by leftwing extremist groups (“Naxalite” movements) in many states of India. It is one the biggest security challenges in India. Left-wing extremist movements are often called “Naxalite” movements as it is derived from the 1967 peasant uprising in West Bengal when peasants attacked the local landlords in the village of Naxalbari. Of late, left extremism has been in rise and increased from 165 district of 14 states in 2005 to 194 districts of 18 states in 2007. Bihar, Chhattisgarh, Jharkhand, Orissa and West Bengal, and the leading states of Andhra Pradesh and Maharashtra are mostly affected (Iyer, 2009). The leading extremist group is the Communist Party of India-Maoist (CPI-Maoist), formed by the merger of the People’s War Group with the Maoist Communist Center (MCC) in 2004. As of October, 2019, from 2000 some 10460 people were killed in Maoist insurgency (South Asian Terrorism Portal, 2019). The trends differ significantly across states: Andhra Pradesh and Bihar show a decline in Naxalite violence in 2006 and 2007, while such violence is on the rise in Chhattisgarh, Jharkhand and Orissa.

Apart from above mentioned violence India has been traumatized many times by some terrorist attacks mostly bomb blasts in major cities. Major targeted areas are Mumbai (1993, 2006, 2008 and 2011) and Pune of Maharashtra, Delhi (High Court Building 2011, Parliament 2001) and Uttar Pradesh (Varanasi 2010, Ayodhya 2005). Of them 1993 bomb

blast, seven train bombing 2006 and 2008 attacks were most terrible. Hundreds of people have been killed in the assaults along with state property and resources.

Nepal

Nepal has been in the throes of political crisis for more than a decade. During this period, this country not only experienced the gradual erosion of the state's capacity to deliver to its citizens, but also the rise of an insurgency, and the failure of constitutional political parties to offer a sustainable solution to the problems faced by the nation. The king's repeated attempts, including a violent and unpopular royal coup, to reestablish an absolute monarchy of a bygone era made the situation worse. These events in Nepal left more than twelve thousand dead, thousands injured, and two hundred thousand displaced (Riaz & Basu, 2010). Communist party of Nepal Maoist or CPN (M) which was led by Pushpa Kamal Dahal Prachanda is the forefront of the revolutionary gunfight. The party launched its armed struggle on February 13, 1996 across six district of western Nepal (Lawoti & Pahri, 2010). Initially, the Nepali government mobilized the Nepal Police to contain the insurgency. The Sher Bahadur Deuba's government and the Maoist insurgents reached in ceasefire On 25 July 2001 following a peace dialogue over two months. However, the ceasefire is broken as dialogue have been failed to bring forth a political solution. The failure of these peace talks resulted in the return to armed conflict, beginning with the Maoist attack on an army barracks in Dang District in western Nepal, on 22 November. The situation changed dramatically in 2002, as the number of attacks by both sides increased greatly, and the number of people died in civil war sharply increased (Lawoti & Pahri, 2010). This was followed by a harsh retaliation from the government with curbing of anti-monarchy elements including shutting down newspapers, imprisoning political activists and journalists. Rounds of negotiations, accompanied by temporary ceasefires, were held between the insurgents and the government. The government categorically rejected the insurgents' demand for the constituent assembly elections. The Maoists also refused to recognize the continued survival of constitutional monarchy. In November 2004, the Maoist have placed tow points demand, negotiate directly with King Gyanendra rather than via Prime Minister Deuba, and dialogue to be mediated by a third party such as the United Nations, which were declined the government. During this civil war the country was standstill due the blockade program initiated by Maoist. This impasse made the room for King Gyanendra to grab full control of Government on 1 February, 2005, claiming incapacity of democratic government. He proclaimed, "democracy and progress contradict one another... in pursuit of liberalism, we should never overlook an important aspect of our conduct, namely discipline" (Nepal Monarchy, 2005).

To deter the move, unexpected to all major political party, taken by King Seven Party Alliance (SPA) was formed on May 5, 2005. The Maoist rebels accompanied by alliance placed 12 points to resolve the political crisis describing "the all-powerful monarchy as the major predicament to democracy, peace, prosperity, social up-liftmen and an independent and sovereign Nepal" (Nepali Times, 2005). Civil war ended with a Comprehensive Peace Accord (CPA) which was signed on 21 November 2006 between the then government and Communist Party of Nepal. In the decade long civil war, the

human cost in terms of losses of life and humane suffering, has been myriad. In an official account the death toll is some 16,278 deaths (BBC, 2009). However, it should not be forgotten that governments, in South Asia, bearing a character of colonial legacy, generally attempts to hide the real number and incidents of casualties as regimes considered it threatening to its survival.

Pakistan

Since independence Pakistan has been suffering from internal conflict stemming from “ethno-nationalism” and sectarianism. The former characterized the dismemberment of the state in 1971 and has helped define competing nationalism in the truncated state ever since. The later encompasses conflict within Islam (Sunni-Shia conflict) and defining who Muslim (Muslim-Ahmadia conflict). Pakistan incorporates five major politically significant ethnic streams: Punjabi dominance, Sindhi regionalism, Muhajir Nationalism, Pakhtun Provincialism, and Baloch Marginalism (Oberst. et al. 2016).

Punjab dominance in central government and in national politics is really responsible for ethno-national conflict in Pakistan. Three specific reasons establish Punjabi dominance in Pakistani society which generates tension among other ethnic groups: Majority of the population, predominant presence of Punjabi in military and civil bureaucracy, wealthy and developed region. Taking advantages of these trio Punjabi people not only establish hegemony over other small minority ethnic group but also exploit resources. This domination dismembered the country into two sovereign nation in 1971. In the face of such facts, nationals of the smaller provinces perceive themselves as underrepresented or even dominated by the larger ethno-regional group.

Sindh has experienced an extensive influx of migrant people, first from India and, after partition, from the other provinces of Pakistan. These outsiders are not only culturally and linguistically different from sons of local Sindh, they are also better educated, wealthier, more competent. Affluent and competent refugees have been filling the higher positions in the government and non-government organizations of the province leaving little benefit for indigenous Sindhis. This creates feeling of deprivation and sandwiched among local peoples which lead to Sindhi-Muhajir conflicts in 1986. Even, once, they demanded Sindhudesh (Sindhi homeland). Non-muhajir Sindhi and Muhajir Qaumi Mahaz (MQM) – a political body of migrant people – got involved in violence that plagued urban Sindh during the 1990s. Ethnic violence reached in peak between 1994 and 1996, claiming over 5,000 lives (Oberst. et al. 2016).

The Soviet-Afghan war and its aftermath complicated issues connected with Pakhtun provincialism. It resulted in as many as 5 million refugees from neighboring Afghanistan – mostly Pashto speakers – who took shelter in Pakhtun province. Local Pashtuns and migrated Afghan refugees are culturally and linguistically close. Their ethnic identity is the same, Pashtun. The refugees in Khyber formed mujahedeen, a militant group, to resist the soviet invasion in Afghanistan. Due to the huge influx of refugees sectarian conflict between Shia and Sunnis are aggravated which woefully radicalized Pashtuns in the border regions. Events of 9/11 have further troubled the area. In the meantime Pakistan have joined so called Global War on Terror (GWT) and Help the USA ouster Taliban

regime in Afghanistan. Accusing that Afghan Taliban militant are hiding in and using the land of North West Frontier Province (NWFP) US allying with Pakistan government propelled military attacked in Federally Administered Tribal Area (FATA) and Provincially Administered Tribal Area (PATA). This bring Pakistan Armed Force and local insurgents and Mujahedins into direct fight in FATA and PATA area. Consequently, Pakistan military and government have been targeted by terrorist attacks in the settled areas of the state. Waziristan, Swat Valley and other regions of NWFP have been battlefield. Many civilians died and thousands of more become IDPs (internally displaced person). Nearly 2.3 million people rendered homeless because of the Pakistan Military action against insurgents in the Swat Valley and adjoining areas. The massive displacement of civilians in the Khyber Pakhtunkhwa was caused by “Operation Black Thunderstorm” on April 26, 2009 (Times of India, 2009). Fatalities in Pakistan, as of October 2018, stood at about 65,000 people, including 90 American contractors, nearly 9,000 local security personnel and more than 23,000 civilians. The rest of the casualties were anti-government fighters (VOA, 2018). Still now, suicidal bombing and terrorist attacks continue making Pakistan a failed state.

Addition to the battle championed by war on terror project, Baloch separatist movement supplements more complexity in the Pakistani polity. Baloch insurgency continues plaguing the provincial public life. Clashes in Baluchistan take place in two dimensions: Baloch and Pashtun fighting and violence between Baloch nationalist and Pakistan military force. Baloch have been fighting for separate state or for more autonomous status since late seventies. Exploitation of natural resource, for example oil and gas, with relatively little corresponding benefit to the local Baloch people, development activities such as building deep sea port in Gwadar by central government and harsh military persecution to quiet ensuing uprising spawn more fury among ethnic Baloch.

Sectarian differences within Islam, Shia-Sunni rift, have also profoundly contributed to the prevailing violence. Ongoing US-Afghanistan War has exacerbated sectarian conflict in the state. From beginning of the war through February 2013, there had been 1035 separate incidents of sectarian violence in which 33091 individual have been killed (Oberst. et al. 2016). Also, clashes between Ahmadi community and the political religious groups of ulema have been frequent. It has been said that the Ahmadi question will continue to haunt decision makers in Pakistan for the foreseeable future. Terrorism and the ‘war on terror’ have been costly for Pakistan – both in terms of human loss and economic costs. Since 2002, more than 50,000 people have died due to terrorism, and the economic cost is estimated to be around US\$120 billion (Peace Insight, 2019).

Sri Lanka

Sri Lanka, an island state in South Asia, gained independence from British rule in 1948 as the dominion of Ceylon, and became the Republic of Sri Lanka in 1972. However, much of its history has been marred by sectarian tensions and ethnic conflicts. Sri Lanka has experienced a civil war that dragged on for nearly three decades. Its people have long borne a burden of violent civil war between LTTE – a Tamil insurgent political party – and Sri Lankan government. The conflict was not only between the rebels and government security forces, it also trespassed among people; Hindu Tamil nationals and

Sinhala Buddhist. The civil war starts in the 1980s but long before Tamil nationals have been marginalized, constitutionally and politically, by Majority Buddhist Sinhalese who are 70% of total population. The Tamil Tigers launched deadly attacks, including some of the earliest use of suicide bombings as a tactic of insurgency. In reaction, the Sri Lankan Army carried out brutal campaigns, largely focused on the Tamil stronghold in the northeast – Jaffna. The civil war ended in 2009 after a large-scale operation by the army that defeated the Tamil Tigers and killed its leader. There is no exact casualty toll, but the United Nations has suggested that as many as 40,000 civilians were killed in the last stage of the war alone (Mashal, 2019). Many of the grievances around systematic prejudice that led to the civil war remain unaddressed. Tamil families are still looki

ng for thousands of people who disappeared during the war, and trying to reclaim land still held by the military. Health services are trying to address the overwhelming trauma left by those decades of violence.

Human Security in South Asia

The region's economic viability, especially where conflict is burgeoning or entrenched, is seriously challenged, as are the social conditions that form the basis for stable community life. While problems such as human rights violations, displacement and poverty may themselves arise due to conflict, they can also contribute to a further escalation of violence. The implications for the affected communities are inevitably multifaceted. Such problems create an insupportable burden for the affected communities, and are often used to legitimize accusations and grievances. They are then responsible for inciting a cycle of further violence, displacement, etc. Below, we examine the human costs that arise from cycles originating from internal conflict.

Nontraditional security has been an important discourse in contemporary world instead of traditional concepts of security e.g. protection of national security from conflict and violence. Due to natural and environmental disasters caused by climate change, looming food and water crises, lack of health security, high rate of poverty and emergence of displaced persons, South Asia is now one of the most vulnerable regions in the world. All of these nontraditional security challenges are creating severe impacts on human security as well as both domestic and regional stability in the region. These issues awakened South Asia's leaders to pay more attention on the seriousness of nontraditional security challenges.

The present scenario of human security in South Asia is raising alarming threats to regional security because, no South Asian country except Sri Lanka ranks in the top hundred countries in the United Nations Development Program's (UNDP) Human Development Index. The Intergovernmental Panel on Climate Change (IPCC) has identified South Asia as the most susceptible region in the world due to climate change. The international community also recognizes Bangladesh as most vulnerable due to hydrogeological and socio-economic factors e.g. flat deltaic topography with low elevation, climate variability, high population density, poverty and so on (*Muniruzzaman, 2014*).

Human opportunity cost of Military expenditure in South Asia

The region's governments spend US \$77.9 billion annually on military expenses (SIPRI, 2019). However, unfortunately, increasing numbers of South Asians are suffering from hunger, illiteracy and preventable diseases. The human opportunity cost of military build-ups is clear. Half the annual military expenditure of South Asia could provide primary school education to 210 million children for one year, safe drinking water for two years to 280 million people and essential medicines for two years to 145 million people who have currently no access to any health facility. Children who embody the future are in fare worse condition (Mufti, 2013). The facts that South Asian governments are directing increasing resource to the production of weapons of mass destruction that marginalizes the issues of human security in massive scale. Economic deprivation also has important implications for the quality of South Asia's human capital and future growth:

- The incidence of malnourishment among children is much greater in South Asian countries than the incidence of poverty amongst the general population (53% vs. 35%)
- The percentage of South Asian children who quit school before grade 5 is much higher than in developing countries (41% vs. 31%)
- A larger percentage of South Asians are deprived of basic services like access to safe drinking water, healthcare and sanitation. (Mufti, 2013)

There are seven basic components to human security according to the United Nations Development Programme: economic security, food security, healthcare security, environmental security, personal security, community security and political security. And unfortunately South Asia fares poorly in every category. No South Asian country –except Sri Lanka (#92) – even ranks in the top hundred countries in UNDP's Human Development Index. Not even once, has it come to public notice that governments in South Asia are ashamed of their position in this index and that steps are being taken to address it. Human life is less valuable in these nations; improvement needs to start from the top.

Non-Combatants and Human Suffering

Conflicts, whether it is interstate or intrastate, bring forth multifaceted anguishes, ranging from intangible human suffering to measurable economic and financial loss, for non-combatants. However, three specific effect can be mentioned: economic loss, displacement and arming of civil community.

Violent conflict leads to displacement and unbearable human suffering to the non-combatants community. Due to conflict the largest displacement have been occurred in the region of South Asia. For example, in Sri Lanka, Tamil conflict forced 800000 people to flee their homes. "War on Terror" in Afghanistan forced a great number of people to cross the international border. According to the UNHCR report in February 2017, approximately 1.3 million registered Afghans have fled their home taking refuge in neighboring Pakistan. While international displacement monitoring center recorded that a total 119,000 people have been displaced because of internal conflicts. Similar instances are available in Bangladesh, Nepal and Afghanistan.

Secondly, a civilian society can be inflicted with lethal arms which has long run upshot. Grave example of armed societies are Nepal, Sri Lanka (Jaffna Island), Afghanistan, Pakistan (Khyber province) and partly in Chittagong Hill Tracts (CHT) are of Bangladesh. Due to the “people’s war” a great number of young people have armed themselves in Nepal. The group is named Young Communist League (YCL) – terrorist wing of CMP Nepal. This armanization of society will lead to feeling of insecurity and periodical violent conflict among mass people.

Additionally, vehement conflict surely harvest economic loss in terms of losing land, living home, livelihood and other economic properties. Civil war, ethnic riot and other forms of clashes make their life economically vulnerable and downhearted which may lead them to extremism. Lives in Jaffna (Sri Lanka), Nepal and Khyber province (Pakistan) have been disastrous. Central Bureau of Statistics has estimated that around 908,000 people are completely jobless by 2018/19 in Nepal (Kathmandu Post, 2019). Similar cases can be found in Sri Lanka, Pakistan and in Bangladesh.

Food insecurity in South Asia

Although Asia-Pacific nations are doing well in food security, South Asian countries are facing serious food insecurity. A rise in prices of global commodities triggered enormous challenges to development activities in South Asia from 2004 to 2008. This swell in food prices generated a massive adverse social impact in South Asia. Net food importing countries like Afghanistan, Sri Lanka and Bangladesh suffered most due to high food price (*Muniruzzaman, 2014*). Rural people in South Asia are net buyers of food due to more likely high food prices. For example, about 80 percent and 70 percent of households in Bangladesh and Nepal are net buyers of rice, whereas 77 percent of households are net buyers of wheat in Pakistan. Food price inflation has severely increased poverty ratio that has particularly threatened the poorest of the poor. Agricultural land areas are being declined in rapid scale in South Asia due to increasing level of urbanization (WB, 2010).

Due to continuous food shortage since 1990s, Bangladesh has become one of the most vulnerable countries in the region. The country will undeniably face far severe food scarcities in the next few years reaching a critical level by 2050. An appraisal shows that flood destroys about 20 percent of Bangladesh’s total agricultural output every year. The country loses about 80,000 hectares of arable land due to droughts, salinity and floods. According to the Economist Intelligence Unit (EIU) Bangladesh is the least food secure country among the six South Asian countries. Sri Lanka ranks as the most food secure country in the region securing 62nd position in overall ranking (EIU, 2012). Pakistan is also facing severe food crisis due to rise of food price at annual rate of 20 percent, large numbers of people in Pakistan run the risk of falling back into poverty. However, Sri Lanka is also at risk of starvation because of tightening food situation. Simultaneously, 44 percent of households in India are deficient in calorie intake (Sardar, 2009).

Threat to Health Security

South Asian countries face a number of shared challenges, including populations with similar biological disease risks, health surveillance limitations, and concerns about emerging or reemerging infectious diseases. A densely populated region—South Asia accounts for around 20% of the global population, approximately 1.8 billion people—the region is vulnerable to changes in climate and weather patterns, which increase the risk for vector-borne disease transmission (Gronvall, et al. 2018). The World Bank estimates that by 2050, changes in weather patterns will decrease living standards in Bangladesh, India, Pakistan, and Sri Lanka, adding to current societal and environmental pressures (Mani et al. 2018). South Asian countries also account for one of the highest disease burdens for typhoid fever, there remains endemic polio transmission in Pakistan and Afghanistan, and the region accounts for approximately 40% of total tuberculosis cases (Akhtar, et al. 2015).³ In addition, zoonotic diseases such as Nipah, Crimean-Congo hemorrhagic fever, and chikungunya are present; in May 2018, a Nipah virus outbreak in India had a fatality rate of almost 90% (WHO).

The 2003 SARS epidemic spread to more than 37 countries and 3 continents in only 4 months, with an economic impact of \$40 billion from 1997 to 2009, 6 major zoonotic outbreaks caused a total economic loss of over \$80 billion.⁸ Major outbreaks can have other significant economic impacts as well, including loss of workforce and loss of travel and trade, as well as an impact on supply chains that have global effects. Ecologic factors allow for rapid pathogen mutation and host adaptation, and these are often worse in areas of disorder, insecurity, and conflict. These factors are immense challenges when coupled with population movement. There are important lessons being learned for the region from experiences in Pakistan and Afghanistan on how to deliver health interventions during conflict, such as conducting polio eradication programs in highly insecure areas. In South Asia, there is both the emergence and reemergence of infectious diseases such as avian flu, MRSA, and MDR/XDR tuberculosis. The HIV epidemic as a good historical example of a disease that raged for over a decade and with tremendous human life and economic losses before necessary preventive measures and funding and resources were allocated. In Pakistan, TB, AIDS, and malaria are all vertical programs that require additional technical resources from the international community to both strengthen laboratory systems and better integrate these vertical programs under one umbrella. Integration could help reduce duplication of effort and would leverage existing resources to improve TB surveillance systems (Gronvall, et al. 2018).

People in South Asia are at a higher risk of infectious diseases rather than from people in industrialized countries. The root causes are poverty, unhygienic living conditions, malnutrition, illiteracy, lack of clean water, 57 pollution, lack of sanitary facilities, and lack of awareness about health security. For example, only in the year 2000, over two thirds of the estimated 3.7 million children died in South Asia due to infections such as pneumonia, diarrhea, and measles. According to the report of the World Bank of 2009, South Asia has both highest percentage and largest number of undernourished children in the world. Malnutrition affects 43 percent to 46 percent of young children in India, Bangladesh and Nepal. The number of malnourished people in the region as a whole rose from 283 million in 1990 to 314 million in 2005. Over 20 percent of children less than

five years of age are underweight in most of the South Asian countries. Compared to 29 percent of global population, about 74 percent of South Asian population has no access to improved sanitation facilities. Another major challenge of health security in South Asia is HIV/AIDS. The National AIDS Control Organization (NACO) estimates that nearly 2.3 million HIV positive adults live in India, the highest estimate for any country. On the other hand, though Pakistan's adult prevalence rate is 0.1 percent, the rate is increasing. Moreover, about 36 percent of the population of Sindh and Punjab was exposed to high arsenic contamination in Pakistan.

Poverty in South Asia

The greatest number of extreme poor people are living in South Asia (Haté, 2010). Approximately 40 percent of the world's poor live in the region. Home to 22 percent of the world's population, South Asia is contributing only less than 2 percent to global income (John, 2011). South Asia is also the home of 23 percent of humanity, amongst them 31.7 percent are living in abject poverty (Tripathi, 2008). According to the latest survey, percentage of poverty rate is very high in most of the South Asian countries respectively 44 percent in Bangladesh, 36 in Afghanistan, 31 percent in Nepal, 27 percent in India, 23 percent in Bhutan, 22 percent in Pakistan, and 15 percent in Sri Lanka (Sekhar, 2012). A report titled 'Food Price Increases in South Asia: National Responses and Regional Dimensions' states that due to high food price, thousands of South Asian fall into poverty line and remain in starvation. If food prices continue to rise without a matching increase in incomes of people, it is estimated that approximately 100 million people could be pushed back into poverty (Sobhan, 2012). Though economic growth has reduced poverty rate in South Asia, its total number of poor people has increased. The number of poor people living on less than \$1.25 a day increased from 549 million in 1981 to 595 million in 2005. Only in India, the number of poor people increased from 420 million in 1981 to 455 million in 2005 (Ghani, 2010). In addition, India's 44 percent people lives below the international US\$1 per day poverty line. Best estimates suggest that about one-third of poor population in South Asia is chronically poor between 135 and 190 million people, of whom from 110 million to 160 million are Indians. However, Bangladesh and Pakistan are also the majority of the remainder.

Threat to Environmental Security

South Asia, the world's most vulnerable regions due to widespread environmental stress is probably more exposed to natural hazards. From 1970 to 2000, the region recorded 15 out of 40 major disasters in the world. Natural disasters have severely damaged natural resources and caused human casualties in the region. For example, during the 2004 Tsunami, the rehabilitation cost was estimated to US\$ 3 billion. The overall cost of the October 2005 earthquake made cost at approximately US\$ 5.2 billion. Besides, disasters killed nearly half a million people in South Asia over the last 25 years. Over 60,000 people were killed by Tsunami in India, Sri Lanka and Maldives. The earthquake of October 2005 killed at least 73,000 people and severely injured or disabled another 70,000 and rendered 2.8 million homeless in northern parts of Pakistan.⁷⁷ The natural disasters in Pakistan in July 2010 had blown out almost one fifth of Pakistan's total land

area, directly affected close to 20 million people and also made cost up to \$43 billion. Floods in South Asia are also very common. Almost 20 million people stranded or displaced across the region by massive flooding (*Muniruzzaman, 2014*).

Environmental hazards, say for example tropical cyclone, generate dire threats to human security in South Asia. Due to sea level rise, millions of people could become homeless in the Asia-Pacific leaving Bangladesh, India, Vietnam, China and Pacific Islands are at highest risk. According to Inter-governmental Panel on Climate Change Convention-IPCCC, 1 meter rise in sea level may submerge nearly 17 to 20 percent of the whole territory of Bangladesh pushing 25 to 30 million people climate refugees (Kamal, 2007). Also IPCC maintains that sea level rise may have devastating consequences in low-lying areas of South Asia, Southeast, and East Asia making millions of people homeless in Bangladesh, India and China.

Green Peace report warns that if left unchecked climate change could lead to global temperature increases of between 4-5°C, unleashing a barrage of impacts that will drive mass migration in India, Pakistan and Bangladesh (Greenpeace, 2008).⁹⁰ It also estimates that more than 120 million people in India and Bangladesh will be homeless due to climate change. It is also a matter of concern that 22 million Bangladeshis could be displaced by 2050. The island nation of the Maldives, off the west coast of India is at high risk of environmental refugees (*Muniruzzaman, 2014*).

Human Development Index (HDI) and South Asian Countries

Name of the Country	Rank/193	Value
Afghanistan	169	0.479
Bangladesh	139	0.579
Bhutan	132	0.607
India	131	0.624
Maldives	105	0.701
Nepal	144	0.558
Pakistan	147	0.550
Sri Lanka	73	0.766

Source: UNDP, 2017

Table demonstrates that South Asia countries score low in the human development index. Except Sri Lanka, all other states show lower performance in terms of their value and score. What is the reason? The simple answer to this question is perhaps the attention of the governments of this region to the conventional security index and not to the human security issues.

Conclusion

The above discussion proves that South Asian states, except Maldives and to some extent Bhutan, are beset with national and transnational strife. Disagreements between the nations, say, bi-lateral tensions, and internal conflict – such as political, ethnic and religious violence – instigate them to emphasize the on conventional security dynamics. Maintaining domestic law and order, that is mostly affected by political violence, for example in Bangladesh, and to keep national territory safe, say, India and Pakistan, from any potential threat have been major focus for the governments. Budget for security apparatus is rising gradually and South Asian governments take pride with some strategic achievements like successful test of missile, acquiring military hardware from foreign country, etc. Politics for narrow individual and group interest loudly speaks that popular interest such as public health, food security, quality education are not in their choice. Lack of vision and sincere efforts and inappropriate planning to achieve human security makes it more susceptible, and leave fewer scopes of convalescing. To promote human security eloquently governments of South Asian nations have to give utmost priority on the agenda. It is true that priority can only be set once attaining human security becomes an agenda and sumptuous spending on strategic affairs is diverted to social sector. Sooner the governments realize the worth of human security the better it is for everyone. Pitiably position in the human development index can be a lesson for all the governments of the region. If they are positively motivated to bring change in the life of ordinary people, who are actual builder of economy, there is time for a fresh beginning otherwise the entire region will remain immersed in great difficulties with few achievements everywhere.

References

- AAC. 2019. <<https://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat>> retrieved on September 10, 2019.
- Adams, B. 2011. India's shoot-to-kill policy on the Bangladesh Border. The Guardian, UK, available at <<https://www.theguardian.com/commentisfree/libertycentral/2011/jan/23/india-bangladesh-border-shoot-to-kill-policy>> Retrieved on 13 June, 2019.
- Bangladesh Pratidin. September 7, 2019. NRC theke badpora hinduder Bangladeshe feranor dabi hindu mohajoter (Hindu Mohjote demands push of back of NRC excluded Hindus in Bangladesh). Available at <<https://www.bd-pratidin.com/abroad-paper/2019/09/07/454943>> retrieved at September 10, 2019.
- BBC. August 31, 2019. Assam NRC: What next for 1.9 million 'stateless' Indians? Available at <<https://www.bbc.com/news/world-asia-india-49520593>> retrieved on 6/8/2020.
- Byron, R.K. 2018. China-funded Projects: Joint body to probe slow pace, The Daily Star: Dhaka. Available at <<https://www.thedailystar.net/frontpage/news/china-funded-projects-slow-progress-be-probed-1773067>> retrieved on September 22, 2019.
- Banglanews24.com. 2019. NRCte baad poreche 11 lakh hindu, 6 lakh muslim bangali (1.1 million Hindu and .6 million Bengali Muslims excluded from NRC), Banglanews24.com: Dhaka. Available at <<https://www.banglanews24.com/kolkata/news/bd/736914.details>> retrieved on September 7, 2019.
- BBC, February 18, 2019. <<https://www.bbc.com/news/world-south-asia-12557384>>. Retrieved on August 19, 2019.

- The Economic Times, 29 June, 2019 <<https://economictimes.indiatimes.com/news/politics-and-nation/india-most-secular-country-in-world-says-vice-president/articleshow/70003404.cms>>. Retrieved on August 10, 2019.
- Bapu, P. 2013. *Hindu Mahasabha in Colonial North India, 1915-1930: Constructing Nation and History*. Routledge: London.
- BBC. 9 September, 2019. Why is there a war in Afghanistan? The short, medium and long story, available at <<https://www.bbc.com/news/world-asia-49192495>> retrieved on September 7, 2019.
- BBC. September 16, 2019. Afghanistan war: Tracking the killings in August 2019 <<https://www.bbc.com/news/world-asia-49662640>> retrieved on September 12, 2019.
- BBC, September 22, 2009. Nepal rises conflict death toll. Available at <<http://news.bbc.co.uk/2/hi/8268651.stm>> retrieved on August 15, 2019.
- Berry, V. R. & Desai, J. 2009. *Rising Military expenditure in South Asia*, Mumbai: Focus on the Global South
- Chakma, J. 2019. Dhaka, Beijing to sign MoU on investment cooperation, Daily Star: Dhaka. Available at <<https://www.thedailystar.net/backpage/news/dhaka-beijing-sign-mou-investment-cooperation-1764046>> retrieved on August 9, 2019.
- Cooper, H. H. A. 2003. What is conflicts? How are conflicts resolved? *Journal of Police Crisis Negotiation*, Vol. 3, Issue, 1. Available at <https://doi.org/10.1300/J173v03n01_06> retrieved on September 1, 2019.
- Dhaka Tribune. November 14, 2016. Two submarines added to Bangladesh armada, available at <<https://www.dhakatribune.com/bangladesh/2016/11/14/two-submarines-added-bangladesh-armada/>> retrieved on September 16, 2019.
- Deshpande, R. 2008. Bajrang Dal: The militant face of the saffron family. *The Times of India*. Available at <<https://timesofindia.indiatimes.com/india/Bajrang-Dal-The-militant-face-of-the-saffron-family/articleshow/3542674.cms?referral=PM>> retrieved on September 11, 2019.
- Dahal, S.H., Gazdar, H., Keethaponcalan, S.I. and Murthy, P. 2003. *Internal Conflict and Regional Security in South Asia Approaches, Perspectives and Policies*, UNIDIR: Switzerland.
- Dettman, P. R. 2001. *Kargil War Operations. India Changes Course: Golden Jubilee to Millennium*. Greenwood Publishing Group: Westport.
- EIU. 2012. Bangladesh Least Food Secure in South Asia: Global Food Security Under Threat, *The Daily Financial Express*
- FFP. 20019. *Fragility in the World 2019*. <https://fundforpeace.org/>
- Groves, S. 2014. India and Nepal Tackle Border Disputes, *The Diplomat*. Available at <<https://thediplomat.com/2014/09/india-and-nepal-tackle-border-disputes/>> retrieved on September 15, 2019.
- Gurung, S.K. 2018. Dhola-Sadiya bridge not enough, China still miles ahead of India in infrastructure along LAC, *The Economic Times*, New Delhi. Available at <<https://economictimes.indiatimes.com/news/defence/dhola-sadiya-bridge-not-enough-china-still-miles-ahead-of-india-in-infrastructure-along-lac/articleshow/58879677.cms>> retrieved on September 16, 2019.
- Ghani, E. & Iyer, L. 2010. *Conflict and Development*. Available at <<https://voxeu.org/article/conflict-and-development-lessons-south-asia>> retrieved on August 9, 2019.

- Gronvall, G. K.; Bland, B.; Inglesby, T. & Cicero, A. 2018. Global Health Security in South Asia, John Hopkins Center for Health Security, Washington DC.
- Higgins, D.R. 2016. *M48 Patton vs Centurion: Indo-Pakistan War 1965*, Osprey Publishing: Oxford.
- Human Rights Watch (HRW). 2002. "Asia Overview", *World Report 2002*, <http://hrw.org/wr2k2/asia.html>.
- HRW. 2017. India: "Cow Protection" spurs vigilante violence. <<https://www.hrw.org/news/2017/04/27/india-cow-protection-spurs-vigilante-violence>> retrieved on September 11, 2019.
- HRW. 1995. *Sri Lanka: Stop Killings of Civilians*. <http://www.hrw.org/reports/1995/Srilanka.htm>.
- Iyer, L. 2009. The Bloody Millennium: Internal Conflicts in South Asia, *Harvard Business School*.
- Jaffrelot, C. 2004. *A History of Pakistan and Its Origins*. Anthem Press: London.
- Jha, P.S. 2016. "Cow vigilantes who are threatening Modi's grip on power" Chatham House, available at < <https://www.chathamhouse.org/publications/twt/cowboys-and-indians>> retrieved on September 10, 2019.
- Jaffrelot, C. 2010. *Religion, Caste, and Politics in India*. Primus Books: Delhi
- Kamal, S.S. 2007. Climate Change and Bangladesh: A Perspective on where are we, <<http://archive.thedailystar.net/newDesign/news-details.php?nid=15364>>.
- Large, J & Timothy D. Sisk. 2006. Democracy, Conflict and Human Security: Pursuing Peace in 21st Century, Stockholm: IDEA.
- Livemint, 2019. NRC will be implemented on priority in areas affected by infiltration: President. <https://www.livemint.com/> retrieved on September 20, 2019.
- Lawoti, M. & Pahari, A.K. 2010. *The Maoist Insurgency in Nepal: Revolution in the twenty-first Century*. Routledge: London.
- Marlow, I. 2019. Cow Vigilantes in India Killed at Least 44 People, Report Finds, Bloomberg, available at < <https://www.bloomberg.com/news/articles/2019-02-20/cow-vigilantes-in-india-killed-at-least-44-people-report-finds>> retrieved on July 15, 2019.
- Marlow, I & Pradhan, B. 2017. Cow-Saving Vigilantes Are a Sign of Rising Political Risk in India, Bloomberg: New York. Available at <<https://www.bloomberg.com/news/articles/2017-04-19/shuttered-abattoir-a-sign-of-rising-political-risk-in-india>> retrieved on September 12, 2019
- Moghadam, A. 2008. *The Globalization of Martyrdom: Al Qaeda, Salafi Jihad, and the Diffusion of Suicide Attacks*. Johns Hopkins University Press: John Hopkins University.
- Mashal, M. 2019. For Sri Lanka, a Long History of Violence, New York Times <<https://www.nytimes.com/2019/04/21/world/asia/sri-lanka-history-civil-war.html>> retrieved August 18, 2019
- Mufti, I. 2013. Peace and Human Security in South Asia: Challenges and Solutions, available at <http://www.lead.org.pk/ow/peace-and-human-security-in-south-asia.htm> retrieved on October, 24.
- Muniruzzaman, A.N.M. 2014. Human security in South Asia: Vision 2025, *Peace and Security Review*, (11): 23-55.
- Muni, S.D. 2012. Bringing the Maoists down from the Hills' in Einsiedel, S. V; Malone. D. & Pradhan. S. (eds.) *Nepal in Transition: from People's War to Fragile Peace*, New York: Cambridge University Press, pp.313-331.

- Muni, S. D. 2013. Conflict in South Asia: Causes, Consequences and Prospects, https://www.files.ethz.ch/isn/162720/ISAS_Working_Paper_170_-_Conflicts_in_South_Asia_26032013170324.pdf
- Nicholson, M. 1992. *Rationality and the Analysis of International Conflict*. Cambridge University Press: Cambridge.
- Nepali Times. 25 November, 2005. 12 point Maoist MoU, available at <<http://archive.nepalitimes.com/news.php?id=9190#.XaQtfVUzbIV>> retrieved on September 15, 2019
- Ojha, H. 2015. The India-Nepal Crisis, The Diplomat, available at <<https://thediplomat.com/2015/11/the-india-nepal-crisis/>> retrieved on September 17, 2019.
- Odhikar. 2018. Human Rights Violation in Bangladesh-India Border Area from 2000-2018. Available at <<http://odhikar.org/statistics/statistics-on-violations-in-the-border-area/>>]
- Oberst. R. C, Malik. Y.K., Kennedy, C.H., Kapur, A., Lawoti, M., Rahman, S. & Ahmed, A. 2016. Government and Politics in South Asia, Westview Press: Colorado.
- Odhikar. 2018. Indian Border Security Force (BSF) must stop killings and violating human rights against Bangladeshi citizens, Odhikar: Dhaka. Available at <http://odhikar.org/wp-content/uploads/2019/01/Statistics_Border_2000-2018.pdf>) retrieved on September 13, 2019.
- Patnaik, P. 1993. The Fascism of Our Times. *Social Scientist*, 21(3/4), 69-77. doi:10.2307/3517631
- Peace Insight. 2019. <https://www.peaceinsight.org/> .
- Sipri. 2019. Trends in world military expenditure, 2018. Stockholm.
- Sardar, S. I. 2009. Food Insecurity: A View from South Asia, *Regional Studies*, (27): Pp. 1-32. available at <http://www.academia.edu/2333343/Food_Insecurity_A_View_from_South_Asia> accessed on May 19, 2019.
- Sekhar, C.S.C & Bhatt, Y. 2012. Food Security in South Asia: Prospects for Regional Integration, available at http://unctad.org/en/PublicationsLibrary/ecidc2013misc1_bp6.pdf
- SIPRI. 2019. World military expenditure grows to \$1.8 trillion in 2018<<https://www.sipri.org/media/press-release/2019/world-military-expenditure-grows-18-trillion-2018>>
- Sobhan, F. 2011. Nontraditional Security Challenges in South Asia, available at <<http://www.nbr.org/publications/element.aspx?id=511#.UkPTpyeNZkg>>.
- Sudirman, A. 2010. The India-Pakistani Military and Nuclear Arms Race in Post-Cold War Period: The Regional Security Complex in South Asia, *Global & Strategis* journal of Airlangga university, Vol 12, No 1: Surabaya.
- Sarkar, R. & Sarkar, A. 2016. Sacred Slaughter: An Analysis of Historical, Communal and Constitutional Aspects of Beef Bans in India. *Politics, Religion and Ideology*. doi.org/10.1080/21567689.2016.1259108
- Safi, M. 2016. "On patrol with the Hindu vigilantes who would kill to protect India's cows, *Guardian*, October 27, 2016. Available at <<https://www.theguardian.com/world/2016/oct/27/on-patrol-hindu-vigilantes-smuggling-protect-india-cows-kill>> retrieved on September 11, 2019.
- South Asian Terrorism Portal. 2019. Available at <<https://www.satp.org/datasheet-terrorist-attack/incidents-data/india>> retrieved on September 17, 2019.
- Rawat, R. B. 2015. *1965: Stories from the Second Indo-Pakistan War*, Penguin: UK.

- Lyon, p. 2008. *Conflict between India and Pakistan: an encyclopedia* ABC-CLIO. Inc.: California
- Ramachandran, S. 2017. Hindutva Terrorism in India, Caravandaily available at <<https://caravandaily.com/hindutva-terrorism-in-india/>>. Retrieved on September 10, 2019.
- Riaz & Basu, 2010) Raiz, A. & Basu, S. 2010. *Paradise Lost? State failure in Nepal*, LEXINGTON BOOKS: New York.
- Nepal Monarchy. 2005. Royal Proclamation of February.
<<https://web.archive.org/web/20171016080039/http://www.nepalroyal.com/proclamationsfeb012005/>>. Retrieved on September 22, 2019.
- Talbot, I. 2010. India and Pakistan in Brass, P. R. *Routledge Handbook of South Asian Politics*, New York: Routledge.
- Tripathi, D. 2008. Human Security in South Asia: Challenges and Solution, available at <http://www.newstrackindia.com/newsdetails/3693> retrieved on May 12, 2019.
- The News.com. November 26, 2017, Bangladeshe prokito shongkhalogu kara (Who are the real minority in Bangladesh? Dhaka. Available at <<http://thenewse.com/?p=80395>>. Retrieved on August 13, 2019.
- Wolpert, S. 2010. *Recent Attempts to Resolve the Conflict: India and Pakistan: Continued Conflict or Cooperation?* University of California Press: California.
- Uddin, S. 2018. Raksi Bahinir Karmo Totporotar kahini 1972 theke 1975, (The story of the activities of Raksi Bahini from 1972 to 1975, Jonojibon.com, November 24, 2018) <<http://jonojibon.com/2018/11/24/>> retrieved on September 12, 2019.
- VOA. November 8, 2018. US War on Terror Kills Nearly 500,000 in Afghanistan, Iraq, Pakistan, <<https://www.voanews.com/middle-east/us-war-terror-kills-nearly-500000-afghanistan-iraq-pakistan>> retrieved on September 14, 2019.
- Wilkinson, S.I. 2010. Communal and caste politics and conflicts in India, in Brass, P.R. *Routhledge Handbook of South Asian Politics*, Routhledge: New York)
- World Bank. 2010. "Food Price Increases in South Asia: National Responses and Regional Dimension", available at http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1269620455636/6907265-1287693474030/South_Asia_Regional_Food_Prices_Final.pdf

Understanding the New Dimensions of Bangladesh-India Relations: A Critical Analysis

Muhammad Kamruzzaman*

Abstract: Literally, bilateral relations of Bangladesh and India have been prized with strong historical and cultural background over the last four decades. However, Bangladesh observed many ups and down relation with India since her inception as independent nation. Bangladesh is apparently experiences number of challenges while deepening bilateral collaboration with India. This study reveals that, various issues are still unsettled .i.e. sharing the water of 54 international rivers that flow from India to Bangladesh, controlling terrorism and promoting economic development as well as building trustworthy relationship. Bangladesh –India relations have improved significantly since a path- breaking India visit of Prime Minister of Bangladesh, Sheikh Hasina in January 2010. Both countries are engaged in the task of implementing number of international development schemes based on mutual cooperation which addresses Indian concern on a regional economic hub in South Asia. The study found that, water sharing of Teesta River, boarder security and regional connectivity which are the long standing issues both countries are struggling to settle down over the years. This paper has attempted to investigate those emerging issues which are apparent bases of divergence in the pursuit of bilateral relations between Bangladesh and India in days ahead.

Key Words: Bilateral relations, Neighbor, Trade deals, Bangladesh, India, Bay of Bengal, Geo- politics.

Introduction

Bangladesh and India both shares historical relations, particularly in the aftermath of liberation struggle of Bangladesh. India has been the long-standing partner which helped the people of Bangladesh in the Liberation war in 1971. Moreover, Bangladesh – India are two significant countries in South Asia. Both of the countries were ruled for a long time by the British colonial power. In 1947 Indian sub-continent first got independence from British colonial rule was divided into two independent states; one is India and another is Pakistan. But in 1971 one of the major parts of Pakistan knew as East Pakistan got independence from Pakistan through Liberation war. Bangladesh-India relations are perhaps the most complex bilateral relations in the subcontinent. Despite its role in Bangladesh's independence in 1971, India is often perceived as serving its own self-interests against Pakistan. With the signing of the Treaty of Peace and Friendship in 1972, the two countries attempted to improve their relations to no avail.

Over all, India and Bangladesh share much in common, beyond culture. They represent one of the most important relationships in South Asia and, for India, a vital element in its look East Policy. Previously the modern pioneer of Malaysia, Prime Minister Dr. Tun Mahathir Bin Mohamad has adopted first time in South East Asia that was look east

* Assistant Professor, Department of Government and Politics, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh, E-mail: k.zaman@juniv.edu &kzamanlec@gmail.com

policy. Presently, Bangladesh adopts and emphasis on look east policy. This is not to say that the relationship has been without challenges. In fact there have been a number of setbacks. The Teesta river water treaty had to be scuttled at the last minute in 2011, due to pressure from Mamata Banerjee, the West Bengal Chief Minister who has agreed to accompany Modi this weekend but did back out at the last moment from former Prime Minister Manmohan Singh's entourage in September 2011, as a protest against the Teesta agreement. Similarly, the India-Bangladesh Land Boundary Agreement (LBA), passed by Indian Parliament on May 7, 2015 has had its share of hurdles, due to opposition from political parties including Modi's own BJP when Congress was in power. It is now well plausible that there are many issues that need to be addressed successfully to Bangladesh and India utilizing the warm relations both countries are currently enjoying.

Sharing the water of 54 international rivers that flow from India to Bangladesh, safety and security at border line of both countries, controlling terrorism and promoting economic development as well as building neighboring relationship have been pretended concerns where both countries are investing diplomatic efforts to draw the line of resolution. The paper is mostly influenced by the existing tension both countries facing as well as keeping positive hope ahead to resolve with the motto of mutual respect and mutual interest.

Methodology

The study has followed qualitative methods and my findings are based on secondary data. I used sources such as government treaties, reports, and statistics and also used diplomatic documents between Bangladesh and India to discover the both countries relations on bilateral issues. Moreover, study related books, journals, research reports, seminar repots, unpublished documents, reviewing reports, editorials of national or international dailies and internet sources have also been used. To conclude, stand on this study; I explore which factors are influencing on bi-lateral relations between Bangladesh-India, and what are the unresolved issues, why those are not resolved till now?

Bilateral Relations: Theoretical Framework

Bilateralism is the conduct of political, economic, or cultural relations between two sovereign states. It is in contrast to unilateralism or multilateralism, which is activity by a single state or jointly by multiple states respectively. For example, free trade agreements signed by two states are examples of bilateral treaties. States with bilateral ties will exchange diplomatic agents such as ambassadors to facilitate dialogues and cooperation's. Typically when States recognize one another as Sovereign States and agree to develop diplomatic relations, they exchange diplomatic agents such as ambassadors to facilitate dialogue and cooperation in various fields.

Bangladesh-India Bilateral Relations: Converging on Contemporary Concerns

Despite trustworthy relations prevailing between neighboring countries, we are still struggling with some challenges averting extended bilateral relations. For instance, insurgency has been playing the role in straining of India with Bangladesh. Northeast

India has been facing insurgency since 1956 due to ethnic separatism among its inhabitants is operating with the support of Bangladesh. National Liberation Front of Tripura¹ (NLFT), United Liberation front of Assam² (ULFA) and the National Democratic Front of Bodoland³ (NDFM) are major insurgent group in Northeast India. There are some various that ULFA has several lucrative income generating projects in Bangladesh to sustain its insurgency activities in India (Ghosh: 2013)

Border Centric Clashes

India's land border with Bangladesh as per the ministry of Defense is 4351 K.M. running through five states, viz., West Bengal (2217 kms) Assam (262 kms), Meghalaya (443 kms), Tripura (856kms) and Mizoram (318kms), including nearby 781 kms of riverine border. The border traverses through 25 districts. The border is mostly used for smuggling goods from India to Bangladesh like livestock, drug trafficking, women trafficking and food items. Sometimes a group of illegal immigrants from Bangladesh cross the border to India in search of improving their livelihood. Because of a large number of illegal immigrants from Bangladesh into India, a controversial shoot on-sight policy has been implemented in border by Indian Border Security Force (BSF). Several times Bangladesh and India Border Security Force meet at flag meetings for resolving push in and push back issues. While operating in the border there are occurrences of violence between the illegal migrants and Indian soldiers. The border has also witnessed occasional skirmishes between the Indian Border Security Force and the Border Guards of Bangladesh (BGB), during the period of 2001-2006. (Dutta: 2009)

The historical land Boundary demarcation agreement (LBA) between Bangladesh and India and related matters, was signed in May 1974. This historical agreement is a sign of in-depth friendship, cooperation, goodwill and mutual trust and above all, the vision of peace and harmony of two great leaders, the Father of the Nation of Bangladesh Bangabandhu Sheikh Mujibur Rahman and Smt. Indira Gandhi, the Prime Minister of India. Article 9 of the Indo-Bangladesh Friendship Treaty provides for mutual consultation between the two signatories in order to remove a threat if either of them is attacked. This agreement is a milestone in the history of Indo –Bangladesh relations. This comprehensive agreement was intended to resolve all lingering and vexing problems. Killing of Bangladeshi people by Border Security Force (BSF) of India has become a high nerve-racking issue in recent times. Public sentiments have been evoked largely in

¹ The National Liberation Front of Tripura (abbreviated NLFT) is a Tripuri nationalist organization based in Tripura, India. It has an estimated 550 to 850 members. The NLFT seeks to secede from India and establish an independent Tripuri state, and is an active participant in the Insurgency in Northeast India. The NLFT manifestos says that they want to expand what they describe as the Kingdom of God and Jesus Christ in Tripura.]The NLFT is currently designated as a terrorist organization in India.

² The United Liberation Front of Assam is a separatist outfit operating in Assam, North East India.[1][2] It seeks to establish a sovereign Assam with an armed struggle in the Assam conflict. The government of India banned the organization in 1990 citing it as a terrorist organization, while the United States Department of State lists it under "other groups of concern."

³ The National Democratic Front of Bodoland (NDFB) is an armed Christian separatist outfit which seeks to obtain a sovereign Bodoland for the Bodo people in Assam, India. It is designated as a terrorist organisation by the Government of India.

Bangladesh on this issue. Human Rights Organization (HRW) like as Odhikar published that from 1 January, 2001 to 30 December 2015, 1809 Bangladeshi's were killed by BSF. According to BGB figures, 936 Bangladeshis were killed between 2001 and 2017, by the BSF and Indian nationals. Of them, the BSF killed 767 Bangladeshis. Since the Awami League came into power, 67 Bangladeshis were killed along the border in 2009 and the figure was 60 in 2010, 39 in 2011, 34 in 2012, 28 in 2013, 40 in 2014, 45 in 2015, 31 in 2016 and 21 until December last year. (Source: Dhaka Tribune, December, 27, 2017) In September 2011, the demarcation of land boundary agreement (LBA) was signed between Bangladesh and Indian Government during the state visit of the Prime Minister of Bangladesh. The Agreement settles the long outstanding land boundary issues related to Demarcated segment of 6.1 kms; territories in adverse possession; and exchange of enclaves.

Maritime Boundary

While Bangladesh, having hollow coast liner, delimits its sea border southward from the edge of its land boundary, India stretches its claim southeastwards, covering thousands of miles in the Bay of Bengal. Due to competing claims of the two countries, delimitation of the sea boundary determining Bangladesh's exclusive economic Zones have remained unresolved. Moreover, in terms of determining the continental shelf, the presence of the Andaman's and Nicobar Islands puts India, in a favorable position. Bangladesh has gained much from the verdict over the 25,602 sq km of disputed bay area with India, says Dr. Md. Kawser Ahmed, an oceanography expert who teaches at Dhaka University. (Harun: 2010)



Source: Bdnews24.com, July 10, 2014

Drug Trafficking and Consequences

Now days, Bangladesh is used as a transit point by drug dealers as well as drug mafia, that dispatches Yabba, heroin, opium, coken, fensidil from Myanmar, Afghanistan and other neighboring countries of the golden triangle to different destinations. As a result, Bangladesh's Department of Narcotics Control has come under the scanner several times and invited criticism. Bangladesh has become the prime transit route for trafficking heroin to Europe from South Asia, according to a report from International Narcotics Control Board (INCB). In 2007 in the annual Report INCB notes that the most common methods and routes for smuggling heroin into Bangladesh are by courier from Pakistan, commercial vehicles and trains from India and via sea through the Bay of Bengal or overland by truck or public transport from Burma.

Imbalance in Trade and Investment

The trade relationship has a detrimental effect on bilateral relationships. Bangladesh is an important trading partner for India. The two-way trade in FY 2011-2012 was US\$5.242 billion with India's exports to Bangladesh accounting for US\$4.743 billion and imports US\$0.498 million. The geographical proximity of Bangladesh and India has made it one of its biggest trading partners. There are pressing concerns in Bangladesh regarding the large bilateral trade deficit with India and the large volumes of informal imports from India across the land border which avoid Bangladesh's import duties. The bilateral trade deficit with India has been increasing rapidly on an average of about 9.5% annually. The trade deficit with India is frequently highlighted by Bangladesh as a major contentious issue. Trade deficit for Bangladesh is more than \$4 billion. For long, Bangladesh has been urging India to reduce this gap by lifting the tariff barriers as they were major impediments to the growth of Bangladesh's exports to India. By responding to Bangladesh's concern, in November 2011, India granted duty free access to all products, except 10 tobacco and liquor items from Bangladesh which amounts to 30% of Bangladesh's export. As much as 98 per cent of Bangladesh's products enjoy zero duty benefits in the Indian market. Bangladesh's exports to India are expected to cross \$1 billion in 2012. (The Daily Star: August, 2012) Political discontent in Bangladesh tends to focus on the issue that India has a lot of non-trade barriers for Bangladeshi exports. Although exports from Bangladesh are growing at a healthy pace, there is no sign of reducing this trade gap. (Farooq: 2006)

Table-1 Bangladesh-India Trade in different financial years (in million US Dollar)

Financial Year	Import	Export	Balance
2001-2002	1018.90	50.19	(-) 968.71
2002-2003	1357.79	83.81	(-) 1274.18
2003-2004	1602.55	89.32	(-) 1513.23
2004-2005	2025.78	144.19	(-) 1881.59
2005-2006	1868.00	241.96	(-) 1626.04
2006-2007	269.00	289.41	(-) 1979.59
2007-2008	3393.00	358.08	(-) 3034.82

Financial Year	Import	Export	Balance
2008-2009	2843.00	245.14	(-)2597.86
2009-2010	3213.70	304.63	(-)2909.07
2010-2011	4574.90	512.5	(-)4062.40
2011-2012	4758.89	490.42	(-)4268.47
2012-2013	4776.9	563.96	(-)4212.94
2013-2014	6035.5	456.633	(-)5578.867

Source: <http://WWW.dhakachamber.com/Bilateral/India-Bangladesh%20bilateral%20Trade%20Statistics.Pdf> and Ministry of Commerce, Government of Bangladesh.



This graphical representation shows that the export and import trade relations between Bangladesh and India are gradually increased consecutively in the year 2009-2010 in an amount US\$ was 304.63, on the other hand amount of import was 3,213.7, in the year 2010-2011 the export was US\$ in 512.51 and the import was 4,569.2 US\$, 2011-2012 fiscal year in an amount of export rate was 498.42 US\$ and the import ratio was 4,743.3, 2012-2013 in an increased proportionately 563.97 and lastly an amount of 456.63 in the fiscal year 2013-2014. So I strongly argued that the trade relations between Bangladesh and India are getting closer and expanding since 2009 to recent times. Because of mutual trust and respect to both sides are strongly involved in head to head negotiations between both nations last decade with a warm relation. It is said that in previously the trade deficit was creating a gap between export and import sides. This is why, Bangladesh suffers a lot. Recently Bangladesh overcomes this trade deficit with a logical view on its greater interest. We know that the Modi government of India starts looking East policy with its

neighboring nations that remind us the Mahathir Mohammad foreign policy towards South- East countries.

The causes of this large gap could be attributed to some trade and non-trade barriers. The non-trade barriers, as pointed by Bangladesh commerce ministry include:

- a) Laboratory tests in Bangladesh, especially for food products, cosmetics and leather and textile products.
- b) Packaging requirements
- c) Inadequate infrastructure facilities such as warehousing, transshipment yard, passing yard
- d) Connecting Roads at land customs stations also hinders exports from Bangladesh. The land border trade is subject to administrative constraints in Bangladesh. The most important customs clearance post is at Beanpole, which borders petrapole on the Indian side and which is on the main roads linking Kolkata with Jeshore and Dhaka. On the other hand as per the report of the Bangladesh Commerce Ministry, trade barriers include: (a) imposition of state tax, (b) anti-dumping which is one of the WTO's measures introduced by India. During 1990's because of countervailing duties 90% of industrial tariffs have come down to 12.5%. It is far lower and far more uniform than they were in the past 50 years from the perspective of SAARC⁴. For Bangladesh, these changes mean that Indian domestic markets, for most of the manufactured goods are highly competitive with complete release from Indian tariffs under bilateral or multilateral free trade arrangements. Porous land border between Bangladesh and India adds to the trade deficit, dating back to the initial years of Bangladesh's birth. (Farooq: 2006) The substantial, informal and unrecorded trade, carried across the Indo-Bangladesh border is more quasi legal in nature and is often described as 'informal' rather than illegal. (Rajpal : 2003)

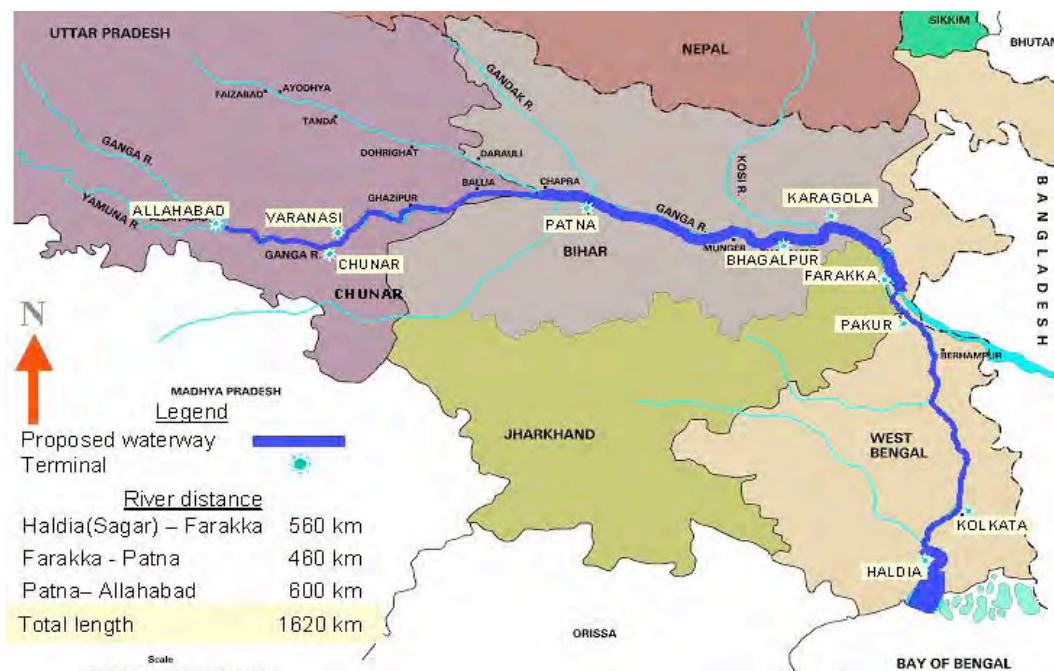
According to recently signed agreement India has agreed to remove several items many of which relate to the garment sector from the negative list of imports from Bangladesh. The Indian textile industry demanded more "protection". But New Delhi had to take a wider view of its interests. India's exports to Bangladesh in the 'fiscal year 2013-2014 stood at \$ 6035.5 million while its imports from Bangladesh amounted to \$ 456.633 million. The Indian Customs Department published a circular on November 9, 2011 to the effect that India has given duty free access to 15 Bangladeshi products. Within three months, India has given the facility to Bangladesh for 61 products. This was a long time demand from the Bangladesh side. However the overall balance of bilateral trade is

⁴ The South Asian Association for Regional Cooperation (SAARC) is the regional intergovernmental organization and geopolitical union of nations in South Asia. Its member states include Afghanistan, Bangladesh, Bhutan, India, Nepal, the Maldives, Pakistan and Sri Lanka. SAARC comprises 3% of the world's area, 21% of the world's population and 3.8% (US\$ 2.9 trillion) of the global economy, as of 2015. SAARC was founded in Dhaka on 8th December, 1985. Its secretariat is based in Kathmandu, Nepal. The organization promotes development of economic and regional integration. It launched the South Asian Free Trade Area in 2006. SAARC maintains permanent diplomatic relations at the United Nations as an observer and has developed links with multilateral entities, including the European Union.

heavily tilted towards India's favor. India is Bangladesh's second most important import source after china and ranks fifth as Bangladesh's export destination.

Disputes in Water Sharing

Sharing of Ganges water is one of the sources of conflict between India and Bangladesh. This conflict between two countries arose when India decided to construct Farakka barrage to divert water from Ganges to Hoogly River in India. The Ganga is a trans-boundary river of India and Bangladesh. The 2,525 km (1,569 m) river rises in the western Himalayas in the Indian state of Uttarkhand and flows south and east through the Gangetic plain of North India into Bangladesh where it empties into the Bay of Bengal. It is the second largest river in the Indian sub-continent by discharge. The aim of the construction of the Farakka Barrage was to increase the lean period flow of the Bhagirathi-Hoogly branch of Ganga to increase the water depth at Kolkata port which was threatened by siltation. **(Harun: 2010)** As irrigation withdrawals increased in Bangladesh conflicts arose over the question of sharing water flow at Farrakka. The inadequacy of water during the slant season to meet the assessed demands in the two countries is the root of cause of the conflict. (Farooq: 2006) Bangladesh government feels that the reduction in flow caused damage to agriculture, industry and ecology in Bangladesh. The Government of India feels that such misgivings are misplaced. Because of the inability of the concerned governments to come to any lasting agreement over the last few decades on sharing the river water, this problem has grown. Now it is also viewed as a case of upstream-downstream dispute. (Arthur: 1990)



Source: <http://WWW.defence.pk/forums/bangladesh-defense/59471-india-going-ahead-tipai-dam-2.html> 8, accessed on 25 January, 2018.

In the relationship between Bangladesh and India the dispute over Ganga water was an important component for over two decades. In 1977, the two countries reached a five year agreement on water sharing which was signed in November, 5 1977. However, the basic issues remained unsolved and hence the agreement was not renewed and lapsed in 1982. Later, a proposal was mooted by India to enhance the flow of Ganga at Farakka by construction of a barrage across the Bramhaputra Jogighopa in India and transfer water of Farakka through a canal. A proposal from Bangladesh was to construct a series of reservoirs on the tributaries of Ganga in Nepal. But this would have brought Nepal in the picture. None of these proposals could be implemented. According to the views in Bangladesh about this dispute, there was a “unilateral diversion” of waters of the Ganga by India at Farakka to the detriment of Bangladesh as reduction in flows had severe adverse effects on Bangladesh. It was also projected that large and more powerful country is disregarding the interests of small and weaker neighbors. This view is more common in Bangladesh. Sentiments grew too such as extent that India was projected as being responsible for all water related disasters whether drought or floods. The Farakka project was supposed to be the cause behind all water related problems.

The perceptions on the Indian side were entirely different. The Ganga River is closely intertwined with religious and social life of the people. There are also legitimate needs of the Kolkata port on the question of siltation and growth of future traffic. It was felt that Bangladesh had greatly over stated its water needs and its claim was disproportionate to its fair share by any logic. Regarding diversion of water for the Kolkata port through the Farakka Barrage and the adverse effects due to reduced flows in Bangladesh were not addressed seriously. It was considered to be to blame India for flood problems. A further complication was the feeling of the concerned State Government in India that their interests had not been properly addressed by the Central Government during bilateral talks with Bangladesh. After 1990, there was a virtual stalemate between the two governments on this issue.

Finally an agreement was reached and a treaty on the sharing of Ganga water between India and Bangladesh was signed on 12 December 1996. The Ganga water treaty is cited as one of the important examples of peaceful negotiations between upstream and downstream neighbor in South Asia. According to this agreement India should release water at the Farakka barrage in the dry season between January to May every year. The 1996 treaty describes three different possibilities of water availability at Farakka according to which shares of water of the two states would vary. Accordingly if water availability at Farakka is more than 75000 cusecs (expected in January, February and last 10 days of May), India receives her full requirement of 40,000 cusecs and Bangladesh the rest. If the flow is between 70,000-75,000 cusecs (expected during first 10 day of March Second 10 days of May), Bangladesh receives 35,000 cusecs and India the rest. In the periods of 10 March - 10 May, if the available water at Farakka is less than 70,000 cusecs but more than 50,000 cusecs the two states share that water on a 50:50 basis. The 50:50 sharing is subject to a provision that Bangladesh and India each receives guaranteed 35,000 cusecs of water in alternative ten-day periods during 10 March to 10 May.

The applicability of the treaty has been delimited by the provision that in case of availability of below 50,000 cusecs (cubic feet per second) of water the sharing formula

of the treaty would have no relevance, In such cases, as article II (iii) of the treaty provides, Bangladesh and India will enter into immediate consultation to make adjustment on an emergency basis, in accordance with the principles of equity, fair play and no harm to either party,' Although sharing under the 1996 treaty depends on stable flows at Farakka, the 1996 treaty contains no effective provision to ensure such flows. It only contains an assurance of India for forfeiting the water flows at Farakka. That assurance falls far short of amounting to an obligation of controlling or regulating uses of the Ganges water in the upper basin. The fragility of that assurance can be discerned from the provision in Article II (iii) in which both the states recognized the possibility of water availability of below 50,000 cusecs. Sharing of Teesta water is another of cause for irritation in Bangladesh -India relations. In 2011, Manmohan Singh, Prime Minister of India visited Bangladesh to resolve Teesta water dispute. It has not been resolved due to objections which were raised by West Bengal Chief Minister, Mamata Banerjee. She has expressed her unhappiness about regular sharing of Teesta water. The Indian sides clearly announced the national interest of its nation is more priority than the necessity of Bangladesh. Because Bangladesh expressed its highly concerned about its northern part has hampered in dry season occurred heavy drought. Present BJP Government has taken initiatives to resolve the Teesta water dispute and has expressed high concerns on this issue. I critically mentioned my argue about Teesta water sharing is a crucial issue with our close neighbor India. Hope that it would be solved in the upcoming day. Recently a general election has completed by Bangladesh and the Grand Alliance (Maha jote) government led by Sheikh Hasina retains in state power. (Gibson: 2006)

Climate Refugee and Tension

According to German Watch, The Global Climate Index - 2009 report expresses that among 170 countries of the world Bangladesh is most vulnerable to climate change. The nation is particularly at risk because it is a vast delta plain with 230 rivers, many of which swell during the monsoon rains. The land in Bangladesh is either below or barely above sea level. This geology, combined with river water from the melting Himalayan glaciers in the North and encroaching Bay of Bengal in the South, makes the region prone to severe flooding. The situation is made worse by the prevalence of intense storms, a marker of climate stresses. It is suspected that sea levels risk in the next 40-50 years, then half of the population in Bangladesh will move across borders to neighboring countries. I.e. India and Myanmar. The situation is complicated by the fact that the population of the country is the highest in the world.

According to US Davis, approximately 75 million (half) of Bangladesh's population would emigrate due to sea level rise. It will have impact not only on Bangladesh but also on South Asia and south-East Asia for many generations. As Bangladesh has very limited high land to which people can move migration to India becomes the next option. With India facing its own population pressures in low lying coastal areas. These new environmental facts throw challenges for both the governments. The two neighbors need to conduct a joint study on the impact of forced mobility from sea level rise, the number of people who will be displaced and possible solutions. For example, India could identify the areas where climate refugees can be accommodated. India - Bangladesh would have

to study the possibility of shifting climate refugees (caused by climate change) from India to other parts of the world. (The Daily Star: August, 2017)

Environmental Degradation

Another climate change induced concern is environmental degradation especially of Sundarban mangrove forest one of the largest such forests in the world. The size is about 9,600 sq.km of Sundarbans, 40 percent of which lie in India and the rest in Bangladesh. The Sundarbans are critical for the protection of low-lying areas because they provide ground stability in the face of high tides, holding the tress and also absorbing salt. As India and Bangladesh are already sharing data on flood forecasting new stations can be set up to expedite the transfer of data on environmental degradation. As climate change will intensify the process of river erosion, this has become an urgent issue for India and Bangladesh. Reports in the Bangladeshi media predict that around 2400 hectares of cultivable land and 400 hectares of settlement on the banks of Jamuna ,the Ganga and Padma rivers will disappear due to erosion in 2017. Sometimes new land emerges along the rivers which lead to controversy over their ownership. In terms of the prospect involved in bilateral relations, India merits greater significance for Bangladesh than any other country. It is enough to mention that the issues at stake in Bangladesh- India relations are of crucial importance more for Bangladesh, but for both the countries for the sake of peace and prosperity.

As indicated earlier interstate relations embrace virtually all aspects of relations. These, while impinge on the prospects for the political and economic emancipation of Bangladesh, not much academic efforts have been employed to gauge the nature, magnitude and intensity of challenges faced by Bangladesh in managing its relations with India. Even, less has been done to explore the policy options for the country in overcoming these challenges. Meanwhile, with the formation of the Government headed by the Honorable Prime Minister Sheikh Hasina on 6 January, 2009, a new era of fresh prospects and opportunities of refurbishing the Bangladesh- India relations have been opened before the two countries. Recently, Bangladesh Prime Minister visited New Delhi on August 15, 2015 and met with Narendra Modi, the Prime Minister of India on 24 September, 2015. (Patkar: 2006)

Recent Development in Bangladesh-India Relations: Heading towards Deepening Relationship

At present time, as per sources of Ministry of External Affairs, Bangladesh high level contacts are developing the relations between these two countries. This is reflected in multi-dimensional relations with Bangladesh at several levels of interaction. High level exchange visits and meetings take place regularly alongside the wide ranging people to people interaction. Indian High Commission in Bangladesh issues about half a million visas every year and thousands of Bangladeshi students study in India on self-financing basis and are recipients of over one hundred annual GOI Scholarships.

Diplomacy on Top: Head to Head Negotiations

Former Indian prime Minister Dr. Monmohan Singh accompanied by, Chief Ministers of four states (Assam, Meghalaya, Tripura and Mizoram), and an official as well as media delegation visited Dhaka on September 6-7, 2011 at the invitation of PM Sheikh Hasina. Ten agreements including a Framework Agreement of Cooperation for Development and Protocol to the Agreement concerning demarcation of the land Boundary between India and Bangladesh were signed. PM of India announced the commencement of 24-hour access to the Tin Bigha corridor to Dahagram and Angorpota Enclaves as well as duty free import of 46 textile items (Subsequently expanded to all items, except 25) from Bangladesh. Prime Minister of Bangladesh Sheikh Hasina accompanied by a 123 member delegation had paid a state visit to India from January 10-13, 2010. The prime Ministers of the two countries agreed to put in place a comprehensive framework of cooperation for development of the two countries based on their mutually shared vision for the flier. The bilateral relations between the two countries are on a high trajectory with regular high-level visits and exchanges. Smt. Sushma Swaraj and General (Retd.) V.K. Singh paid their first stand-alone visits abroad to Bangladesh after assuming charge as Honorable Minister and Minister of State of External Affairs in June and August 2014, respectively.

Prime Minister of India Shri Narendra Modi paid a State visit to Bangladesh on June 6-7, 2015. During the visit, 22 bilateral documents were concluded, including the exchange of instrument of ratification for India-Bangladesh Land Boundary Agreement (LBA). Sheikh Hasina Hon'ble Prime Minister of Bangladesh visited New Delhi on 19 August 2015 to attend funeral of late Smt. Suvra Mukherjee, spouse of Hon'ble President Shri Pranab Mukherjee. Both Prime Minister met in New York on 24 September 2015 on the sidelines of UNGA. Hon'ble President Pranab Mukherjee visited Bangladesh in March, which was his first trip abroad since assuming the office. Hon'ble President of Bangladesh Mr. Md. Abdul Hamid visited India in December 2014, which was the first visit by Bangladesh's ceremonial Head of the State after a gap of 42 years.

Recent Economic Assistance to Bangladesh

On the economic assistance side, India has extended credit of US\$ 1 billion to Bangladesh for a range of projects including railway infrastructure supply of Bangladesh locomotives and passenger coaches, procurement of buses and dredging projects. The line of credit Agreement was signed in Dhaka on August 7, 2010 between EXIM Bank of India and Government of Bangladesh. During the visit of Sheikh Hasina, Hon'ble Prime Minister of Bangladesh to India in January 2010, India announced a US\$ 1 billion line of credit (LOC) for Bangladesh. Most of these projects have been completed and the remaining is under various stages of completion. Hon'ble prime Minister Shri Narendra Modi announced a new LOC of US\$ 2 billion during his visit to Bangladesh in June 2015. The new line of credit (LOC) will cover projects in areas of Roads.

Security Issues

India's main concern had always been its perception that Bangladesh had, consciously or otherwise been providing safe heaven for or even abetting, elements of various militant

groups from the North-east Indian states who were actively pursuing anti India activities using Bangladesh as a launching pad. However the Mohajote (Grand Alliance) government led by Prime Minister Sheikh Hasina considered these elements inimical to Bangladesh's own security concerns and detrimental to its overall societal development. The Government of Bangladesh issued India in clear categorical and unambiguous terms that Bangladesh would not allow its territory to carry out activities inimical to India's security concerns and enunciated policy of zero tolerance towards any terrorist activity conducted or launched from Bangladesh. The commitment made in the very early days of government, has been more palpably demonstrated. It has been deeply appreciated by India security concerns alone cast cloud over the growing relations between two countries. Within the overall security rubric, the Home Ministers of the two countries signed a Treaty in Dhaka in January 2013. Earlier during visits of the Bangladesh Prime Minister Sheikh Hasina to India in January 2010 the two countries had signed the agreement of Moral Legal Assistance on Criminal matters, transfer of sentenced persons and an Agreement on Combating International Terrorism Organized Crime and Illicit Drug Trafficking. (The Daily Star: February, 2013) & (Bindra: 1982)

Cultural Exchanges

The *Indira Gandhi Cultural Centre (IGCC)* in Dhaka regularly organizes programmes covering the entire scope of cultural activities since 2010. Scholarships are being granted by ICCR every year to students from Bangladesh for pursuing general courses in Arts, Science, Engineering and also specialized courses for culture drama arts and sports etc. Youth delegation of 100 members is visiting India annually since 2012. The High Commission of India has been publishing a print and electronic edition of Bengali literary monthly magazine; 'Bharat Bichitra' for the last 42 years. The magazine is considered as one of the best of its kind in Bangladesh and has a wide leadership among all sections of society. (Source: The Bangladesh Observer: September, 2012).

Connectivity

The movement of goods by road is conducted through more than 20 Land Customs Stations (LCSs) along the border and more than 20 are notified for operationalization. The Protocol on Inland Water Trade and Transit (PIWTT) has been operational since 1972. It permits movement of goods over barges/vessels through the river systems of Bangladesh on eight specific routes. Connectivity through the Coastal Waterways enabled by the signing of the Coastal Shipping Agreement is also of priority to both India and Bangladesh. There are bus services between Dhaka-Kolkata, Dhaka-Agartala, Dhaka-Shillong-Guwahati and Kolkata-Agartala via Dhaka. Commencement of Khulna-Kolkata bus service is also at an advanced stage of preparation. Three Broad Gauge inter country rail links between the two countries are operation out of the 6 rail links that exist while work on the Shahbazpur-Kulaura rail link is in progress. There is regular Passenger train service 'Moitree Express' between Kolkata and Dhaka, which now operates 4 days a week. National airlines of both countries and few private airlines operate between Dhaka, Chittagong and New Delhi, Kolkata and Mumbai.

Conclusion and Way Forward

Bangladesh - India relations have more than an academic strategic context. Over the years, Bangladesh- India relations have been caught warp and woof, sometime in the 1970's if not further back. This relationship needs to finally come of age by moving its discourse into the 21st century. Bangladesh observed many ups and down relation between Bangladesh and India in last four decades. Although, the relations between two countries have built the victory of liberation war in 1971, however, it was cracked in the post 1975 events. The 21st century is the challenging century to build up relationship between two countries. They have a strong economy and strategic position in South Asia. For this reason, we never ignore India. In the long run, India's national interests primarily lie towards and beyond its eastern flanks to South - East Asia and the new geographical and strategic construct namely Indo- Pacific Asia. Now days, Bangladesh is facing some challenges with India to resolve some issues, challenges and prosperity for further development and cooperation. Apart from the above observations, the following crucial issues are recommended to achieve rigorous development between Bangladesh – India in the days ahead:

1. Both the countries should be arranged several dialogues between Bangladesh and India.
2. Head to head contact must be essential for further consolidating -bilateral relations between two countries.
3. People to people contract, cricket diplomacy, and diplomatic relation will be leverage at the Ministerial level is badly needed.
4. To promote regional cooperation and proper use of water resources as said by bilateral trade or as per international law for the benefit of both sides in this regard is very urgent.
5. Ensure duty free access for each country commodities to promote greater economic cooperation.
6. Both countries should work together to combat illegal arms trade, illegal migration, drug, women and children trafficking for the sake of regional security, peace and stability.
7. To ensure non-interference policy should adopt each other's internal affairs to promote trust, respect, and confidence with mutual cooperation is essential.
8. To take initiatives for cultural exchange between both countries.
9. Agreement on water sharing should be given priority.
10. Early resolution of the Teesta issue is necessary;
11. Connectivity should be given top most priority. Both the countries should work together to operationalize it;
12. There is need for addressing the issue of illegal migration. In this regard innovative measures should be taken to resolve the problem, being extra careful to ensure the illegal migration does not acquire voting rights and Indian nationality;

13. Liberal visa system should be put in place is necessary, as well as people to people contact needs to be encouraged;

I argue that the relationship with Bangladesh and India is historically examined by a greatest experienced. Furthermore, for greater welfare of the two nations trade relationship has improved significantly between the two countries. India has provided zero duty access Bangladeshi products thereby addressing the tariff related issue to a great extent. The two countries should now consider an agreement on non- tariff barriers; Progress can be made by cooperation on common challenges like disaster management, food security, environmental degradation, Border security and also included energy security etc.; Indian investment should be encouraged in Bangladesh through visits of trade delegation, trade fairs and bilateral assurances on protection of the interests of potential investors. We have to understand that there are many issues that need to be addressed successfully. If we are going to reduce border crisis, achieve well management in border issue, overcome the challenges of natural disaster and remove environmental degradation, it is imperative for the top most political leadership of the two countries to work together in being able to achieve these goals. Recently, Bangladesh conducted 11th parliamentary election on 30th December, 2018. This election result shows the present Government of Bangladesh led by Awame league and its alliance (Mohajote- Grand Alliance) retrains in the power. Grand Alliance got brute majority in the polls. This result focused landslide victory of Grand Alliance Government. For this reason we hope that the relations between two nations closely connected in the upcoming day. The some unsettled issues could be resolved within mutual cooperation and as well as people to people contact, diplomatic agreement and so on. Historically the relations between two close neighbors are very friendly. We hope that the prime unsettled issue like Teesta River Treaty will be signed with gentle agreement between the nations within a short time. Earlier, after the independence of Bangladesh, India extended best support with profound respect. This is why; India is our real kneeboard on South Asian nations. To march forward in the 21st century along with other developed and developing countries of South Asia , we need a modern, vibrant, inclusive , pro - people , pro- development issues, challenges to be carried forward by visionary crop of educated and enlightened leadership , those , who have helped both of the two nations in one goal and same destination. Finally, we may quote a Dickensian phase, “we are in the best of times, we are in the worst of time, we are in the edge of hope, and we are in the edge of despairs.”

References

- Bhari, N.K, (2015), “India- Bangladesh Relations: Analyzing the Recent Developments”, International Journal of Advanced Research in Management and social Sciences, 4, 8 August, India.
- Budania, Rajpal (2003) The Emerging International Security, Strategic Analysis, Vol- 27, Jan - March, 2003, Institute for Defense Studies and Analysis.
- Dhaka Tribune, December, 27, 2017
- DR MANSI MEHORTA - KHANNA, (2010) Security Challenges to India - Bangladesh Relations Center for Land Warfare Studies 10(1)
- DR S.S BINDRA, (1982), Indo - Bangladesh Relations, Deep & Deep Publications, New Delhi

- Dutta, Piyali (2004) IPCS Special Report India - Bangladesh Relations Issues, Problems and Recent Developments
- Gibbson, Micheal T. (2006), "Hermeneutics, Political Inquiry, and Practical Reason: An India - Bangladesh: 21st Century Battle for Water Sharing: Published in River Linking : A Millieninium Folly? Edited by Medha Patkar, National Alliance of peoples Movements, Initiative, Mumbai, India, January 2004
- [https:// www.defence.pk/ forums/ Bangladesh- defense/ 59471- india-going-ahead-tipai-dam-2.html](https://www.defence.pk/forums/Bangladesh-defense/59471-india-going-ahead-tipai-dam-2.html)
- [https://www.dhakachamber.com/ Bilateral/ India - Bangladesh%20 bilateral%20 Trade%20 Statistics.Pdf](https://www.dhakachamber.com/Bilateral/India-Bangladesh%20bilateral%20Trade%20Statistics.Pdf) and Ministry of Commerce, Government of Bangladesh.
- [https:// www.mfa.gov.sg/](https://www.mfa.gov.sg/).Ministry of Foreign Affairs, (2015), Agreement on Kolkata- Dhaka – Agartala Bus service,11 August, Dhaka: Government of the Peoples Republic of Bangladesh,
- Human Rights Watch Report, 2015, Bangladesh.
- India and Bangladesh Land Boundary Agreement, (1974), Public diplomatic division, Ministry of external Affairs, *indiandiplomacy.In.*, government of India.
- Jahan, Munira and Hossain, M. Farid (2016), “Bangladesh- India Relations: Some Critical Observations on Land- enclaves Transfer Agreement”, Asian Studies, Jahangirnagar university Journal of Government and Politics, No.35, June 2016
- Joyeeta, Bhattacharjee, (2012), India - Bangladesh Relations: Finding away Forward, ORF ISSUE BRIEF
- Krishnasari, Das (2013), Indias Relations With Bangladesh: Issues and Concerns World Focus
- Mantoo S.A, (2013), “India and the strategic importance of Bangladesh”, *Peace and security Review, First Quarter*, 9 September.
- Pant, H.V, (2007), “India and Bangladesh: Will the train ever meet?”, Asian Survey, No.47, 2 February
- Quadir, S. (2015), “India, Bangladesh sign historic land boundary agreement”, The daily Star,6 June.
- Rahman. M. M, (2006). “The Ganges water conflict-A comparative analysis of 1977agreement and 1996 Treaty”, Asterisk’s, *Journal of International and Peace Studies*, No ½, The Galizan Institute of International Security and Peace Studies (IGESIP), Coruna: Spain
- Rashid, H., (2 014). “Teesta water sharing: Some Hard Fact”. The Daily Star, Dhaka, 11, October, 2014
- Rashid, Harun (2010) Bangladesh - India Relations Living With a Big Neighbor, A H Development Publishing House
- Rashid, Harun Ur (2002), Indo - Bangladesh Relations an Insider's view, HAR - ANAND publications Pvt. Ltd.
- Sobhan, Farooq (ed), (2006), Bangladesh Enterprise Institute, The University Press Ltda.
- Sobhan, Rehman (ed) (2002), Bangladesh - India Relations Perspectives from Civil Society Dialogues, The University Press Ltd.
- Stein, Arthur A, (1990), Why Nations Cooperate? Circumstance and Choice in International Relation, Thaca, NY: Cornell University Press
- The Bangladesh Obserbr, 2011
- The Daily Star, August 2012
- The Daily Star, February 2013

Impact of Digital Media on Electoral Campaign: A Study on 2018 Parliamentary Election in Bangladesh

Md. Sayeed Al-Zaman*
Manir Uddin Sikder**

Abstract: In modern representative democracy, election is considered as the most significant way of producing and promoting democracy. To successfully accomplish the electoral process, manifold groups, such as political parties, and citizens participate in political activities. However, this practice is evolving over times, and in modern world, digital media has emerged as a game changer in electoral participation. Bangladesh with a skyrocketing number of cyber-dwellers is not lagging in this race. In the last decade, an apparent paradigm shift has taken place, and prior public sphere has become digitalized. In such circumstances, this research investigates and analyses how various political actors: publics and political parties, participated in the 11th Jatiya Sangsad Election of Bangladesh through digital media. It also explores the dynamics of this communicative environment extrapolating a few unique propositions. It has been seen that digital media has widely been used by the new digital publics to actively participate in electoral campaign and exert influence.

Keywords: Electoral participation, democracy, political communication, digital media, Bangladesh.

Introduction

Media has profound impact on political process of every democratic country. Theorist in recent times are giving importance on media effect in shaping political behavior and awareness of the related groups: public, political parties, regarding the electoral process (Aalberg & Curran, 2012).

However, media in the meantime has evolved tremendously and turned into a key political participant in political process. The miracle comes with the origin and advent of digital media. The role of traditional media in pre-digital Bangladesh was nominal, and the expression was most often unnoticeable. Political communication through placard, festoon, banner and graffiti have been becoming almost history, and some of them have found a new nest in new media by changing their previous form: from traditional to digital. When politics met digital media in Bangladesh, precisely from the second half of the 2000s, it was a wonderful beginning of a new era of political activities and participation.

Although online platform could not and possibly never would substitute the physical playground of politics in Bangladesh and elsewhere, but the involvement and influence of digital media is booming in political arena. Thus, contemporary electoral politics in Bangladesh following many other countries is taking a new shape. Instead of roaming

* Lecturer, Department of Journalism and Media Studies, Jahangirnagar University, Savar, Dhaka, Bangladesh, Email: msalzaman@juniv.edu

** Assistant Professor, Department of Public Administration, Jahangirnagar University, Savar, Dhaka, Bangladesh, Email: sikdermanir62@gmail.com

around to persuade the prospective voters, public representatives as politicians are employing much of their efforts in political campaign through digital media. Thus, a new journey toward digitalization of political participation has begun.

The 11th Bangladesh Jatiya Sangsad Election held on December 31, 2018 in fact came with a ray of hope in Bangladesh traditional political atmosphere. Participants from various groups and categories got involved in political participation: supporting parties, disseminating messages, favoring and resisting political information and issues, political debate and discourses, etc.

In such circumstances, it is imperative to carefully examine the usage of digital media, with a specific focus on social networking sites (SNSs), in elevating or evaporating and directing or diverging the public opinion since political leaders were passionate to harboring and reaping the benefit of online interaction. Even the publics were also partaking in this political gamble.

Therefore, this study deals with the explicit and implicit characteristics of electoral participation through digital media, dimensions of political communication during the election period, unravels the underlying mechanism of political game regarding online community, and the political correlation and reciprocity of interest groups. To do so, digital media in Bangladesh have been observed and studied carefully for four months starting from October 2018 to January 2019. Analysis of digital media contents and, to some extent, systematic observation have been the predominant way to analyze digital data. As the utmost interactive section of internet, social media has gained more privilege in this research in terms of analysis and discussion.

Although the focus would be the case of the 11th Jatiya Sangsad Election, a holistic discussion has been articulated here. What has not been dealt in this study is the direct impact of digital political participation in electoral (or political) outcome. Rather, it has been hinted that a heavy communication might influence an outcome either in positive or negative direction.

Digital Media in Bangladesh

Comparison between previous and contemporary culture of communication might present an overall comprehension on how the acquisition, distribution, manipulation, and storage of communication contents has been changing over the last few years, more precisely, a decade or little more.

A single invention with many names: new media, cybermedia, internet-based media has revolutionized the entire history and context of human interaction. Digital media has converged computing with media for the first time in the six hundred years' history of mediated human communication (Manovich, 2006). To demonstrate the pivotal differences between traditional analogue and new digital media, Creeber and Martin presents the following idea:

First, digital media surpasses analogue technology in that it is easily transferable across distinctly different media platforms, it is easily manipulated and networked, it can be stored and remotely accessed or distributed and is

more resilient to corruption during storage or transmission. Second, digital data is also easier to manipulate, and the end result can be reproduced indefinitely without any loss of quality. In short, digital material exceeds analogue systems in terms of speed, quality and performance. (Creeber & Martin, 2009:02)

Digital media penetrated Bangladesh traditional communicative environment in 1997, although the intensity was nominal and unimportant. Only 0.00075 per cent people of the entire population was using internet then (World Bank, 2016). However, after the arrival of social media, particularly Facebook in 2004, the things have been changed dramatically. Online community has started getting bigger.

Even in the last decade, a big explosion took place in Bangladesh internet sector that uplifted the total internet user from 1 per cent of the total population in 2006 to 18.25 per cent in 2016, that is almost eighteenfold (The Global Economy, 2016). Facebook, Twitter, and Youtube are the three most surfed digital media platforms in Bangladesh.

Electoral Participation in Bangladesh

Electoral participation is the most popular political participation in democratic system. Since electoral participation is the kernel of political participation, this section is presented the analysis of political participation from different dimensions. To define political participation, Verba, Nie and Kim (1978) refer to “those legal activities by private citizens which are more or less directly aimed at influencing the selection of governmental personnel and/or the actions they take.” (p. 01).

In practice, political participation is the act of citizens who are willing to change policy or decisions taken by authority. The policymakers can be governmental personnel, and authority can be government body. Political participation, precisely after the Second World War, is considered as a legal right of any citizen in any democratic state.

However, through the penetration of open access digital communication platforms, the traditional way of participation in election as well as other forms of politics has been changed a lot, and changing speedily. Bangladesh as a digitally thriving country is also experiencing such tendency.

Modes of political participation

Political theorists define the modes of political participation in different manners: active, and passive (Milbrath & Goel, 1977), and instrumental, and expressive (Mukhopadhyay, 1977). Hitherto the most recognized classification of political participation is proposed by Smith et al. (1980): conventional, and unconventional. The conventional and approved political participation includes voting, public opinion, campaign, etc., and the unconventional and unconstitutional political participation includes demonstration and violence, procession and slogan, riot, etc.

Nevertheless, theorizing procession, demonstration and slogan as unconventional is erroneous as in democratic process, these are usual, perceptible, and spontaneous. Expansion of digital media has transformed the effectiveness and inner mechanism of almost all modes of political participation drastically in Bangladesh.

From the aspect of online and offline participation, a clear demarcation line can now be illustrated. Offline and online participation from the aspect of impact has been divided into low- and high-effort participation, thus we got four total participation categories: (a) offline low-effort participation, that includes displaying campaign signs (stickers, posters), signing a petition on the street, reminding someone to vote; (b) online low-effort participation, that includes liking a political actor or cause, sharing political information, posting short political comments, signing an online petition; (c) offline high-effort participation, that includes attending political meetings and demonstrations, contacting political candidates, working for parties or candidates; and (d) online high-effort participation, that includes sending email to politicians, writing political blog, engaging in political discussion, creating political group on social media (Knoll et al., 2018).

Real space political actions previously were assisted by online political activities. The scene has changed to a certain degree. Political campaign, which has significant effect in electoral process, has now incorporated a new strategy called “social media campaign”. The presidential election campaign of Barack Obama through SNSs is often considered the first successful and most decisive instance of it. Like John F. Kennedy who mastered television to achieve political goal, Obama succeeded in identifying the potential of social media as a political tool (Bogost, 2017). However, theorists often exaggerate the fear of digital media effect:

Many studies focus on the decline of many traditional forms of participation, in particular voting, joining political parties and campaign related activities, to suggest a decline of political engagement that will have a catastrophic impact upon democracy if not arrested. (Lilleker, 2004:151)

Based on this statement, it can certainly be argued that the modes of political participation in electoral process are not in decline but under a unique transformation, and a paradigm shift is happening: from real space to cyberspace. In public opinion formation, SNSs like Facebook and Twitter have already proved their efficiency over traditional media in several key elections and referendums across the world. Consequently, in Bangladesh, politicians are moving towards social media to conduct their election campaigns. Therefore, to say euphemistically, digital media is only transforming the practice of political involvement often within the traditional mode of participation.

Medium of political participation

Accompanied by digital communication system, political communication between party and public has considerably been altered. Former gaps between three compulsory components of political ground in Bangladesh: people, politician, and policy, are reduced noticeably. Nowadays, individuals as citizens are getting closer to the political figures as well as political decisions with the help of effective new media communication.

Open-access digital platform provides the opportunity to discuss political issues, share political information, and form political opinion within the active virtual community who is willing to participate in politics, directly or indirectly. The USA election in 2016, for an example, was determined by specifically two tendencies: (a) online platform, a ground

of political debate with a range of information as well as stimulants, such as fake news; and (b) online community, an active participants body who were influenced in politics (Allcott & Gentzkow, 2017).

Specifically, from the last decade, the thriving epoch of cyberspace, world elections are being dictated by cyberpower. Emergence of “big data” and other data firms are contributing and facilitating this process. Algorithm makes the job lot easier analyzing the public opinion and helps political body to take necessary measures to guide the opinion flow. Cambridge Analytica’s breaching and hijacking the Facebook users’ data, and mediating three vital voting incidents: Donald Trump and Ted Cruz’s political campaign in USA, Brexit vote, Mexican general election, is considered few of the biggest political incidents in digital age (Davis, 2015; Cadwalladr & Townsend, 2018; Ahmed & Hakim, 2018).

The fundamental way of political communication is under ultimate reconstruction due to the penetration and growth of new media, and digital public sphere is substituting the existing real space public sphere. Consequently, traditional form of interaction among participant groups in an electoral process is going highly virtual than the physical, and new age media as an intensive reciprocate channel is acting as the determinants of political incidents.

In the past, individuals as active citizens took part in political activities and interacted with political organizations in the absence of effective mediators (e.g. television and newspaper). What we still observe in now Bangladesh is that the conventional media usually gather information and publish news instead of maintaining active mediation betwixt participants and political bodies despite a few exceptional endeavors (e.g. Vox pop and quote of general people).

Moreover, only political elites could use traditional media as a political weapon in formulating public opinion. Therefore, the entire political process was, to some degree, deprived of a truly effective and interactive negotiator. However, with the emergence of digital media, political communication became two-ways with prompt feedback and impact, and more accessible as well that filled up the existing gap in political communication.

Digital Media in Electoral Participation

During the previous century, three pivotal mainstream media: television, radio, and press were playing the directional role in elections and political participations in terms of media. Although the scope and luxury to participate in politics through these media were limited, more specifically for the mass people. Hence, traditional media was, to some extent, failed to serve the greater interest of the public.

On the contrary, media in digital age is unique in nature and operation, and relatively better performer than its predecessor. British Prime Minister David Cameron in his 2009 speech, addressing internet as “amazing pollinator”, said it “turns lonely fights into mass campaigns; transforms moans into movements; excites the attention of hundreds, thousands, millions of people and stirs them to action” (Polonski, 2016).

However, in 2016 European Union (EU) referendum on Brexit, internet turned against him becoming his worst nightmare, and due to Russian alleged social media mechanism, anti-EU sentiment soared up (Quinn, 2018).

Following many global events and phenomena and the housing of huge number of Bangladesh citizens in SNS drive the political figures to get into virtual in order to influence their potential voters. First palpable evidence of social media campaign was seen in Dhaka City Corporation Election 2015 where the candidates used the most prominent SNS in Bangladesh, Facebook, to mobilize the potential voters. The competitors were conscious about the strength of online community.

However, not only pre-election period, rather stimulating public opinion needs to be a continuous process in digital media since online dwellers are the “most updated entities” who regularly monitor the activities of the potential leaders, discuss political issues within their community, and therefore, try to form effective public opinion in favor or against specific political figures or parties. For that reason, enthusiastic politicians invest their concern for SNS with their compelling images (“Bangladesh Road”, 2016).

Based on several fundamental reasons, politicians are going for digital media campaign. Firstly, the new media platforms are getting extremely populated by individuals, and the nature of this online community is centralized and intensely interconnected, although diverse at the same time. This provide a unique scope for an information to spread and reach huge number of people with immense impact ultimately with no cost at all, those are absent in traditional broadcast and print media.

Digital media grandstand in Bangladesh is perhaps going to be parallel or supersede the mainstream media (“Is social media”, 2017). In some contemporary cases including Shahbag Movement in 2013, Road-Safety Protest in 2018, Quota Reform Protest in 2018, digital media surpassed the appeal and advantages of traditional mainstream media.

Secondly, the context and pattern of communication matters when it is all about impact. Direct and two-way communication in digital media work more than indirect, passive and linear one. Politicians have to endure explicit public trial and open criticism of virtual individuals as online platform enables the users to express their feelings of gratitude or disgust, and affection or criticisms against political organizations more independently and in non-filtered manner.

Thus, with almost no effort, the public representatives of the governmental authority can measure public temperament and opinion climate, and get a wonderful perception regarding public demand that could make the activities and policies of governing body and its implementation more accountable and fruitful (Bene, 2017). To be more credible to the citizens is the key to a political party or politician to be succeed eventually. Therefore, these are the *raison d'état* of the politicians' involvement in digital media in contemporary Bangladesh.

Digital Media and Political Participation in Jatiya Sangsad Election

Two major contesting parties: a Grand Alliance¹ (*Mohajot*) headed by AL, and Jatiya Oikya Front² (National United Front) headed by BNP appeared in the 11th Jatiya Sangsad

Election 2018 along with Left Democratic Alliance³ and independent contestants. However, AL as the foremost political party swept a landslide victory 259 of 300 seats whereas JP and BNP secured 20 and 5 seats respectively. Election of two constituencies (Brahmanbari-2 and Gaibandha-3) was postponed and not declared due to irregularities and death of a candidate respectively. Therefore, the results of 298 seats were declared out of total 300 seats.

Total 39 political parties and 1846 candidates participated in this national competition. The total number of voters were 104.1 million and voter turnout was 80 per cent. Meanwhile, Sheikh Hasina, for the third consecutive time, rewarded with the chance to form government (Chaity, 2018; BSS, 2018; The Daily Star, 2018). Most of the countries including India, China, Russia, Iran, Saudi Arab, United States, United Kingdom, European Union, OIC, SAARC congratulated the victory despite certain allegations from the opposition (“India, Nepal”, 2018; “Hat-trick”, 2018).

Unconventional political participation has been observed during the pre-election period amongst the participants. Public discourse regarding upcoming election issues was at a peak after the nominations of the contesting candidates. The 11th Jatiya Sangsad Election of Bangladesh was having a remarkable number of political importance due to two specific reasons: (a) it is the first ever election in which digital media has widely been used for political campaigning and political discourse; and (b) legitimacy and credibility of the previous election was questioned from certain corners. Therefore, this election was supposed to be the “key” to restore democracy.

It is to mention that in 2014, the then ruling party AL snatched the victory through almost an uncontested election while the main opposition party Bangladesh Nationalist Party (BNP) boycotted the election (Bhattacharjee, 2014). The voter turnout was only 36 per cent according to the Bangladesh Election Commission (Mollah & Jahan, 2018).

Such episodes left a room for doubts amid international as well as Bangladesh population. For those reasons, the following election gained mass interest within and outside the country. Amid such circumstances, a newly emerged virtual populace, popularly known as online community, played an important role in mobilizing the electoral discourses and moving towards constructing successful opinion polls.

Online dwellers during the election

Unlike previous elections, the 11th Jatiya Sangsad Election, to some degree, is different, and what separates the recent one from the preceding elections is the intense use of digital technology in electoral participation. Two other distinctive features are: (a) Electronic Voting Machines (EVM) is introduced for the first time in Bangladesh (Anik, 2018) along with online voter services sanctioned by the Election Commission (“How to know”, 2018); and (b) the largest number of active political participations to date.

Most importantly, the educated youngsters have been observed as more willing to participate in electoral process and political discourses demanding necessary changes in conventional ill-practices within the existing political framework, possess more political knowledge, updated information, and come up with more solid and polished reasoning

than their seniors. The highest number of online dwellers in Bangladesh was sought in the eve of the national contestation (BTRC, 2018).

Thus, the election experienced a new charm and received a new dimension. Centre for Research and Information (CRI) surmised that online content and campaigns are more effective than traditional method (Miaze & Raju, 2017). A comparison of four election years in terms of the internet users (see the Table) shows the growing tendency in user's number.

Table: Changes in Population and Internet User in the Years of National Elections

Jatiya Sangsad elections	Total population (million)	Population growth rate	Internet users (million)	Users percentage of total population
2001	134.12	1.90	8.08	0.1
2008	148.81	1.13	22.95	2.5
2014	159.41	1.16	39.77	13.9
2018	167.10	1.03	92.47	55.34

Source: World Bank (2017). *Total population*. Retrieved from: <https://bit.ly/2F6ksNH>

World Bank (2017). *Population Growth*. Retrieved from: <https://bit.ly/2Q3Sqr3>

Bangladesh Telecommunication Regulatory Commission (October, 2018). *Internet Subscribers*. Retrieved from: <https://bit.ly/2rbNSjA>

World Bank (2016). *Individuals Using the Internet*. Retrieved from: <https://bit.ly/2BGjdB8>

World Population Review (September 18, 2018). *Bangladesh Population*. Retrieved from: www.bit.ly/2AJ2Ced

Online population is mushrooming in Bangladesh on a swift fashion. The election in 2001 was the first one after the arrival of internet, and internet community was literally passing its infancy period then with only 0.1 per cent users of total country population. The number grew up slightly during the election of 2008 in 2.5 per cent. However, a remarkable inclination of internet users (13.9 percent) was observed in 2014 during the 10th Jatiya Sangsad Election.

Back then, digital contents and discussions regarding election flooded the digital public sphere. In 2018, a breakthrough in internet using population took place as 55.34 percent of the entire population have become online dwellers. This is a significant hint of how they had put impact in the electoral participation and political communication through digital media.

Astonishingly, in October 2018 onward, the netizens crossed 92.47 million in numbers and constituted more than half (55.34 percent) of the entire population. It is highly compelling that such a massive community would play an important role in electoral participation with their active observation, political debates, and opinion polls.

Influenced by the contemporary political trend across the globe, Bangladesh politicians and political parties stepped a little further in virtual world and convinced in social media campaign like their counterparts, the elected bodies from different countries who succeeded using this very platform. In India, Narendra Modi, for an instance, accomplished his goal assuming the position of Prime Minister harvesting Twitter and

organizing potential voters, and thereafter was entitled as “India’s first social media Prime Minister” (Pandey, 2015).

Meanwhile, although Bangladesh Election Commission was planning to propose a ban on digital campaign in elections (Irani, 2018), a remarkable number of key players of the election were found employing incredible efforts on online political campaigning by their positive political activism. The prime purpose was to let the people as voters know how effective they as representatives could be if they (people) elect them (representatives) through voting. These social advertisements and circulation were performed through both personal social media profiles and pages.

Digital content, audience and exceptionality

Almost all the politicians, including some popular faces, such as Obaidul Quader (Minister of Road Transport and Bridges, AL), Barrister Andaleeve Rahman Partha (Chairman, Bangladesh Jatiya Party - BJP), Zunaid Ahmed Palak (Minister of State for Information and Communication Technology, AL), Sajeeb Wazed Joy (Advisor to the Prime Minister on Information and Communication Technology, AL), Md. Shahriar Alam (State Minister for Foreign Affairs, AL), etc. were observed proactive during the pre-election period with their social media activism.

Besides, Facebook profiles and pages of political parties including AL and BNP were also filled up with written posts, photos, and videos (Raju & Antara, 2018). Pondering official Facebook pages of AL and BNP, few incredible features have been sorted out.

At least 71 videos for upcoming election have been posted in BNP’s Facebook page before election, titles of some are “*Rukhe Darabe Tarunno*” (Youths will revolt), “*Amrai Sobai*” (We are the everybody), “*Apni Desher Shokti*” (You are the strength of the country). Of them, lion’s share of the videos and writings targeted the young voters. The spokesmen of most videos are Tarique Rahman (Acting Chairman of BNP) and Mirza Fakhrul Islam Alamgir (Secretary General of BNP). These videos are well-scripted and with rhetorical narrative.

Several appealing songs, slogans, and rhymes are also generated for the election purpose, such as: “*Dhaner shish jitle jitbei Bangladesh/jonogoner dukkho hobei sesh*” (If “Sheaf of Paddy”⁴ wins, Bangladesh will win so/thus, the plight of mass would end). Criticisms of AL during its previous two terms were tried to represent in these audio-visual productions. Few specific allegations by BNP against AL were postulated in BNP’s digital contents to provoke and mobilize the potential voters to turn against their (BNP’s) opposition. Of these allegations, the disappearance and extrajudicial killings, academic dishonesty and educational failure, shrinking and mismanaged job sector, etc. during AL regime earned values.

On the other hand, AL pursue their support through intense digital campaign both in social networking sites: (a) creating and disseminating digital contents (e.g. videos, photos, illustrations and articles); (b) offline public sphere inducing digital media contents into discourse, such as title song for the election “*Jitbe Abar Nouka*” (“Boat”⁵ will win again); (c) fueling digital political debates and discourse, such as “AL era of

development is better than BNP's", "BNP is the espouser of *Razakars*⁶ and Islamic fanatics", and other worthwhile ways of digital media, such as mobile phone messaging, party's official website.

The primary motives of these initiatives are to capture public sentiment and consents in favor of AL, and kicking the opposition out of the public mind by spreading propaganda. What exclusive AL public relation wing CRI generated was: (a) Let's Talk with Sheikh Hasina; and (b) Policy Café both targeting young generation (Youth Bangla, 2019). Like BNP, AL too came up with slogan specifically targeting youths: "*Tarunner shokti, Bangladesher shomriddhi*" (Youth's vigor is Bangladesh's progress).

Some commonality between digital campaigns of AL and BNP have been seen. They both emphasized on youths in order to (re)activate their sentiments to get favor in polls. This is because youths have been being considered the changemaker of Bangladesh politics from the past three elections. In 2008 election, AL secured a remarkable victory by including "Digital Bangladesh" in their manifesto which was the mandate for youth, thus they secured a huge victory.

In this very election of 2018, more than 23 million new voters have been registered. Therefore, it is easily comprehensible that both parties would propose their appeals to this enormous youth community (Rana, 2018). On the other hand, blaming each other adjoining political contempt and popular sentiments was highly practiced by both parties and party-men in digital public sphere through digital contents. To produce impactful and burnished digital contents, political parties also hired professional advertisement firms (Alam, 2018).

Conclusion

Meddling elections, digital media has already earned the fame of effective mediator across the globe. Although in Bangladesh, this propensity is newfangled in politics, it is gaining popularity among both mass people and political authorities.

This election of 2018 is the first ever almost-full-fledged "digital national election" of Bangladesh in terms of wide political participation. Online community has been getting larger and its cumulative strength is uplifting. Bangladesh politicians, sensing this tendency, are becoming more tangled in digital communicative spheres to harvesting the fruits.

Besides, BNP as one of the would-be key players in the election has allegedly been suppressed before the election by the ruling party (Roy & Aman, 2018, "No end in", 2018). In such circumstances, they might have found it more convenient to conduct electoral campaign through digital media than in physical spaces.

On the other hand, ahead of poll, Bangladesh Telecommunication Regulatory Commission (BTRC) postponed the high speed 3G and 4G internet services of the country by promulgating that online might cause disinformation targeting election ("Govt. shuts", 2018). All these incidents suggest the importance of digital media in electoral campaign this time. Further, from several other perspectives, digital media was significant in election campaigning.

First of all, a heavy surge in online population in recent years was a hint of how this huge community would participate in political discourses through internet sites. Secondly, as most of the online publics are young so their version of participation, interaction and decision might have been different.

On the other hand, as we have seen earlier, contending political parties were pretty active in convincing the potential voters through intense online electoral campaign using digital contents. Such practices simultaneously declare a significant paradigm shift of political culture and role and usage of media in political participation. All these chronicles suggest about cyberpower.

The increased power of digital discourse has considerable impact on opinion formation, policy change, and policy implementation. Before the election, digital media nevertheless has been believed to overshadow mainstream media in sense of action, intensity, and significance. The reality somewhat supports the idea as each of the three “political man”: political leaders, political activists, and grassroot voters have welcomed and exploited digital platform as an instrument of electoral participation.

On this context, to forecasting the future of digital media usage in Bangladesh political participation, two probable trends could be postulated: (a) an optimistic view that political discourse and partaking in digital media would invigorate consensus, compromise, cooperation, unity, and nation-building; and (b) a pessimistic view that political participation through digital media would lead toward conflict, disunity, discrimination, and catastrophe.

It is hard to foretell accurately what is coming ahead as offline politics in Bangladesh still has massive impact on online political discourses, and often dictate the course of digital political participation. However, it is better to keep in mind that with the unimaginable growth rate of online community, digital media might lead the political environment of Bangladesh in near future. Although specific impact and outcome of digital media campaign in this election is yet to reveal, this article would assist further research in this area.

Notes

1. Grand Alliance or *Mohajot* includes: Awami League, Jatiya Party (Ershad), Workers Party of Bangladesh, Jatiya Samajtantrik Dal, Bikalpa Dhara Bangladesh, Jatiya Party (Manju), Bangladesh Tarikat Federation, Bangladesh Nationalist front, and others.
2. Jatiya Oikya Front (National United Front) includes: Bangladesh Nationalist Party, Gano Forum, Bangladesh Jamaat-e-Islami, Jatiya Samajtantrik Dal-JSD, Nagorik Oikya, Krishak Sramik Janata League, Bangladesh Jatiya Party, Bangladesh Khelafat Majlish, Bangladesh Muslim League, Jatiya Ganatantrik Party, Jatiya Oikya Prokriya, Kalyan Party, Liberal Democratic Party, and others.
3. Left Democratic Alliance includes: Communist Party of Bangladesh, Gonoshonghoti Andolon, United Communist League of Bangladesh, Basad (Marxist), Ganatantrik Biplobi Andolon, Samajtantrik Andolon.
4. The party symbol of Bangladesh Nationalist Party (BNP).

5. Boat is the symbol of Bangladesh Awami League (BAL).
6. An anti-Bangladesh paramilitary force constituted with local people and organized by Pakistan army during the Liberation War of 1971.

References

- Aalberg, Toril & James, Curran. (2012). How media inform democracy: A comparative approach. In Aalberg, Toril, & James, Curran (ed.). *How Media Inform Democracy: A Comparative Approach*. pp. 11-20. doi <http://doi.org/10.4324/9780203803448>
- Ahmed, Azam, & Hakim, Danny. (June 24, 2018). Mexico's Hardball Politics Het Even Harder as PRI Fights to Hold on to Power. *The New York Times*. Retrieved from: <https://nyti.ms/2lys7HE>
- Alam, S. S. (December 27, 2018). Public relation-debates in social sites. *Daily Prothom Alo*. Retrieved from: <https://bit.ly/2F5YE38>
- Allcott, Hunt, & Gentzkow, Matthew. (2017). Social Media and Fake News in the 2016 Election. *Journal of Economic Perspective*, 31 (2), 211-236
- Anik, S. S. B. (December 30, 2018). 2.124 million voters expected to cast vote using EVM. *Dhaka Tribune*. Retrieved from: <https://bit.ly/2GQ9xIP>
- Arrest spree not ending. (November 09, 2018). *The Daily Star*. Retrieved from: <https://bit.ly/2AqCXY4>
- As we saw. (December 31, 2018). *The Daily Star*. Retrieved from: www.bit.ly/2R1K6sj
- Bangladesh Awami League. (2019). Facebook. Retrieved from: <https://bit.ly/2F4zqSp>
- Bangladesh Nationalist Party. (2019). Facebook. Retrieved from: <https://bit.ly/2LMKvJb>
- Bangladesh Road and Bridge Minister Obaidul Quader takes public transport to go to office. (September 29, 2016). *bdnews24.com*. Retrieved from: www.bit.ly/2KTz9To
- Bangladesh Sangbad Sangstha. (BBS) (December 31, 2018). 11th election polls a "bright example" in national life: EC Secretary. *The Daily Star*. Retrieved from: <https://bit.ly/2C2FtUq>
- Bangladesh Telecommunication Regulatory Commission (BTRC). (October, 2018). *Internet Subscribers*. Retrieved from: <https://bit.ly/2rbNSjA>
- Bene, M. (2017). Go viral on the Facebook! Interactions between candidates and followers on Facebook during the Hungarian general election campaign of 2014. *Information, Communication & Society*, 20 (4), 513-529. doi: <http://doi.org/10.1080/1369118X.2016.1198411>
- Bhattacharjee, Joyeeta. (January 24, 2014). Bangladesh: Election-2014, an assessment. *Observer Research Foundation*. Retrieved from: <https://bit.ly/2Ud9pWm>
- Bogost, Ian. (January 06, 2017). Obama was Good at Social Media. *The Atlantic*. Retrieved from: <https://bit.ly/2jcBycl>
- Cadwalladr, Carole, & Townsend, Mark. (March 24, 2018). Revealed: the ties that bound Vote Leave's data firm to controversial Cambridge Analytica. *The Guardian*. Retrieved from: <https://bit.ly/2HL6KQY>
- Chaity, Afrose Jahan. (December 31, 2018). Nearly 80% voter turnout. *Dhaka Tribune*. Retrieved from: <https://bit.ly/2Rq9rvz>
- Creeber, Glen, & Martin, Royston (ed.). (2009). *Digital Cultures: Understanding New Media*. United Kingdom: Open University Press.

- Davies, Harry. (December 11, 2015). Ted Cruz using firm that harvested data on millions of unwitting Facebook users. *The Guardian*. Retrieved from: <https://bit.ly/2IHR0Ac>
- Govt. shuts off mobile internet. (December 30, 2018). *Dhaka Tribune*. Retrieved from: <https://bit.ly/2F6dB51>
- Griffin, Em. (2012). *A First Look at Communication Theory* (8th ed.). New York: McGraw Hill.
- Hat-trick for Sheikh Hasina. (December 31, 2018). *The Daily Star*. Retrieved from: <https://bit.ly/2VmH14v>
- How to know your polling center online? (December 29, 2018). *The Daily Star*. Retrieved from: <https://bit.ly/2BSbbDX>
- India, Nepal, SAARC and OIC happy with election. (December 31, 2018). *Dhaka Tribune*. Retrieved from: <https://bit.ly/2TijJLh>
- Irani, Bilkis. (March 03, 2018). EC Proposes ban on digital campaign in national elections. *Dhaka Tribune*. Retrieved from: <https://bit.ly/2QADqjV>
- Is social media getting stronger than the mainstream media? (January 29, 2017). *BBC News*. Retrieved from: <https://bbc.in/2ANS6SE>
- Knoll, Johannes, Matthes, Jörg, & Heiss, Raffael. (2018). The social media political participation model: A goal systems theory perspective. *Convergence: The International Journal of Research into New Media Technologies*, 1-22. doi: <http://doi.org/10.1177/1354856517750366>.
- Lilleker, D.G. (2014). *Political Communication and Campaigning*. London: Palgrave Macmillan.
- Manovich, Lev. (2006). What is New Media. In Hassan, Robert, & Thomas, Julian (ed.). *The New Media Theory Reader*. United Kingdom: Open University Press.
- Miaze, Manik, & Raju, Fazlur Rahman. (September 27, 2017). Bangladeshi political parties embrace the social media revolution. *Dhaka Tribune*. Retrieved from: <https://bit.ly/2EedpRx>
- Milbrath, L. W., & Goel, M. L. (1977). *Political Participation: How and Why Do People Get Involved in Politics?* (2nd ed). New York: University Press America.
- Mollah, Md. Awal Hossain, & Jahan, Rawnak. (2018). Parliamentary election and electoral violence in Bangladesh: the way forward. *International Journal of Law and Management*, 60 (2), 741-756. doi: <http://doi.org/00-00.10.1108/IJLMA-07-2017-0161>
- Mukhopadhyay, Amal Kumar. (1977). *Political Sociology: An Introductory Analysis*. Calcutta: K. P. Bagchi and Company.
- No end in sight to violence. (December 27, 2018). *The Daily Star*. Retrieved from: <https://bit.ly/2LAsuOm>
- Pandey, Vikas. (May 26, 2015). Narendra Modi: India's 'social media' PM. *BBC News*. Retrieved from: <https://bbc.in/2rilpr9>
- Polonski, Vyacheslav. (2016). Impact of the social media in the outcome of the EU referendum. In Jackson, Daniel, Thorsen, Einar, & Wring, Dominic (ed.). *EU Referendum Analysis 2016: Media, Voters and the Campaign*. United Kingdom: Dorset Digital Printing Ltd.
- Quinn, Ben. (February 10, 2018). Social media firms must tell users exposed to Brexit propaganda, MP says. *The Guardian*. Retrieved from: <https://bit.ly/2APVKvD>
- Raju, Fazlur Rahman, & Antara, Nawaz Farhin. (September 15, 2018). Awami League, BNP ramp up social media campaign ahead of polls. *Dhaka Tribune*. Retrieved from: <https://bit.ly/2Qh7mlW>

- Rana, S. M. (December 30, 2018). Consideration of the Young Voters. *Daily Samakal*. Retrieved from: <https://bit.ly/2GRnPsF>
- Roy, Pinaki, & Aman, Amanur. (December 26, 2018). BNP out of scene: AL running vigorous campaign. *The Daily Star*. Retrieved from: <https://bit.ly/2QkkJwy>
- Smith, David Horton, & et al. (1980). *Participation in Social and Political Activities*. London: Jossey-Boss Publishers.
- The Global Economy. (2016). *Bangladesh: Internet Users*. Retrieved from: <https://bit.ly/2E9ye0D>
- Verba, Sidney, Nie, Norman H, & Kim, Jae-on. (1978). *Participation and Political Equality: A Seven-nation Comparison*. New York: Cambridge University Press.
- World Bank. (2016). *Individuals Using the Internet*. Retrieved from: <https://bit.ly/2BGjdB8>
- World Bank. (2017). *Population Growth*. Retrieved from: <https://bit.ly/2Q3Sqr3>
- World Bank. (2017). *Total population*. Retrieved from: <https://bit.ly/2F6ksNH>
- World Population Review. (September 18, 2018). *Bangladesh Population*. Retrieved from: www.bit.ly/2AJ2Ced
- Youth Program of CRI. (January 02, 2019). *Youth Bangla*. Retrieved from: <http://youngbangla.org>

