BANGLADESH DELTA PLAN 2100

Baseline Studies : Volume 3

Land Use and Infrastructure Development

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BANGLADESH DELTA PLAN 2100

Baseline Studies on
Land Use and Infrastructure Development

Volume 3

Baseline Study 12: Land Resources Management

Baseline Study 13: Urbanization and Settlement

Baseline Study 14: Sustainable Transportation and Infrastructure

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Disclaimer

Baseline studies were conducted to review past performances, to generate information and knowledge, identify caveats and draw policy lessons and observe inter-sectoral impacts relating to water resources, land and agricultural practices and analyse climate change impacts. All these have been done to formulate delta action plan based on strategies developed through research by eminent scientists and professionals. Data, information and statements provided in the studies entirely belong to the authors, as such, GED bears no responsibility of inaccuracy, if any of data or statement.

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A H M Mustafa Kamal, FCA, MP
Minister
Ministry of Planning
Government of the People's Republic of Bangladesh

Message

I am happy to know that the General Economics Division (GED) of Bangladesh Planning Commission is publishing the Baseline Studies in six (6) volumes which were prepared for formulation of the Bangladesh Delta Plan (BDP) 2100.

Over the past 47 years since independence Bangladesh has secured tremendous gains in development. Bangladesh has achieved food self-sufficiency and the economy is gradually transforming from an agrarian base towards a modern manufacturing and services economy. Making this growth sustainable is even more challenging in the face of extreme adverse climate variability, with frequent storm and tidal surges, flooding, and droughts. I am confident that the BDP 2100 will amply guide us in realizing the vision that is aspired in the plan of being a prosperous country beyond 2041 and also contribute directly in making the growth sustainable by ensuring long term water and food security, economic growth and environmental sustainability while effectively reducing vulnerability to natural disasters and building resilience to climate change and other delta challenges. I hope BDP 2100 will also contribute to the making of 5 year plans as well as contribute to achieving SDG's and other national policy goals.

The Baseline Studies generated both quantitative and qualitative benchmark information for relevant subject areas of the plan and identified critical areas for future intervention. It also forms the basis for determining strategies and measures that have been suggested in BDP2100 for different climatic Hotspots.

I am particularly pleased to note that BDP 2100 being a techno-economic plan, is the first attempt in our national planning history to formulate a real long term plan prepared by GED. The publication of the Baseline Studies in book form which served as basis for the preparation of the BDP 2100 has immense importance to keep the institutional memory preserved. These will be useful references to the policymakers, development partners, academics, researchers, students and professionals alike to further research endeavor and knowledge sharing.

In this instance, I would congratulate relevant officials of GED of Bangladesh Planning Commission for their hard work in compiling the Baseline Studies in book form. My sincere appreciation goes to the experts in their respective fields for completing the Background Studies for formulation of the BDP 2100.

(A H M Mustafa Kamal, FCA, MP)

M. A. Mannan, MP
State Minister
Ministry of Finance and Ministry of Planning
Government of the People's Republic of Bangladesh

Message

It gives me immense pleasure to learn that the General Economics Division (GED) of Bangladesh Planning Commission is going to publish 26 Baseline Studies in six (6) volumes which have been used as the inputs for preparing the country's first long term Plan i.e. Bangladesh Delta Plan (BDP) 2100. The Baseline Studies of BDP 2100 are the culmination of both quantitative and qualitative benchmark information for relevant subject areas of the plan and identified critical areas for future intervention. I believe, GED of Bangladesh Planning Commission has pursued with various eminent professionals, scientists, researchers, academia etc. at national and international levels for conducting these Baseline studies.

I know that BDP 2100 is the long term plan for the country to realize sustainable and a commonly agreed upon strategy with specific short, medium and long term interventions involving all relevant stakeholders for an optimum level of water safety and food security as well as sustained economic growth of Bangladesh and a framework for its implementation.

I congratulate the GED for taking up this bold initiative. I would like to thank the authors and also the reviewers who have contributed to prepare these Baseline Studies. Documented Baseline Studies will also be helpful for policy planners, development practitioners, researchers, academicians, professionals and even students as well. I also expect that the Baseline Studies will be useful for the officials of GED to prepare necessary policy briefs and write-ups they often prepare. I believe that not only GED but also other relevant officials will be immensely benefited with these Baseline Studies for upgrading and updating their knowledge and professional competences. Finally, I thank GED leadership for undertaking this endeavor for publishing Baseline Studies of the BDP 2100 for much wider use.

I wish all the best and all out success.

M. A. Mannan, MP

Shamsul Alam
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Prefatory Comments

Bangladesh is one of the largest deltas of the world and its rivers and floodplains support life, livelihood and economy. The country is defined by the delta, with almost a third of the country lying less than 5 (five) metres above sea level, on the contrary however, coastal zone, the low-lying area, is highly vulnerable, especially to cyclones and storm surges. In addition, salt-water intrusion, floods, sea level rise intensify the vulnerability of the community of the areas. These problems are likely to become even worse due to climate change adverse impact.

Many more challenges lie ahead for Bangladesh, the most important being pressure on land use, environmental protection, governance, globalization and macro-economic development. Given the ambition to be a developed country by 2041, addressing the expected impacts of climate change, there is a need for an integrated approach to future land and water management in relation to water safety, agricultural growth and food security. The recent and future anthropogenic changes in the hydrological cycle due to e.g. climate change, construction of dams and barrages in the upstream countries in combination with increasing water demand are expected to make future water governance and management even more challenging.

With a view to meeting the above challenges, the Government of Bangladesh (GoB) requested the Government of the Netherlands (GoN) to assist for formulation of adaptive, multi-sectoral, comprehensive and holistic Delta Plan taking lessons from Dutch experiences. The GoN agreed to provide the necessary support through its Embassy in Dhaka. In accordance with the decision of the Government, the General Economics Division (GED) of the Planning Commission, Ministry of Planning was assigned to lead the formulation of Bangladesh Delta Plan 2100, as the GED is mandated for medium and long term planning at the national level.

Bangladesh Delta Plan 2100 has been conceived as a techno-economic, long-term, holistic, water centric, strategic plan. As such, formulation of strategies in the short (budgeting), medium and long term is the most significant part in the planning process. The long term strategies will help to fulfil the Delta Vision, whereas the short and medium term strategies will help achieve benefits within the country's 5 year planning horizon as well as contribute to achieving SDG's and other national policy goals. An interactive planning process has been followed comprising three major steps: i) Conducting Baseline Studies; ii) Formulation of Adaptive strategies; and iii) Development of the Delta Management Framework. These steps were supported by country wide consultation processes which eventually led to the outcome of an Investment and Implementation Plan.

The project has prepared 26 Baseline Studies on known delta problems, reviewing existing policies and governance challenges in the sector of water resources, land, environment, disaster, agriculture, fisheries, livestock, transportation, finance, governance, knowledge generation etc. The studies followed the basic steps of reviewing the current policy situation, assessing the status of individual sectors, identification of drivers or pressures, conducting integrated analysis

for the right interpretation of problems, challenges and knowledge gaps. For starting an integrated analysis with stakeholders it was essential to create an overview of already established and agreed-upon policies as well as to rank priorities for further investigation, research and discussion. The key elements in the approach were (a) knowing the present state, problems, impacts, challenges and current responses or interventions; (b) consideration of uncertainties of social and natural systems and knowledge gaps; (c) the evaluation of drivers, trends or events in the interaction between the delta and society.

These Baseline Reports have been clustered into Six Volumes on the basis of thematic issues and topics.

Volume 1: Water Resources Management consists of seven Baseline Reports: 1. Sixty Years of Water Resources Development in Bangladesh: Lessons Learnt; 2. River System Management; 3. Water Resources; 4. Groundwater; 5. Coast and Polder Issues; 6. Water Supply and Sanitation; 7. Part A- Sediment Management and Part B- Meghna Estuary Study;

Volume 2: Disaster and Environmental Management consists of four Baseline Reports: 8. Climate Change; 9. Disaster Management; 10. Environmental Pollution; 11. Ecological Setting;

Volume 3: Land Use and Infrastructure Development consist of three Baseline Reports: 12. Land Resources Management; 13. Urbanization and Settlement; 14. Sustainable Transportation and Infrastructure;

Volume 4: Agriculture, Food Security and Nutrition consists of four Baseline Reports: 15. Agriculture and Food Security; 16. Fisheries; 17. Livestock; 18. Forests and Biodiversity;

Volume 5: Socio-Economic Aspects of the Bangladesh Delta consist of three Baseline Reports: 19. Population Growth and Management; 20. Socio-Economic and Demographic Condition; 21. Socio-Economic Characteristics of Chittagong Hill Tracts;

Volume 6: Governance and Institutional Development consists of five Baseline Reports: 22. Institutional Framework and Arrangements; 23. Information and Knowledge Management; 24. Regional Cooperation; 25. Financial Mechanisms & Arrangements in the Water Sector in Bangladesh; and 26. Private Sector Engagement in Deltas.

Volume 3: Land Use and Infrastructure Development

Land Resources Management: The land use or land coverage include forests, herb/shrubs, fallow/agricultural land, river and water bodies, settlements, hill shades etc. About 83.5% of land is covered with agriculture-related land use (crop land, forest, mangrove, river, lake, *beel* and *haor*, aquaculture, tea plantation and salt pan) and the rest 14.5% is used under non-agricultural land (rural and urban settlement, industrial zone, and accreted). The land form is mainly floodplains. Distribution of land type throughout the country is, maximum area (40%) is covered with medium highland and the highest area coverage (38.6%) is under a poorly drained condition. About one fifth of the land is in the coastal zone of which approx. 1.06 million ha is affected by different levels of soil salinity. Soil salinity areas have been found as 0.83 million ha, 1.02 million ha and 1.06 million ha in 1973, 2000 and 2009, respectively. The increasing trends of soil salinity area are of 26.7% and 3.5% from 1973 to 2009, and 2000 to 2009, respectively. The area of soil salinity is expanding due to reduction of the upstream flow mainly due to human interventions.

The main challenges for land resources management are - optimizing of land use in relation to spatial planning, restoring soil health, increasing land area of the country along the rivers and coast, checking the threat of salinity intrusion and desertification, saving agricultural land from increasing urban and rural settlements, river bank erosion and industrialization due to increase in population, reducing conflicts in coastal land use, integrating management of coastal land resources, stopping conversion of potential agricultural land to brackish water shrimp culture, etc. The increase of the population and decrease of crop land, are threatening the food security. To meet the increased demand of food, there will be extreme challenges for infrastructure (e.g., embankments, irrigation and drainage systems, inland

waterways, roads, transportation facilities, housing etc.), resources (e.g., food, water, electricity), and jobs, accompanied by reduction of crop land. Intensive cultivation would be required for additional food which would deplete the nutrient status of soil. Climate change would induce land degradation. The sea level rise would enhance land loss, salinity intrusion and migration of settlement. Lands are also being polluted by being contaminated with heavy metals through industrial effluents and irrigated water.

The present government has been pursuing inclusive and sustainable development of the country with a view to establishing Bangladesh as a middle income country by 2021; and developed country by mid- 2041, mainly through development of industries, infrastructure, roads, electricity production and construction of new power plants.

Urbanisation and Settlement: With regard to urbanisation and settlement, a rapid growth is observed driven by amongst others, population growth, especially in the urban areas due to the migration of people from rural to urban. The situation is critical in the Mega city Dhaka and the metropolises of Chittagong, Khulna and Rajshahi. The growth may be termed to be developing in an unsustainable manner. An unbalanced development of urban centres is observed with Dhaka as a primary city. The centralised government makes Dhaka the focus point for services, government and economic developments and investments. This attracts from rural areas many migrants who settle in the city. This increase of inhabitants gives tremendous pressure on the capital city, plus the other populous metropolis. There is pressure on open space of floodplains and agriculture land, availability of sufficient services and affordable houses, infrastructure and in general to the liveability of the city, especially for the poor.

Bangladesh is one of the highest populated countries. According to 2011 census data, the total population density is about 1,015 people per square kilometre. According to the recent UN data, approximately 25% of Bangladesh's current population lives in urban areas. Of this urban population, more than half lives in the four largest cities: Dhaka, Chittagong, Khulna and Rajshahi. The population density is now believed to have reached around 34,000 people per km^2, making Dhaka amongst the most densely populated cities in the world. The area under rural settlement was estimated 885,637 ha in 1976 occupying 6.1% of the total area of the country. The rural settlement area consistently increased over time at a faster rate and become 10.0% (1,458,031 ha) in 2000 and 12.1% (1,766,123 ha) in 2010.

In the national road network some rural regions are still poorly connected to markets and services. With regard to the water management aspect of the Bangladesh Delta Plan the main urbanization and settlement issues are the uncontrolled and unplanned growth within areas that either have a function or reservation for water management (such as water storage, drainage or flood plains) or are prone to a high risk of disasters such as hurricanes, erosion or floods.

Though there are plans, policies and acts in place for managing housing and urban development in relation to the preservation of open space, they are not integral and are in general poorly implemented. There is no structure for urban or spatial planning that is applied on a national and hierarchic level, resulting in a lack of coordinated holistic spatial planning and with that a lack of connections with national budgets. There are two main challenges for Urbanisation and Settlements with regard to the Delta Plan:

- A well-functioning planning and implementation structure
- A national holistic long term plan combining (amongst others) water management and sustainable spatial and urban development

Additionally, a large part of the population is not serviced by the formal institutions. In absence of the formal institutions, lower and middle income groups perform informal governance activities (building roads, self-initiated access to services and amenities) to bridge the gap between their needs and the ones which are offered. Private sector real estate developers take advantage of weak urban governance by anticipating on poor implementation and compliance to acts and laws that should protect the environment and limit unwanted land use. Furthermore, the private sector exacerbates

inequality in the large cities by investing only in luxury housing projects, neglecting the urban poor and the lower and middle income classes.

A variety of possible measures is recommended in the Baseline Report to enhance the national and local planning and implementation systems: i) bringing coordination and hierarchy in physical planning and policy, ii) effective urban governance, iii) decentralization and participatory planning, iv) aligning budgeting with the modern urban context, and v) accepting the informal sector in the formal urban governance system.

Sustainable Transportation and Infrastructure: An adequate and efficient country-wide transportation system is a pre-requisite for initiating and sustaining economic development. Investment in improving transport efficiency is the key to the expansion and integration of markets – sub-national, national and international. In addition, it contributes to the generation of economies of scale, increased competition, reduced costs, systematic urbanization, export-led faster growth and a larger share of international trade. The transportation system of Bangladesh consists of roads, railways, inland waterways, sea ports, maritime shipping and civil aviation, catering to both domestic and international traffic. Besides an efficient transportation system, a reliable power system (production, transmission and distribution) is an integral component to initiating and sustaining economic development. From BDP 2100 point of view, roads and highways as well as railways need to be designed in relation to requirements of the water systems and future risks due to climate change.

The *Roads and Highways Department (RHD)* is responsible for the construction and the maintenance of the major road and bridge networks in Bangladesh. The major road network has a length of 21,481 km, out of which, the length of the national highway is 3,544 km, regional highway 4,278 km and Zila (district) road 13,659 km. Local Government Engineering Department (LGED) is responsible development and maintenance of rural road networks. The rural road networks are classified as upazila road, union road, village road A and village road B. These roads both consist of earthen or paved road. The total length of roads under LGED is about 296,000 km, out of which the earthen road 213,000 km and paved road 83,000 km. Despite the large investments to develop the country's road network, the condition of the most of the roads remained far from satisfactory.

The transportation sector in Bangladesh does not have any direct revenue generating programs. Transport related revenue generators; such as tolls and vehicle taxes are given to the government exchequer first - it is up to the government to decide how much of the revenue is allocated to which Ministry and division. According to a 2003 World Bank study, less than 40% of money collected from road users was actually spent on road maintenance. Bangladesh also has one of the world's lowest levels of tax revenues in comparison to GDP, for instance in FY 2013 total tax revenue was only 11.3% of GDP. As a result of the lack of sufficient funds in the budget and the low levels of government revenue, it is difficult for the Roads and Highways sector to develop at the desired rate at which it should be able to cope with a growing population and economy.

Railway communication is considered to be the most environmental-friendly, safe, and an affordable form of transportation. Unfortunately, the railway only represents 4% of passengers' modal share and 4% of freight modal share – a strikingly low percentage considering the many benefits of the railway sector. This is due to railway's poor infrastructure, insufficient funding, deteriorated physical assets, and low efficiency of services compared to other available transport types. Bangladesh Railway (BR), the state-owned rail transport agency of the country, currently includes approximately 2,877 km of railway network (connecting 44 districts), 440 stations, 286 locomotives, 1,503 coaches and 10,226 wagons. There are 261 passenger trains of which 68 are intercity, 66 are mail and express, 127 local, and 55 goods and container trains.

BR, both a public utility service and a commercial enterprise, is heavily subsidized by the Government and has historically been incurring large operating deficits that have only been increasing year by year. Although BR is legally allowed to

act commercially and is able to set its own freight tariffs, and add and cancel trains and services as they find suitable, they do not generally exercise this power primarily for fear of public and political backlash. For example, FY 2012's operational deficit is approximately ($128.05 million) and FY 2013's operation deficit is approximately $108.5 million (Tk. 841 crore); a large deficit and therefore a burden for the Government to subsidize.

The main challenges of the Railway are lack of connectivity, geographical constraint, chronic lack of investment, slow implementation, institutional issues, and negative perception. A major constraint in BR is its lack of rail connectivity between rail networks, usually due to difference in rail gauges and the incompatibilities in rolling stock. The railway network is mainly built on two different gauges, broad gauge and meter gauge, which involve transhipments of traffic at certain points where there is a break of gauge points. Moreover, as Bangladesh is a riverine country and hundreds of rivers flow throughout the country, many far-flung locations cannot be connected rail-wise, as it would need to build costly bridges across the rivers. This makes it even more difficult for BR to adequately serve the needs of the country. Moreover, since the liberation of the country in 1971, the government has not adequately focused on the construction of new rail-routes; the existing railway routes did not have the required proper maintenance. There has been minimal investment in the railway, which has left this particular transport sector in desperate need of adequate funding.

Climate change is also a huge threat. A World Bank study titled *Climate Proofing Infrastructure in Bangladesh* stated that, "using the 1998 flood as a benchmark for evaluating additional protection measures, the authors calculate conservatively that necessary capital investments out to 2050 would total US $2.671 billion (at 2009 prices) to protect roads and railways, river embankments, surrounding agricultural lands, and drainage systems and erosion control measures for major towns."

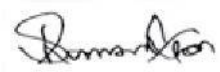
Inland Water Transport (IWT): The extensive river network provides many natural navigation facilities almost throughout the country. Although navigability is the cheapest and an environment friendly mode of transport of goods and passengers, the possibilities for inland shipping have been deteriorating, mainly due to sedimentation, wrong human interventions and lack of maintenance over the last decades. In the coming decades, it would be a challenge to maintain the navigability as a complementary and important sector of communication and transport.

One of the main causes of the declining trend of inland water transport identified in the Baseline Study is the deteriorating condition of the river system in Bangladesh caused by both morphological and natural processes, and withdrawal of water beyond the border and within the country. Length of navigable waterways determined by a 1989 survey was about 6,000 km in the wet season which used to be reduced to about 3,600 km during the dry period. One of the main factors for revival of IWT would be container traffic in inland waterways. To meet the growing demand of transporting containers between Dhaka and maritime ports, utilization of inland waterways has become inevitable. Railways suffer from capacity constraints and the road does not have bearing capacity to accommodate trailers, so all the studies conducted recently recommended for inland waterways and related facilities. An Inland Container Terminal has already been developed through a joint venture project of BIWTA and Chittagong Port Authority (CPA) with an annual handling capacity of 116,000 TEUs which is to be followed by another 4 inland container terminals under construction by private sector.

BIWTA is unable to recover its cost from revenue. In the FY 2013-14, the total revenue expenditure of BIWTA was Tk 3,164.06 million as against revenue earning of Tk 3,041.05 million. BIWTA had to incur a deficit of Tk 123.01 million. Of the total revenue earned by BIWTA, 55% on average comes from GOB grants and contribution. The GOB has to support the Mongla Port Authority on regular basis to meet its revenue expenditures. But in recent years the financial picture of MPA looks brighter. The MPA was able to earn surplus of Tk 341.43, 433.32 and 480.95 million in 2011-12, 2012-13 and 2013-14 respectively. The Chittagong Port Authority has been enjoying the monopoly in the trade of maritime port services with significant amount of surplus every year.

Power: Power sector in the country is experiencing a transition period at present. Till now the power sector is heavily dependent on the local natural gas and coal. The gas reserve of Bangladesh is declining. So, it is expected that in the near future the power sector will shift its dependence from natural gas to imported coal and then local coal. Therefore the power sector will be more dependent on transportation sector especially on rail and waterways. Bangladesh has quite a good reserve of high grade coal, but due to the dense population it is difficult to evacuate a vast area of land to explore the coal. Government is yet to decide how to explore the national coal reserve, whether it should go for open mining or tunnelling method or underground coal gasification method. Coal is the cheapest alternative to natural gas for near future power solution. Bangladesh is aspiring to have nuclear based power generation and is planning to have approximately 4000 MW of electric power capacity from nuclear by 2030. In future, CO2 emission from coal based power plants, safety of nuclear power plants and source of cooling water for these power plants will be of great concern.

The power sector is facing many challenges such as: lack of adequate resources (private/ public/ external); issues relating to Good Governance; lack of adequate co-ordination; lack of appropriate cost and asset accounting system; irregular and insufficient gas supply; inadequate maintenance of power plants; tariff rate and structures; delay in implementation of power projects; organizing funds for project implementation; lack of prioritization of projects, load shedding; lack of maintenance budget; failure in routine maintenance and forced shutdown of power plants and blackout. In addition, the power sector will face more challenges in future mainly due to expansion of the sector. The future challenges include transportation of fuel, lack of cooling water due to the changing situation, project financing, transportation of fuel, safety of nuclear power plants, human resource development for new technologies, limited budget of research & development on new technologies and overdependence on Imported Power. The Study indicates potential new sources of power like Hydro-power, Solar- and Wind generated energy which are to be studied and related to BDP 2100 strategies and interventions.



(Shamsul Alam)

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The International Economics Wing of the General Economics Division (GED), Bangladesh Planning Commission, coordinated all the reports under the broad and extensive guidance of Dr. Shamsul Alam, Member (Senior Secretary), GED, so that, the Plan could meet the quality standard. Mr. Naquib Bin Mahbub, Division Chief; Mr. Md. Mafidul Islam, Joint Chief; Dr. Md. Mizanur Rahman, Ex. Project Director; Mr. Mohd. Enamul Haque, Deputy Chief and Project Director, Dr. Md. Taibur Rahman, Senior Assistant Chief; Mr. Md. Murtuza Zulkar Nain Noman, Senior Assistant Chief, Mr. Mohammad Asaduzzaman Sarker, Senior Assistant Chief and Mirza Md. Mohiuddin, Assistant Chief provided constant support in the process of preparation of the plan.

The Embassy of the Kingdom of the Netherlands, in addition, regularly arranged funds and meetings. Ms. Martine van Hoogstraten, Head Development Cooperation, Mr. Carel de Groot, and Mr. Peter de Vries, First Secretary, Mr. ATM Khaleduzzaman, Senior Advisor, Water Management of EKN, always extended their valuable support to the activities related to the BDP 2100 project.

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We from GED gratefully acknowledge the efforts by all concerned.

June 2018

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Abbreviations

AEZ	Agro-ecological Zones
APB	Actionable Policy Brief
BADC	Bangladesh Agriculture Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agriculture Research Institute
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
BJRI	Bangladesh Jute Research Institute
BRRI	Bangladesh Rice Research Institute
BTRI	Bangladesh Tea Research Institute
BWDB	Bangladesh Water Development Board
CA	Conservation Agriculture
CARE	Co-operative for Assistance and Relief Everywhere
CARDP	Coastal Area Resources Development Plan
CCA	Community Conservation Area
CDS	Coastal Development Strategy
CEC	Cataion Exchange Capacity
CEP	Coastal Embankment Project
CHT	Chittagong Hill Tracts
CLDDP	Community Livestock and Dairy Development Project
CZPo	Coastal Zone Policy
DAE	Departmemt of Agriculture Extension
DLRS	Directorate of Land Record and Survey
DLS	Department of Livestock Services
DoE	Department of Environment
DOF	Department of Fisheries
DOR	Department of Forest
ECA	Ecologically Critical Area
FD	Forest Department
GOB	Government of Bangladesh
ICZMP	Integrated Coastal Zone Management Plan
IISD	International Institute for Sustainable Development
IPTT	Immovable property transfer tax
IWMP	Integrated Water Management Plan
MOFL	Ministry of Fisheries and Livestock
MDGs	Millennium Development Goals
MoWR	Ministry of Water Resources
NAP	National Agricultural policy
NCA	Net Cultivable Area
PCU	Project Coordination Unit
PIP	Priority Investment Program
PRSP	Poverty Reduction Strategy Plan
REDD	Reducing Emissions for Deforestation and Degradation in Developing Countries
SRDI	Soil Resource Development Institute
USF	Unclassified State Forest
WARPO	Water Resources Planning Organization

BASELINE STUDY: 12

Land Resources Management

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Executive Summary : Study 12

Bangladesh is a deltaic country, located in South Asia with a coastline of 710 km on the northern hub of the Bay of Bengal. The total land area of the country is about 148,400 km^2 of which 52.8% is net cultivable area (NCA). The fertility of the soil is due to the deltaic plain of rivers such as the Ganges, the Brahmaputra and the Meghna (GBM) and its tributaries. The country is densely populated (1,174 people per km^2). Land scarcity, in relation to demand, is showing up in accelerating increases in land prices. Land availability, as well as its sustainable management, has important bearings on overall development of the country. The Government of the Netherlands, through its Embassy of the Kingdom of the Netherlands (EKN) in Dhaka, provides support for the formulation of Bangladesh Delta Plan (BDP2100) as per request of the Government of Bangladesh (GOB). Land resources management is one of the 19 themes that have been selected for the formulation of BDP2100. The main objective of the project for the formulation of the Delta Plan is to realize a sustainable and commonly agreed upon strategy, with all relevant stakeholders, for an optimum level of land resources management, water safety and food security, as well as, sustained economic growth of Bangladesh, and a framework for its implementation elaborated investment plan phased in short, medium and long term interventions.

The baseline information on land resources (agro-edaphic characters, land use, constraints, challenges, trend analyses-related land use patterns, land degradation, erosion, accretion, coastal land management, land governance, gender, and population) have been collected, mainly from secondary sources. The data were screened, verified, collected, co-related and analyzed, and presented in the baseline situation of Bangladesh Delta. Different important sub-thematic issues have been identified as indicators for the preparation of future development plan. The information furnished in the report would be used for the formulation of BDP2100 project.

The existing policies/strategy documents/ plans relevant to land resources in Bangladesh have been reviewed. The land sector policies include those related to land use policy, coastal zone policy (CZPo), national *Jalmohal* policy, saltmohal management policy, national urban sector policy, national water policy, water Act, environmental policy, and national rural development policy. The cross-cutting sectors, covering crop production, fisheries & livestock and forestry appears less prominently both in terms of coverage and focus, including coastal land management plan, integrated coastal zone management plan, sixth five yeagr plan, perspective plan of Bangladesh, Master Plan for Agricultural Development in Southern Region of Bangladesh, Master Plan of Haor Areas were reviewed and the possible gaps have been identified.

About 83.5% of land is covered with agricultural related land use (crop land, forest, mangrove, river, lake, *beel* and *haor*, aquaculture, tea plantation and salt pan) and the rest 14.5% is used under non-agricultural land (rural and urban settlement, industrial zone, and accreted) of the Bangladesh Delta. The land form is mainly floodplains. Agro-ecological regions of Bangladesh have been incorporated with their main features, characteristics and indications of existing agro-ecological constraints. Distribution of land type throughout the country has been furnished in the report. Maximum area (40%) is coverd with medium highland and the highest area coverage (38.6%) is under poorly drained condition. About one fifth of the Bangladesh Delta is in the coast of which about 1.06 million ha is affected by different level of soil salinity. Soil salinity area has been found as 0.83 million ha, 1.02 million ha and 1.06 million ha in 1973, 2000 and 2009, respectively. The increasing trends of soil salinity area are of 26.7% and 3.5% from 1973 to 2009, and 2000 to 2009, respectively. The area of soil salinity is expanding due to reduction of upstream flow mainly due to human interventions.

The nutrient status of soils of Bangladesh Delta has been collected and presented in the report. Most of the soils have less than 2.0% organic matter (O.M). The soils suffer from nitrogen deficiency for most of the crops grown. The optimum level of P- status (18.1-24.0 µgm-1) is about 11.4% of the NCA. About 20.3% of the total area is under optimum level of K- status (0.225-0.30µgm-1). The coverage of low and medium classes of soil S is about 26.9% and 18.6%, respectively of the NCA. The optimum level of S-status (27.1-36.0 µgm-1) is about 11.4% of the total area. The

optimum level of Zn (1.351-1.80µgm-1) and B-status (0.51-0.60µgm-1) is about 15%, and 16% of the NCA of the Bangladesh Delta, respectively. Zinc and S- deficiency appear due to intensive cultivation of wetland rice.

The river bank erosion and accretion is common in Bangladesh Delta. Detailed information on erosion and accretion in the Ganges, Brahmatutra and Meghna rivers with locations has been incorporated in this report. A significant amount of land has already been reclaimed in the Lower Meghna Estuary and from the sea in the coastal area of the country. The main constraints for land use [resources management] in Bangladesh are: flood (flash flood, river/monsoon flood, rain flood), drainage congestion/ water logging, drought, coastal surge, soil salinity, river bank erosion, land degradation, soil erosion, soil fertility depletion, decrease of land productivity, siltation on river bed and khals, rise of sea water level due to climate change, increase of population and settlements, and decrease of crop land.

Land productivity has been assessed based on the agro-edaphic (soil permeability, effective soil depth, available soil moisture, nutrient status, soil reaction (pH), soil salinity, soil consistency, drainage) and agro-climatic factors (length of *kharif* growing period, pre-*kharif* transition period, thermal zone and extreme temperature) of Land Resources Information System which are being used for land suitability assessment in order to identify and delineate suitable area for growing particular crops. The major crops suitability maps have been shown in the report.

The main challenges for land resources management of the Bangladesh Delta have been identified. These are: optimizing of land use, restoring soil health, increasing land area of the country along the rivers and coast, checking the threat of salinity intrusion and desertification, saving agricultural land from increasing urban and rural settlements, industrialization due to increase in population and river bank erosion, reducing conflicts in coastal land use, integrating management of coastal land resources, stopping conversion of potential agricultural land to brackish water shrimp culture, and recovering of organic matter content in agricultural land which is declining. The increase of population and decrease of crop land, are threatening food security. To meet the increased demand of food, there will be extreme challenges for infrastructure (e.g., schools, hospitals, housing, roads), resources (e.g., food, water, electricity), and jobs, resulting in the reduction of crop land. Intensive cultivation would be required for additional food which would deplete nutrient status of soil. Climate change would induce land degradation. The sea level rise would enhance land loss, salinity intrusion and migration of settlement. Lands are also being polluted by being contaminated with heavy metals through industrial effluents and irrigated water. The present government has been pursuing inclusive and sustainable development of the country with a view to establishing Bangladesh as a middle income country by 2021; and developed country by mid- 2100, mainly through development of industries, infrastructure, roads, electricity production and construction of new power plants.

Analyses on land use pattern or trends of various land use scenarios with drivers have been incorporated in the report. Land covering maps of Bangladesh were estimated by using Landsat MSS 1976 and Landsat TM 2000 and Landsat TM 2010 (SRDI, 2013). The findings indicated that the land use pattern is continuously changing, while the suitability of land is also changing. The percentages of the total land mass area lost annually from agricultural land are 0.172, 0.416 and 0.244 during 1976-2000, 2000-2010 and 1976-2010 respectively. The annual trend of decreasing forest area was 1.054% from 1976 to 2000 and that of increasing trend was 0.0938% from 2000 to 2010. The area occupied by forest was 12.11% of the total land area in 1976. The forest area decreased to 9.02% in 2000 and then increased to 9.84% in 2010. It is estimated that the rate of annual decrease in river area was 0.007% from 1976 to 2000 and that of increase 0.033% from 2000 to 2010 with overall increase of 0.004% from 1976 to 2010. The average rate of increase of salt pan was 0.005% of the total area during 1976-2010. It is estimated that the annual rate of accretion was 0.003% during 1976-2000 and 0.180% during 2000-2010 with an average of 0.055% during 1976-2010. There is significant increase in urban and industrial areas of the country during the period from 1976 to 2010. The increase was almost double from 1976 to 2000 and more than three times from 1976 to 2010.

Non-agricultural land included rural settlement, urban and industrial area and accreted land. The use of non-agricultural land as estimated in this study, were 8.17%, 12.31% and 16.47% of the total area in 1976, 2000 and 2010,

respectively. The area of rural settlement was estimated to be 6.11% in 1976 which increased to 10.03% in 2000 and 12.12 % in 2010. The annual rates of increment of rural settlement area were 0.163%, 0.208% and 0.177% during 1976-2000, 2000-2010, and 1976-2010, respectively. There is significant increase in urban and industrial areas of the country during the period from 1976 to 2010. The annual rate of increase was also higher (0.027%) during 2000-2010, although the increase was only 0.006% during 1976 to 2000. The overall annual rate of swelling of urban and industrial areas was 0.012% during 1976-2010. The rate of land accretion was 1.8%, 1.95% and 3.75% in 1976, 2000 and 2010, respectively while estimated annual rate of accretion was 0.003%, 0.180% and 0.055% during 1976-2000, 2000-2010, and 1976-2010, respectively.

The distribution of land cover of Chittagong Hill Tract (CHT) has been estimated using processed satellite images for the years 2003 and 2008. The percentages of land coverage for dense forest, medium dense forest, low dense forest, herbs/shrubs and grass, fallow/agriculture land, river and water bodies, settlements and hill shades in the year 2003 and 2008 have been studied. It is observed that the maximum area (44.9%) was covered with medium dense forest in 2003 which reduced to 17.4% in 2008. Similarly, the area of dense forest was about 15.2% in 2003 which declined to 5.9% in 2008. On the other hand, low dense forest, herbs/shrubs grass and fallow/agriculture land increased in 2008 from that of 2003. The area of water bodies including river, *chhara* etc. more or less remained unchanged

Land use management practices in Bangladesh have been studied and presented. Techniques and key principles of conserving and protecting agricultural land and its management strategy development have been described. The coast land management and its strategy were also elaborately cited in the report. Benefit and conserving agricultural land uses management system and improvement of land use management, in respect of agricultural and non-agricultural (urban, rural-settlements and industrialization) sectors have been elaborately cited.

Land governance, its related policies and legislation, institutional land governance framework have been reviewed and recommendations have been made to address the identified gaps. Gender in land resources management, including climate change, gender equity, realities and government initiatives towards pro-women policies and laws and its gaps have also been identified.

Many barriers are hindering the growth and economic development of Bangladesh of which population growth, natural calamities and environmental problems, political instability, inequality and corruption have been identified as important factors. Other prevailing factors, such as a general disregard for the rule of law, rampant corruption, and a judicial system that suffers from political interference, provide a weak foundation for economic growth of modernization. Lack of a national consensus on the direction of future policy changes has diminished the momentum for economic reforms, and deteriorating prospects for improvements in economic freedom make it unlikely that the relatively high growth rates of recent years can be maintained.

Strategy would be developed with the vision of stakeholders based on insights from the baseline studies, joint fact finding, as well as, professional knowledge and experience on land resources management. It might be started with a number of building blocks for the Delta vision. BDP 2100 comprises a long term (50 to 100 year), integrated and holistic vision and strategy, to improve safe living and sound economic development in the Bangladesh delta, while taking climate change into account in various aspects of proper land resources management.

A number of tentative development plans (projects) related to land resources management planning have been identified which might be considered for implementation in the BDP2100, as well as input to 7th Five-year plan.

1 Introduction

Land and water are the basic elements of life support system on our planet. Throughout human history, all great civilizations flourished where these resources were available in plenty and declined or perished with the depletion of these resources. Land is a physical entity in terms of its topography and spatial nature. Land comprises natural resources such as the soils, minerals, water and biota. These components are organized in ecosystems which provide a variety of services essential to the maintenance of the integrity of life-support systems and the productive capacity of the environment. Land resources are used in ways that take advantage of all these characteristics. Land is a finite resource, while the supports of natural resources can vary over time and according to management conditions and usage. The requirements of human are expanding, and economic activities are placing ever increasing pressures on land resources, creating competition and conflicts, resulting in suboptimal use of both land and land resources. The management of land resources should be based on integrated approach and may be associated with the reorganization, strengthening of the decision-making structure, including existing policies, planning and management procedures.

Bangladesh is principally an agrarian country, characterized by rice-based agriculture dominated landscapes. So, land resources are the major asset contributing wealth and livelihood in rural areas, although land-man ratio is very low in the world- estimated to be 0.06 hectares per person (FAO, 2013). The lands of Bangladesh are being utilized for agriculture, forest/mangrove river, lake, beel /haor, aquaculture, tea estates/plantation, saltpan, rural and urban settlements, and industry. Land use is directly linked to drivers such as climate change and population growth. The country is going to witness a rapid spread of urbanization. The growth of rural settlement is one of the main drivers of the land lost from crop agriculture followed by urbanization and industrialization. Land for dwellings for population is expanding towards agricultural land. As the food security is the main concern of Bangladesh, all these threaten the land resources for agricultural use. Simultaneously, Bangladesh is one of the most vulnerable countries to climate change in the world and will become even more susceptible in the future. Climate induced hazards like floods, cyclones, storm surges, and droughts are expected to become more frequent and severe. Excessive erosion, increase of salinity and water logging would cause decrement in agricultural productivity due to land degradation. The land may be polluted through the contamination with industrial effluents, use of fertilizers, pesticides along with poor quality of irrigated water. All these above problems that have already been initiated need to be curbed before the situation runs out of control. As such, a comprehensive land resources management plan is urgently needed, to meet the present and future demands in a suitable way through formulation and successful implementation of BDP2100 with 19 different thematic areas under which individual sectoral studies have been planned to be conducted.

1.1 Background

The Government of Bangladesh (GoB) has requested the Government of the Netherlands (GoN) for advice and recommendations on the formulation of a Bangladesh Delta Plan 2100 (BDP 2100). In response, the Government of the Netherlands provides necessary support through its Embassy of the Kingdom of the Netherlands (EKN) in Dhaka. The formulation of a BDP 2100 is of great significance for the future prosperity of Bangladesh and is fundamental to addressing the vulnerability faced by the delta of Bangladesh. An interdisciplinary team of national and international experts assists and advises GoB in its ambition to develop BDP 2100.

River deltas form when river carrying sediment reaches a body of standing water, such as a reservoir, lake or ocean. When the flow enters the standing water, it is no longer confined to its channel, and thus, expands in width. Bangladesh forms the largest delta in the world. The vast plain land is washed by the mighty rivers-the Meghna, the Padma, the Jamuna and the Karnafuli and their numerous tributaries and deposited. The total area of Bangladesh is about 1,44,570 sq km with population over 160 million, which makes Bangladesh a densely populated country and land-man ratio is lowest in the world, which is estimated to be 0.06 hectares (ha) per person (FAO, 2013). The river

system of Bangladesh has been carrying about 1-1.6 trillion cubic of fresh water and 1 billion tons of sediments, annually. Over the centuries, the natural delta of Bangladesh has become highly modified, interfering with the natural water dynamism, and thus, exacting several comprehensive resource oriented development plans and strategies by the Government of Bangladesh. In the past, a number of sectoral master plans, policies offering different development strategies to ensure Integrated Natural Resources Management (INRM) have been initiated. Most of the plans are confined within short to medium term (20 to 30 years), limiting the prospects to properly address long term effects of climate change or other uncertainties (such as population and land use changes).

In recent years, the land resource of Bangladesh Delta has been subjected to a variety of pressures. Still it is surviving and sustaining about 160 million people. It is alarming, so to say, in the way land is being used in the tendency towards over-exploitation on account of a number of reasons leading this pristine resource being robbed of its resilience. Land use (agricultural, forest, mangrove, river, lake, beel/haor, aquaculture, tea estate, saltpan, rural settlement, urban and industry etc.) considered as a force of national importance. The changes to farmlands, forests, and water bodies are being driven by the need to provide food, fiber, water, and shelter which is caused considerable losses of biodiversity. In the coming decades, Bangladesh would probably face challenges of increasing flood risks, sedimentation on the rivers and water bodies, water quality, drought, salinizations, river bank erosion, land degradation, water logging, natural hazard like cyclone; tidal surge etc. due to climate change. The availability of agricultural lands would reduce due to rapid and unplanned urbanization and industrialization. The land may be polluted through the contamination with industrial effluents. All these problems have already initiated and need to be curbed before the situation runs out of control. The agro-edaphic and agro-climatic indicators of Land Resources are very essential for land suitability assessment in order to identify and delineate suitable area for growing particular crops. The indicators are also changing with elapse time and current situation. Therefore, a comprehensive land resources management plan is urgently required, to meet the present and future demands of the country through proper formulation and implementation of BDP2100.

1.2 Objectives

The objectives of the Thematic Baseline study are:

- To evaluate existing problems, developments and (government) plans in view of the long term (land use management) changes
- To evaluate expected problems/opportunities in view of the long term (socio-economic and climate change) changes
- To identify existing trends/ forecasts and scenarios'
- To facilitate the identification of challenges and opportunities for the BDP2100 (also priority ranking).
- To translate towards building blocks for Delta Vision and development, as well as 7th 5-year Plan.
- To identify (additional) (no-regret) measures and strategies.
- To support joint fact-finding (contributing to trust and project ownership)
- To contribute a common knowledge base to develop and manage a common and widely shared information and knowledge base in support of development and implementation of BDP2100".
- To identify knowledge gaps and research needs
- To identify exemplary projects for implementation

1.3 Deliverables

The deliverables of the baseline study include:

- A Baseline reports
- GIS layers as input to Touch Table
- Model output, data, input to information portal (to be determined)

1.4 Structure of the Report

The report is divided into nine Chapters. Chapter 1 describes the introduction which includes background and objectives. Chapter 2 deals with approach and methods. Chapter 3 describes review of policies, strategies and plans. Chapter 4 cites the present land and soil resources settings. In this chapter various physical and chemical properties of land/soils such as agro-ecological zones, land form, land use, land type, drainage characteristics, surface water recession, soil salinity fertility status, land reclamation and land development have been reflected. Main constraints related to land use such as monsoon flood, flash flood, water logging, drought, salinity, erosion and accretion, depletion of soil fertility and land productivity have been described in Chapter 5. In the Chapter 6, challenges including identification of trends, forecasts, drivers of changes of land use have been described. Chapter 7 deals with institutional framework and legal aspects related to governance and gender in land management. Chapter 8 deals with Land Resources Management and Strategy Development, Identification of conservation areas, productive areas and areas under urban development, Spatial and physical characteristics of land use for urbanization, conserving and protecting agricultural land, benefits of conservation agriculture, conserving and protecting land in CHT, sustainable land use system, legislation for sustainable agricultural productivity, improvement of land use management practices in Bangladesh, coastal land management in stabilization and protection of new accreted or char lands, response of crops to fertilizers in Bangladesh, strategy development etc. Chapter 9 deals with future vision (2100) for land resource management in Bangladesh, national vision of Bangladesh, future vision and primary goals, delta vision, toward a vision for the land resources management, possible list of strategies, policies to attain the goals, analysis of major constraints to attain the goals, conclusion. At the end of the report, the detail of the references is listed.

2 Approach and Methods

Land includes the combination of the geological materials in which particular kinds of soil have been formed and the landscape on which they occur. Data collection on land resources concentrated on land development, utilization and management. It also includes (biophysical characteristics) soils, agro-ecological regions, land form, land use, land type, drainage characteristics and surface water recession. The baseline information on land resources have been collected mainly from secondary sources. Land Resources Appraisal of Bangladesh for Agricultural Development (Report-2), "Agro-ecological Regions of Bangladesh" prepared by FAO/UNDP (1988) has been utilized to derive secondary information on soils and agro-ecological regions. Most of the land and soil information (land form/ and type,, drainage characteristics, and surface water recession) have been collected using SOLARIS (2006),tool which has been developed by CEGIS for SRDI. Soil fertility status has been collected from BARC (2012).The main sources of data collection are shown in Figure 1.

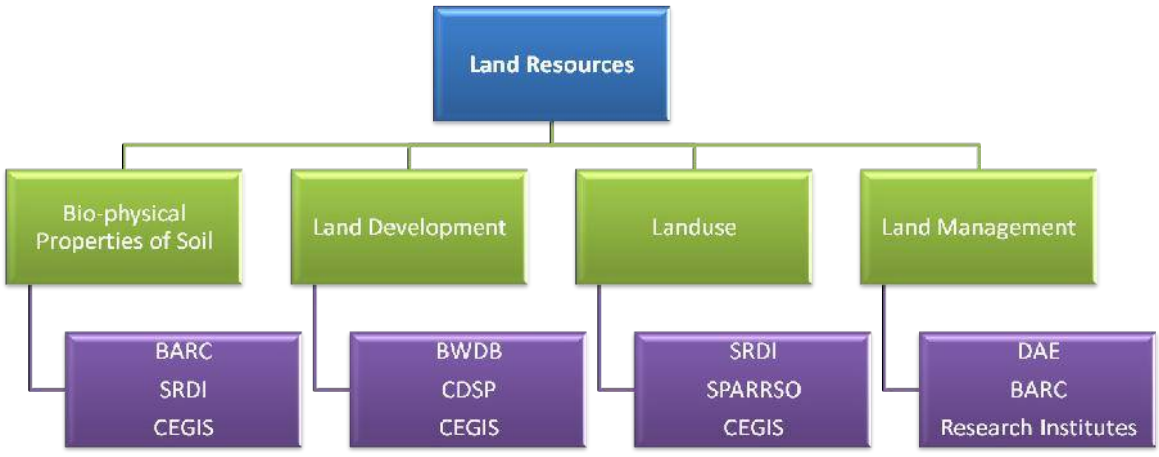

Figure 1: Diagram on Approach and Methods

The land use/ land cover has been developed from the satellite images. The major classes of land use such as agricultural land, forest land, water bodies (baors, beels, rivers, streams, canals, estuaries, ponds and ditches), rural settlements with homestead vegetation, urban built up area, industrial area, environmental critical area, mining area, char land/sand, water logged/drainage areas, teagardens, etc. have been collected from secondary sources(BBS, 2011) and Hasan et. al., (2013) and forest cover has been calculated by the Department of Forest (DF) as described by Tanzim (2011).

The trend analyses on agricultural land, crop land, forest, mangrove, river, lake, beel and haor, aquaculture, tea garden, salt pan, rural settlement, urban and industrial area and land reclamation/accretion have been estimated with the available data from Hasan, *et. al.,* (2013) for the year 1976, 2000 and 2010 which were produced using Landsat MSS 1976 (left panel) and Landsat TM 2000 (middle panel) and Landsat TM 2010 (right panel). Soil salinity information (salinity increase trend) of 1973, 2000 and 2010 were collected from SRDI (2012).

The constraints of land use (flood i.e, flash flood, river/monsoon flood, rain flood, drainage congestion/ water logging, drought, coastal surge, soil salinity, river bank erosion, land degradation, soil erosion, soil fertility depletion, decrease in land productivity, siltation on river bed and khals, rise of sea water due to climate change, increase in population and settlements, and decrease of crop land)have been collected from secondary sources and through discussion with resource person and stakeholders. Erosion and accretion information have been collected from erosion prediction of the GBM Rivers as developed by CEGIS (2005, 202012, 2013 and 2014). Land productivity and crop zoning assessments have been collected from BARC (2012) and Husain *et al* (2012).

Marine land: Bangladesh gained a significant marine land from Myanmar and India. Institute of Marine Sciences and Fisheries of Chittagong University (CU) published a new area and complete map showing the country's water territory area but the map is yet to be circulated through competent authority (MOWR).

A number of sub-themes have been identified for the preparation of development plans. The program consists of specific objectives, proper justification, and specific activities. Programs would be finalized through discussion with stakeholders. The collected information would be analyzed for the preparation of development program (portfolio) under each sub-theme. The prepared programs would be validated through national workshop. The development program would be selected on the basis of priority for implementation (short term, medium term and long term). These activities are in progress and would be reported in the next milestone report.

3 Review of Policy, Strategies and Plans

3.1 Analysis of relevant policies, strategies and plans

Land management is the process of managing the use and development (in both urban and rural settings) of land resources. Land resources are used for a variety of purposes which may include organic agriculture, reforestation, water resource management and eco-tourism projects. In order to have a sustainable environment, understanding and using appropriate management strategies is important. In terms of understanding, the following important points of land management have to be considered: (i) Comprehending the processes of nature including ecosystem, water, soils; (ii) Using appropriate and adaptive management systems in local situations; (iii) Cooperation between scientists who have knowledge and resources, and local people who have knowledge and skills.

There is a plethora of policy/strategy documents relevant to land resources management in Bangladesh. As one would expect, about a significant number of policy documents deal with land, water and crop sub-sector at large, although the contents of these documents deal mainly with land use associated with cereal crops, especially rice. The land sector policies include those related to land, water, coastal zone management plan, integrated coastal zone management plan, National Jalmohal Management, Salt Mohal Management Policy, Land use Policy and Rural Development, and Water Act. The cross cutting sector, covering crop production, fishery, livestock and forestry, appears less prominently both in terms of coverage and focus.

The existing land use policy was adopted in (2001). With the passage of time, some issues and concerns may have arisen in land use, in some cases, with new dimension. For instance, dwindling land resources, declining biodiversity, climate change, increasing frequency and intensity of natural disasters, land use pattern, increasing trends to non-agricultural sector such as urbanization, and rural settlements, require transformation of agricultural land to non-agriculture sector in such a way that would address challenges to meet demands. This necessitates revision and updating of the earlier document to make it relevant to the present land resources management context. Considering all these, some addition or alteration is necessary. The following policies were reviewed for land resource management:

i. Land use Policy (2001)
ii. Coastal Zone Policy (CZPo, 2005) and strategy
iii. National Jalmohal Management Policy (2009)
iv. Salt Mohal Management Policy (1992)
v. Land Zoning
vi. National Urban Sector Policy (2011)
vii. National Water Policy, 1999
viii. Water Act, 2013
ix. Environment Policy 1992
x. National Rural Development Policy, 2001
xi. Livestock Policy and Action Plan, 2005
xii. National Forest Policy 1994
xiii. Draft National Agriculture Policy, 2010
xiv. National Fisheries Policy , 1998
xv. National Wetland Policy (Draft
xvi. National Environment Policy and Implementation Plan, 1992
xvii. National Housing Policy 1993 and 2001

An overview of major thrusts and objectives of various policies related to land use and its cross cutting sectors are presented below:

3.1.1 Land use Policy (2001)

The policy emphasis is mainly on

- minimizing loss of cropland, stopping indiscriminate use of land; preparing guidelines for land use for different regions, rationalizing land acquisition, and synchronization of land use with natural environment ;
- protecting the agricultural land to meet the additional food requirement for increased population;
- ensuring best utilization of land through "land zoning" for agriculture, marketing, brackish water shrimp-cum-paddy, settlements, etc. through modern technology;
- rehabilitating landless people on newly reclaimed land (char land, coastal reclaimed land , haor etc);
- reserving government *khas* land for future development projects;
- making land use environmental friendly;
- increasing the opportunity of income generation through proper utilization of land resources to reduce poverty,;
- protecting natural forest, river erosion and hilly areas;
- protecting land from pollution;
- constructing multi-storied building for Govt, Semi-Govt and non-Govt organizations in a limited land ;
- limiting area of land use to agriculture, settlement, afforestation, river, irrigation and drainage channel, pond and jalmohal, roads and highways, railway, urbanization and industrial areas, tea, rubber and horticulture garden, coastal area, char lands and others.

3.1.2 Gaps/discrimination of Land use Policy:

- In Bangladesh, national level policies and local level plans are prepared, whereas regional level plan and policies are mostly absent. As a consequence, there is lack of integration and coherence among different levels of plan.
- Bangladesh, basically an agriculture-based country, is experiencing decrease in cultivable land day by day due to urbanization, industrialization and construction of roads, hospitals, educational institutions etc. This needs to be addressed for proper land use policy. It needs further modification or improvement.
- The Land use Policy states that loss of crop land will be minimized[pl state the numerical rate], but the fact, is, agricultural land is reducing by 68,760 ha, annually.This reduction is being caused by converting agricultural land to non-agricultural land such as new unplanned homesteads/ residential or industrial area. Policy is not being implemented.
- In the land use policy, there is scope to ensure best utilization of land through "land zoning" for agriculture, markets, settlements, etc. through modern technology, but this is not being implemented.
- The government *khas* land should be reserved for future development projects, but it is generally seen that acquired land like that of BCSIC industrial city or most of the industrial areas, are mostly good agricultural lands in unplanned way.
- There is this phenomenon of private housing companies sprouting in all big cities including Dhaka, who are destroying agricultural lands by occupying them for housing.
- In the land use policy, it is stated that govrnment khas land should be reserved for future development projects. These khas lands are under the control of powerful quarters. There are some loopholes in the existing laws to recover the khas land. The Government fails to take necessary support from the courts to overcome this issue.
- In land management, corruption is taking place in survey, settlement etc. So, settlement lands are not properly distributed to the landless people. Policy regarding settlement of land is not being properly exercised.

3.1.3 Recommendation for Improvement of Land Use Policy 2001

In Bangladesh, there are many laws in existence with regards to land management and survey operation. Due to contradiction in application of laws, the management process is of problems. In most of the cases, people involved in the administration process are not aware and in some cases, they do not understand the laws. To accommodate all the laws and ordinance related to land management, these should be brought under a single code. The policies related to land use will not bring about any benefit if not applied properly. Therefore, what is urgently needed is a

critical review of the present land use policy to some extent and updated considering the existing situation that prevails in the area of land administration.

In the year 2001 "National Land Use Policy" was introduced. Most of the land related problems and prospects are existed and taken into consideration although all polices are not implemented. It requires updated problems, issues, information to address regarding problem of land matter of the country to bring expected result. Following recommendation may be considered for further improvement of the policy:

- Local government institutions be strengthened to implement land zoning.
- Land ceiling of rural areas be minimized and ceiling determination of the urban areas be considered by land limitation;
- Khas, Char, Haor, and Marsh land kept reserved for future distribution among the poor to ensure their maximum utilization;
- Land ceiling for homestead of both urban and rural areas be determined as minimum as possible;
- Growth centre based development activities in rural areas be included in the land use policy for maximum utilization of land;
- Strategy for women empowerment and child rights be included;
- Provision of data base be included for proper planning and development of land management issue;
- Fertile land not to be settled for development activities;
- Policy regarding awareness-building be included to ensure optimum use of land;
- Policy decision needed with regards to waste management to keep the land inhabitable and pollution free;
- Society/Community- based cultivation be given priority to ensure maximum utilization of land to avoid the tendency of land division into pieces;
- A provision be included to ensure environmental protection and protection from the adverse effects of global warming and climate change ;
- Policy to focus on development and management of protected areas such as eco parks, botanical garden and safari park under a reformed legal framework;
- Proper management of jalmahal, balumahal and other mahals be ensured for poverty reduction.
- Protection and conservation of wet lands, hilly areas, tea gardens, and rubber gardens including coastal land be ensured;
- Delivery of land related services to the people through modernized and efficient land administration be ensured.

3.1.4 Coastal Zone Policy (CZPo, 2005) and Strategy

Natural disasters have made coastal land-use management an important aspect in national development. Hence, coastal land-use management is one of the key features in national coastal development policy and strategy. The Coastal Development Strategy (CDS) is based on the approved Coastal Zone Policy (CZPo), 2005**.** The linkage between CDS and CZPo should be concrete interventions. It has been prepared for coordinated priority actions and arrangements for their implementation through selecting strategic priorities and setting targets. The followings have been addressed:

- The CDS are consistent with national strategy for accelerated poverty reduction (PRSP document).
- The PRSP supports Implement Integrated Coastal Zone Management Plan (ICZMP).
- The PRSP also supports Implementation of Priority Investment Programme (PIP), to be developed under ICZMPP.

The CDS takes into account the emerging trends: increasing urbanization, changing pattern of land use, decline land and water resources; unemployment and visible climate change impacts.

The CZPo establishes the goal of ICZM as "to create conditions, in which the reduction of poverty, development of sustainable livelihoods and the integration of the coastal zone into national processes can take place".

The following specific development objectives have been determined for attainment of the goal:

- economic growth;
- basic needs and opportunities for livelihoods;
- reduction of vulnerabilities;
- sustainable management of natural resources;
- equitable distribution;
- empowerment of communities;
- women's development and gender equity; and
- conservation and enhancement of critical ecosystems.

The CDS (Coastal Development Strategy) is the linchpin in the ICZM process, linking the CZPo with concrete development programmes and intervention. The CDS is also built on existing national sectoral strategies and plans and on the document on National Strategy for Accelerated Poverty Reduction (PRSP).

Nine strategic priorities and three routes of implementation have been adopted in the CDS document. One of the nine priorities is "Optimizing the use of coastal land." It is elaborated in the CDS document (MoWR, 2006) that the "Land use in the coast is diverse, competitive and often conflicting.

Erosion of land is a common feature, especially in the Meghna estuary and on the islands. Land is also degrading due to increased salinity and water logging. Moreover, new lands are accreting and being gradually developed.

Acceleration of the land accretion process and optimum use of these coastal lands would significantly contribute to the regional economy and well-being of the local people. Land zoning is one instrument that optimizes the use of coastal lands

3.1.5 National Jalmohal Management Policy (2009)

National Jalmohal Policy (2009) has been developed to utilized water bodies and Jalmohal through real fishers to earn reserve along with the preservation of biodiversity and increase fish production for the interest of the people of the country. This policy will help in proper utilization of watersheds through fish production.

3.1.6 Salt Mohal Management Policy (1992)

This policy will ensure the selection of land for salt production with appropriate management system through creation of salt management committee. The main functions of this committee are:

(i) To create facility for salt Mohal area and increase salt production;
(ii) To identify the suitable land for salt production and to control the salt production area
(iii) To protect *khas* land of salt mohal areas from being leased out for agricultural use,
(iv) To bring all the lands for salt mohal under salt cultivation.

3.1.7 Gaps/discrimination:

It was expected that the salt mohal management policy would help to protect the agricultural as well as salt production areas, but recently, it was found that several acres of land of salt mohal are being proposed for requisition for construction of coal based thermal power plant in the Cox's bazar and Chittagong districts in the interest of improvement of power sector. Therefore, the policy needs to be reviewed.

3.1.8 Land Zoning

Land zoning can be a very powerful tool for protecting critical environmental areas such as wetlands, restricting development in hazard prone areas, industrial areas, concentrated urban area, and separating conflicting land uses. Zoning is particularly useful for managing sensitive lands and cultural resources. This should be used to:

a) Protect productive agricultural lands by limiting the intrusion of non-agricultural uses;
b) Manage floodplains by controlling uses of land within hydrologically defined areas;
c) Preserve wetlands by limiting permissible uses or runoff and substantially restricting land –disturbing uses within area identified as wetland areas;
d) Restore and conserve natural canals and ponds;
e) Preserve open space by designing land areas for a variety of purposes such as recreation, future use green belt, compacted township and industry;
f) Protect hilly areas; and
g) Protect peri-urban areas from unplanned development.

The National Land Use Policy 2001 of the Ministry of Land highlights the need, the importance and modalities of land zoning for integrated planning and management of land resources of the country. Many other policies, strategies, plans of the government have also recommended for land zoning since long. The National Land Use Policy 2001 also mentioned the need of formulating a Zoning Law and Village Improvement Act for materializing the identified land zoning area. In the Sixth FY Plan and Strategic Priorities of Digital Bangladesh there is a priority goal mentioning ' *Planned use of land according to Land Zoning Maps prepared on the basis of present and potential land use will be ensured through enforcement of the provisions of relevant laws* '. For this reason, the present government has given priority on National Land Zoning Project. The National Land Zoning Project is in line with the long-term political vision of present government towards building a 'Digital Bangladesh '

The present land zoning which have been preparing by the by Ministry of Land will not be applicable in most of the above purposes. It may be modified as per requirement of proper land resources management.

3.1.9 National Urban Sector Policy (2011)

The policy emphasizes on:

i. Regionally balanced urbanization through decentralized development and hierarchically structured urban system;
ii. Facilitation of economic development , employment generation, reduction of inequality and poverty eradication through appropriate regulatory frameworks and infrastructure provisions;
iii. Protection, preservation and enhancement of urban environment , particularly water bodies;
iv. Development and implementation of urban management strategies and governance arrangements for enhancing complementary roles of urban and rural areas; and
v. Establishment of accountability.

3.1.10 National Water Policy, 1999

The policy will ensure

i. Development and management of surface and groundwater in an efficient manner;
ii. Capacity building for designing future water resource management plans;
iii. The Government to exercise its water allocation power in identified scarcity zones on the basis of specific priorities;
iv. Ownership of FCD/FCDI projects to be handedover to Local Government, local and community organizations; and by joint management committee (in case of large project i.e., > 5000ha project) on the basis of the size of the projects;
v. Management of river basin, planning and managing of water resources, water for agriculture, industry, fisheries and wildlife, preservation of Haor, Baors and Beels, for financial management, research and information management and stakeholder participation.

The role of National Water Policy for proper management of land resources with the help of water resources would be indispensble.

3.1.11 Bangladesh Water Act 2013

Bangladesh Water Act 2013 is based on the National Water Policy 1999. It is designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh. In general, the Act has provided a framework for better management of water resources in the country. The Act implies undertaking basin-scale initiatives for integrated water resources management of the Transboundary Rivers, and exchange of data on flooding, drought, and pollution with co-riparian countries. As per this Act, all forms of water (surface water, ground water, sea water, rain water and atmospheric water) within the territory of Bangladesh belong to the government on behalf of the people. The act has prioritized drinking and domestic water uses over irrigation and fishing. Other uses such as, bio-diversity, wildlife, in-stream flow, industrial uses, salinity control, power generation, recreation etc. have been prioritized as well. The Act2013 provides provisions for punishment and financial penalty for non-compliance with the Act, including negligence to abide by government policy, ordinance, and protection measures for water resources management.Gap: The Water Act falls short of making a commitment by the government to ensure the quality of water for various beneficial uses.

3.2 Cross cutting sector

3.2.1 Livestock Policy and Action Plan, 2005

Improvement of small scale poultry and dairy farming replicating CLDDP, reform of DLS, enforcement of law and regulations towards animal feeds, vaccines and privatization of veterinary services, adoption of breeding policy, establishment of livestock insurance development fund, and livestock credit food. Livestock policy and action plan may encourage land resources management through livestock and poultry sectors.

3.2.2 National Forest Policy 1994

The policy approach is to bring 20% area under afforestation, enriching bio-diversity, extending assistance to forestry sector development through development of land and water resources, implementation of national and international efforts and agreements relating to global warming, desertification control of wild bird and animal trade, and prevention of illegal occupation of forest lords, felling of trees, encroachment and haunting of wild animals.

National Forest Policy is in favour of environmentally friendly land resource management.

3.2.3 Draft National Agriculture Policy, 2010

National Agriculture Policy, emphasizes on Research and Development (R&D), well-coordinated research plan for the rapid development of the crop sector, a paradigm shift from a supply-driven to a demand-driven approach in agriculture, change from production level to production efficiency, productivity and profitability; equity, employment, environmental sustainability, nutrition, food quality, and trade. have been taken as new areas of concern even as efforts to maintain food security to continue; demands effective introspection, reprioritization and consolidation of R & D activities overall accountability.

The policy will help in land use management in respect of crop production, environmental sustainability and food security.

Natural Resource Management

Natural Resource Management, NAP-2010 will encourage generation and promotion of eco-friendly technology and sustainable land and water management for different agro-ecological zones and regions; research thrust needs to be placed on weather and crop forecasting, climate change and disaster management; conservation and effective use of

life support system of soil, water, flora, fauna and atmosphere; strengthen the efforts to collect, conserve and utilize genetic resources.

National resource management, NAP-2010 will be applicable for smooth helpful for proper land use management.

Programme for Agro-ecologically Disadvantaged Regions

This will pursue programme for hilly area, drought-prone area, Barind Tract, Char land, monga-prone area, Haor-Baor and coastal belt with appropriate technological support. Measure will be taken to protect crops in the coastal, Haor, beel and char areas keeping harmony with other sub-sectors' production. Therefore, it is also in favour of land resource management.

3.2.4 National Fisheries Policy, 1998

The National Fisheries Policy (NFiPo), 1996 recognizes that fish production has declined due to environmental imbalances, adverse environmental impact and improper implementation of fish culture and management programs. The policy particularly focuses on coastal shrimp, aquaculture and marine fisheries development. The policy suggests the following actions:

- Shrimp and fish culture will not be expanded to the areas which damage mangrove forest in the coastal region
- Biodiversity will be maintained in all natural water bodies and in marine environment
- Chemicals harmful to the environment will not be used in fish shrimp farms
- Environment friendly fish shrimp culture technology will be used
- Expand fisheries areas and integrate rice, fish and shrimp cultivation
- Control measures will be taken against activities that have a negative impact on fisheries resources and vice-versa
- Laws will be formulated to ban the disposal of any untreated industrial effluents into the water bodies.

Development of fishery resources has been increasing fish production and self employment, meeting demand for animal proteins accelerating fish exports, and improvement of public health.

The CEIP project interventions may facilitate fisheries production in coastal area. The guidelines of NFiPo may be integrated while designing and implementing the CEIP interventions. However, conflicts over agriculture and fisheries cultivation may accelerate in future.

3.2.5 National Wetland Policy (Draft)

The principal objective of the Wetland Policy is

- to promote the conservation of wetlands in Bangladesh, in order to sustain their ecological and socio-economic functions and thereby, further the aims of sustainable resource development. In this regard the Wetland Policy provided guidance for the conservation of fish habitats, production of both capture and culture fisheries and its management.
- The Wetland Policy placed higher priority on the preservation and development of fisheries over agriculture and conservation of biodiversity for the haors and wetlands. Thus optimum fisheries development will be ensured and some provision for crop cultivation and grazing will be made. Some beels, haors and baors should be specifically set aside for fisheries, and a few baors, beels and haors should be set aside for biodiversity conservation.
- Fisheries needs, will have higher importance except where irrigation or navigation requirements are considered more significant. In the Wetland Policy, agricultural development of wetland area has been identified as tertiary objective to be achieved next to fisheries.

- The siltation process of new land or char is formed in some places and at the same time erosion occurs in other areas. So dredging should be undertaken after due consideration of wetland ecosystems.

3.2.6 National Environment Policy and Implementation Plan, 1992

This policy was prepared by the Ministry of Environment and Forest. The major objectives are to:

- Maintain the ecological balance through preservation of environment and development,
- Minimize the country from natural disaster.
- Ensure environment friendly development.
- Identify and control the all types of pollution and environmental degradation activities,

The specific statements regarding water resources management, flood control, forest, wildlife and biodiversity, fisheries and livestock are:

- Preservation and development of all the wetlands and migratory birds.
- Keep the rivers, canals, ponds, lakes, haors, baors and all other water bodies and water resources, free from pollution.
- Prevent activities which diminish the wetlands/natural habitats of fish and encourage rehabilitative measures in this area.

In short, protection of environment, identification and control of pollution, sustainable use of natural resources, and participation in all international initiatives to protect environment, have been included , in environment policy which will be favourable for management of land resources.

3.2.7 National Rural Development Policy, 2001

The policy emphasis has been given for improving income and employment opportunity of the rural people, by ensuring participation of rural people in development activities of youths and women; and development of disadvantaged, small minority communities and hill tract regions.

In National Rural Development Policy, the development activities should be concentrated in minimum land use for the protection of agricultural land.

Policies and regulations governing coastal land/resource management and use: Conflicts and gaps

Land management is promoted through the land-use policy, the agricultural policy, the forest policy, the water policy, the coastal zone policy, the environment policy and the fisheries policy.

The Land Use Policy of 2001 has provided guidelines for the protection of agricultural land, water bodies and the optimal use of other land, as well as for restriction or minimization of the acquisition of land for non-productive use. There are 28 policy directives that should be followed by all concerned in land management and administration.

3.2.8 National Housing Policy 1993 and 2001

The major emphasis of the policy approved in 2001 by the Ministry of Housing and Works in 2001 is on resource mobilization, land availability, incentives for homeownership, incentives to developers and constructors and promotion of research and development activities to make construction cost effective. The objective is to create affordability, specially, for the middle and low income groups. One of the corner stone of the Policy is to ensure development of housing for the poor and needy and housing for the majority rural population through the use of different instruments like free land, cross-subsidy and concessionary finance, etc

The National housing Authority is the authority responsible to implement the National Housing Policy (NHP), which has been updated in 1999 and 2004. The goal of the NHP is to ensure housing for all strata of society, especially the poor by reducing the necessity of housing in slums and improving the existing ones. The policy

also focuses on the rehabilitation of disaster affected houses, developing financial institutions from personal savings; engage local available materials, strengthening housing institutions and developing property tax.

3.3 Review of Plans

3.3.1 Coastal land management plan and integrated coastal zone management plan of Bangladesh

Coastal land management plan

The coastal zone of Bangladesh covers 19 coastal districts and the exclusive economic zone. The coastal zone of Bangladesh forms the lowest landmass and is part of the delta of the extended Himalayan drainage ecosystem. The Ganges–Brahmaputra–Meghna Delta, covering most of Bangladesh, is also one of the largest and youngest deltas in the world, and is still very active. Sixty-two percent of the land of the coastal zone has an elevation of up to three metres and 86 percent up to five metres (Islam *et al.*, 2006).

Coastal Zone of Bangladesh may be divided into three regions depending on geomorphologic features. The coastal zone of Bangladesh is shown in Figure 2.

The Eastern Region: Morphologically, the eastern coastline of Bangladesh started from the Feni river to Badar Mokar (southern tip of the main land) along Chittagang can be classified as 'Pacific Type' coast running parallel to the young (tertiary) folded hill ranges.

The Central Region: This region begins from the Tetulia river to the Feni river estuary including the mouth of the Meghna river upto the confluence of the Padma (Ganges).

The Western Region: The region covers the coastline westward from the Tetulia River to the international boundary (India) located at the Hariabangha River. The region is mostly covered with deeply scoured tidal channels of the tidal plain overlapping abandoned Ganges Delta.

The coastal zone of Bangladesh is prone to multiple threats such as cyclones, storm surges and floods, as well as earthquakes, tsunamis, and above all, climate change. The government has identified the zone as an "agro-ecologically disadvantaged region" (GoB, 2005). Scarcity of drinking water, land erosion, the high groundwater arsenic content, water logging, water and soil salinity, and various forms of pollution have also slowed down social and economic developments of the region (Islam and Ahmad, 2004)

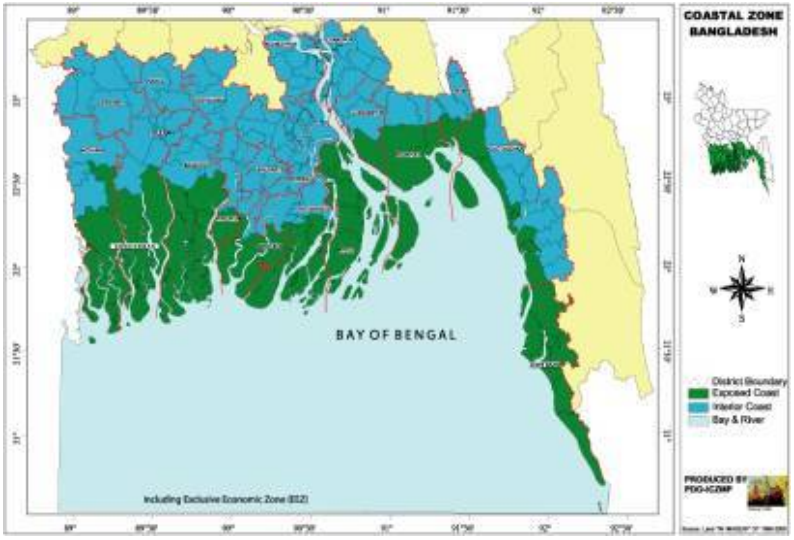

Figure 2: Coastal zone of Bangladesh

The coastal land management plan has commenced on 18 March, 2014. It is made under the Coastal Protection and Management Act 1995. The Coastal Management Plan provides non-regulatory policy guidance to coastal land managers. Key management policies dealt with by the plan include:

- maintaining coastal landforms and physical coastal processes;
- conserving nature;
- maintaining access to coastal resources for indigenous cultural activities;
- maintaining or enhancing public access;
- management planning;
- Knowledge sharing and community engagement.

The Coastal Management Plan does not address land-use planning or development regulated under the Sustainable Planning Act 2009.

Policies and regulations governing coastal land/resource management and use: Conflicts and gaps

Land management is promoted through the land-use policy, the agricultural policy, the forest policy, the water policy, the coastal zone policy, the environment policy and the fisheries policy.

The Land Use Policy of 2001 has provided guidelines for the protection of agricultural land, water bodies and the optimal use of other land, as well as for restriction or minimization of the acquisition of land for non-productive use. There are 28 policy directives that should be followed by all concerned in land management and administration.

Integrated Coastal Zone Management (ICZM)

The following area-specific management initiatives in the coastal zone were pursued in Bangladesh (Islam, and Ahmad, 2004):

- Off-Shore Islands Development Board (1977–1982);
- Bangladesh National Conservation Strategy (1987);
- UN/ESCAP-GoB Coastal Environment Management Plan for Bangladesh (1987);
- Coastal Area Resources Development Plan (1988);
- Special Parliamentary Committee on Coastal Area Development (1988–1990); and
- National capacity building approach in the Integrated Coastal Zone Management (ICZM) initiative (1997).

All these initiatives gradually prepared the ground for the government's initiative in 1999 to embark on a process of Integrated Coastal Zone Management (ICZM). In that year, the government expressed its commitment through a policy note entitled "Integrated Coastal Zone Management: Concept and Issues" to prepare for a plan for the operational and effective introduction of ICZM under Ministry of Water Resources (MoWR in 1999). The preparatory phase for introducing ICZM in Bangladesh was carried out from February 2002 to June 2006 for the conceptual approach, as formulated in the policy note. It was elaborated through a joint mission of the Bangladesh Government, the World Bank and the Netherlands Development Assistance.

For proper utilization of coastal zone, following zones need to be considered:

a. Shrimp (brackish water) Zone;
b. Shrimp (sweet water) Zone;
c. Salt - Shrimp Zone;
d. Forest Zone;
e. Mangrove Zone;
f. Urban and Commercial Zone (Industrial, Port, EPZs and Ship breaking Yards);
g. Tourism Zone;
h. Agriculture Zone

Consultation with stakeholders in coastal planning

The documents of CZPo and the CDS are formulated through a process of multilevel consultation over a long period (Islam, 2005). The CZPo was formulated over detail discussion as described hereunder:

- Based on the discussion, the outline was elaborated in a preliminary draft of the policy.
- An outline was prepared and presented during the Dialogue in September/October 2002.
- An annotated outline was discussed with a group of selected experts in March 2003.
- This preliminary draft was presented at a national workshop held 12 May 2003.
- Based on discussions and comments, the first draft was prepared in August 2003. A Bangla version of the draft was prepared in September 2003.
- During September-October 2003, the draft CZPo was presented and discussed at the local level in 19 coastal district towns, facilitated by the district administration.
- The draft was discussed at the Task Force on Policy & Strategy, at the Inter-Ministerial Technical Committee and at the Inter-Ministerial Steering Committee during 2004.
- The Coastal Zone Policy 2005 was approved at the cabinet meeting on 17 January 2005.

The CDS was also formulated through multilevel consultations as like as CZPo and reviews as follows:

- An annotated and extended outline was prepared in August–September 2004. In preparing this outline, all relevant documents were reviewed.
- The outline was presented at one national and four regional consultative workshops held in October 2004.
- Based on the workshop recommendations, the first draft was prepared in February 2005 and sent to relevant agencies and members of the task forces.
- "CDS highlights" were disseminated through Coast News and posted on the Web site.
- Comments and suggestions were solicited from the general public through a public announcement in four national dailies (February 2005).
- The draft was presented during March–April 2005 at 28 local level consultation meetings: three remote chars/islands, three selected unions, three selected thanas and 19 coastal district headquarters. These consultations contributed to further revision of the draft CDS, including strategic priorities and prioritization of concept notes.
- A paper review of the draft by selected experts was organized in June 2005.
- The draft was presented to the members of parliament in July 2005.
- The draft was presented at the Eighth Inter-Ministerial Technical Committee meeting and finally endorsed at the Ninth Inter-Ministerial Technical Committee meeting held 16 October 2005.
- The draft was approved at the Second Inter-Ministerial Steering Committee meeting held 13 February 2006.
- Proposed institutional mechanisms to facilitate integrated planning between agriculture, fisheries and forestry in coastal areas.
- The institutional structure is based on the assumption that line agencies are the best implementers within an agreed planning and implementation framework at the national level, while coordination is to be ensured at the local level. This institutional set up of integrated management at the project or programme level will work more effectively if parties realize that working together in this manner is mutually beneficial to achieving common goals. Each of the parties should have sufficient institutional capacity to enter into such an arrangement for integrated management. There must be commitment to the common goals, while the respective responsibilities are clearly and precisely spelled out.
- The proposed national level ICZM structure consists of the Inter-Ministerial Steering Committee (SC), Inter-Ministerial Technical Committee (TC), Focal Points, Task Forces and a Program Co-ordination Unit (PCU). The PCU for ICZM is an arrangement proposed in the CZPo to discharge its function for institutionalization of ICZM in Bangladesh. It is a multidisciplinary and multi-agency arrangement. The PCU's role is to coordinate, monitor and

harmonize operation of the ICZM process and to serve as a service for relevant government and non-government agencies, local government institutions and private sector entities active in the coastal zone.

- The Inter-Ministerial Steering Committee (SC) provides policy guidelines on issues related to the coastal zone. This high-level committee is chaired by the minister of the lead ministry and includes representatives (at the Secretary level) of concerned ministries including land, agriculture, forestry and fisheries. The Ministry of Water Resources (MoWR) will act as the secretariat for this committee. The SC preferably meets at least half yearly.
- The Inter-Ministerial Technical Committee (TC) resolves inter organizational conflicts and removes planning and implementation bottlenecks. It is headed by the Secretary, MoWR, and comprises representatives of all the concerned agencies who are members, including the director-generals of the Department of Agricultural Extension, Department of Fisheries, the Forestry Department and the Directorate of Land Records & Surveys. The TC also comprises representatives from universities, NGOs, the private sector and civil society. The TC convenes at least once every quarter.
- Focal Points are established in all relevant agencies to act as operational contact points in relation to ICZM activities and to maintain contact with the lead agency.
- Task Forces are established on specific issues for an agreed time period. They consist of members of the TC, PCU, Focal Points and/or topic experts.

This institutional structure was operational during 2002–2006 and contributed to the preparatory operationalization of ICZM in Bangladesh.

3.3.2 Sixth Five Year Plan (SFYP)

Strategies and policies for land management in the SFYP

The main goal of the government's land use policy and management is to ensure best possible use of land resources and delivery of land related services to the people through modernized and efficient land administration for sustainable development with accelerated poverty reduction. The lack of coordination between different departments responsible for preparation and maintenance of Record of Rights (ROR) often leads to confusion, conflicts and many instances of litigation causing suffering of the people especially the small and marginal farmers. To mitigate this problem, the Ministry of Land has already undertaken projects to conduct digital surveys and introduce e-governance. Land records will be computerized and land mutation will be made automatic. Necessary measures would be initiated to ensure sound coordination of the activities undertaken by department of registration, A.C. Land and DLRS. Through appropriate delineation of supervisory responsibility of settlement activities, better coordination of the two offices in dealing with the preparation and maintenance of land records at the upazila level will be achieved. The Directorate of Registration will be directed to remove inconsistency in land records management and also for immediate updating of land titles.

A database including all land resources, land zoning information and other resources in selected areas such as Char land and other ecologically endangered areas will be developed. The Ministry of Land is implementing a coastal land zoning project to ensure proper use of land and mitigate land degradation. There will be provision for a participatory and joint monitoring system with government employees and the local people for overseeing the activities of land classification, and land record modernization for effective land management. The participation of the poor in the whole process, from formulation to implementation of laws and policies will be instituted.

The land in CHT is administrated under the relevant Acts, Rules and Regulations of the Manual of 1900. The customary common property rights of the ethnic people will be protected. Laws and policies would be framed for the proper management of the land in the CHT. The provisions for Rangamati/Khagrachari/Bandarban Hill District Local Government Council Act 1989 have been amended according to the CHT Peace Accord. Laws and policies will also be introduced to avoid environmental degradation, such as hill-cutting and tree felling, while using available land for the development of tea and rubber plantation. The modification and simplification of all land-related laws are expected to

remove many of the land related disputes. A special committee will be set up to come up with recommendations in this regard. Planned use of land according to Land Zoning Maps prepared on the basis of present and potential land uses will be ensured through enforcement of the provisions of relevant laws. The provisions of the Town Improvement Act of 1953 will also be more strictly enforced. The Government will take up projects for the development of rural townships where specific areas are to be earmarked for housing, marketplaces, industries and infrastructure. Land acquisition act and policy would be rationalized. Unused acquired land or acquired land not used for the declared purposes would be resumed by the Deputy Commissioner. Unused land of Bangladesh Railway may be given to Roads and Highways and Local Government Engineering Department for construction of roads if needed. In the case of big public-sector projects like the Padma Bridge (for which the government has already approved the resettlement plan) affected persons would be motivated to make their resettlement voluntary. They would be compensated for their land at the price suggested by the National Involuntary Resettlement Policy.

While building rural roads, highways, bridges and culverts, the government departments do not keep enough space for the natural flow of water. In the big cities, the land grabbers are filling up the water bodies, thus creating drainage problems. Provisions are to be made for free flow of water. The natural flow of rivers and canals is to be restored by removing the land grabbers. The water bodies and the flood plain areas in Dhaka and other big cities would be freed from illegal occupants. The rivers, canals, haors, etc. would be leased out to poor and genuine fishermen. This will be ensured with the involvement of the MOFL, DOF and major stakeholders including NGOs. The Jalmahal Management Policy 2009 has already been finalized and gazetted in June 2009. Similarly, Balumahals and other Sairat Mahals would be managed in a way which will benefit the poor.

Inspections of industries would be conducted more frequently to strictly enforce the construction of ETPs and their due continuous operation. The relevant provisions of EBSATA would be strictly enforced to stop degradation of crop land by industries. Projects would be taken to develop perennially inundated areas like Bhabadaha. The conflict between the growers of shrimp and crops would be resolved by involving the Union Parishads, DOE, DOF, DAE and stakeholders' representative organizations including local NGOs. The Ministry of Land would continue with its program of housing for the urban poor. *Khas* land in urban areas (i.e. non-agricultural) would be utilized for housing the slum dwellers. Non-agricultural *khas* land would be provided to the Ministry of Food and Disaster Management and Ministry of Social Welfare for constructing (i) houses for disadvanged women, marginalized people and endangered communities, and (ii) vagrant homes and night shelters in the cities for the uprooted population.

SFYP Policies and Strategies for the Crop Sub-sector

- Key Challenges: Lack of modernization of soil and water tests, Growth of population and rapid, Decreased Crop Area, Decreased Soil Fertility, Detrimental Effect of Climate Change, Fragmented Land Structure, Constraints to raising productivity
- Diversification in food production must address the challenge of achieving balanced nutrition. To achieve this objective we must adopt system-based rather than crop- based planning for crop sector development. We must also use the rich information on agro ecological zoning for identifying areas suitable for different crops and also use it for area based approach to development.
- For crop intensification, the coastal zone, the Sylhet region and the char areas must receive priority in crop sector development plans.
- Appropriate land reforms such as (i) ceiling of rents for the fixed rent system, (ii) distribution of Khas land among landless and non-viable marginal farmers where ever feasible, (iii) imposition of restriction on conversion of prime agricultural land for nonagricultural uses, (iv) hourly rental system for irrigation equipment instead of crop-share based or season-based fixed irrigation charge, and (v) computerization of records of landownership and land transfer, etc must be attempted.
- In order to meet the growing demand of additional food for the increasing people of the country emphasis should be given in utilizing the unutilized hoar land of the north-east part of Bangladesh.

- Strategy, policy and action should be formulated to convert the single crop land into double crop land, double crop land to triple crop land.
- The plan considers the importance of land reclamation in coastal areas and reclamation of cultivable land in water logging areas and emphasizes on the intensive cultivation of saline tolerant varieties particularly in Rabi season and will take necessary steps in this context. In addition, the plan also emphasizes policy strategy on protecting agricultural land from inundation, river erosion and other productive purposes.
- In order to maintain soil fertility, use of organic fertilizer will be popularized.

3.3.3 Forestry Management Policies, Strategy and Programs

- An estimated 250,000.00 ha land of hill forest and 7000.00 ha of plain land forest will be planted during the plan period.
- The existing coastal aforestation and enrichment plantation will also be continued. The existing mature coastal plantations will remain. Some 40,000 ha will be planted and replanted in the coastal areas.
- To prevent the extent of damage by cyclones and tidal surges, Coastal Green Belt will be created and seedlings will be raised to distribute or sale in the coastal zone.
- The redlands of Sylhet has long been lying unutilized. Under the Sixth Five Year Plan 5000 ha. of redlands will be planted.
- Presently, only 1.70 percent of the total land area falls under protected land area category which is about 10 percent of the total forest land. The protected area will be increased to 15 percent of the total forest land during the Sixth Five Year Plan period.

SFYP Strategies and Policies for Fisheries Sub-sector

Major causes of resource degradation in this sub-sector can be identified as: (i) construction of flood control embankments and roads, (ii) siltation, (iii) over fishing and fishing of undersized, (iv) outbreak of fish diseases, (v) discharge of chemical fertilizers and industrial effluents in the water, and (vi) conflict between paddy cultivation and fish production.

SFYP Objectives and Targets for Water Resources

- Protection of river erosion.
- Land reclamation.
- Flood Control/ Flood Management
- Heights of coastal and flood embankments to be raised.
- Prevention of saline intrusion through augmenting the fresh water flow in the south west region including the Sundarbans (the old-world heritage).
- Integrated coastal zone management.

Environmental Management Targets in the SFYP

- Increase productive forest coverage by 2 percentage points.
- Territorial coverage of protected area increased to 5% including Community Conservation Area (CCA) and Ecologically Critical Area (ECA)
- Treat all urban waste water by FY15 to clean river waters
- Promote Zero discharge of industrial effluents.
- Urban wetlands are restored and protected in line with Wetland Conservation Act
- At least 10% of the wetland in peak dry season is protected as aquatic sanctuary
- Regeneration and aforestation of 25,000 hectares of fresh water swamp forest in haor basin.
- 500-meter-wide permanent green belt established and protected along the coast
- Land zoning for sustainable land/water use completed.

3.3.4 Flood Action Plans (1989-1995)

The Flood Action Plans (FAP) studies were conducted by the FPCO during 1989-1995. There were 26 components. The FAP described the baseline situation of the area in respect of water resources, population, poverty, health, education, literacy, agriculture, fisheries etc. It also included projections for the future. The report further discussed the strategy for change, which include the following:

- Protection of urban centres and infrastructure from flood and improvement of the urban environment
- Intensive agriculture for urban consumption
- Institutional strengthening and development
- Enhanced production systems on seasonally flooded are as
- Integrated development of deeply flooded areas
- Biodiversity enhancement and sustainable management
- Improvement of the livability of rural settlements

The study developed a portfolio of 44 initiatives for the above-mentioned strategy.

The FAP Study reports have been reviewed thoroughly to understand the complexities of the issues. It will help in identifying remedial measures as well as formulation of new strategies for development.

3.3.5 Perspective Plan of Bangladesh (2010-2021)

Development priorities of the Perspective Plan are distilled from the vision statement formulated to take Bangladesh to where it ought to be in the year 2021, given its human potential and natural resource endowments. The development priorities include ensuring broad-based growth and reducing poverty; ensuring effective governance and sound institutions but creating a caring society; addressing globalization and regional cooperation; providing energy security for development and welfare; building a sound infrastructure and managing the urban challenge; mitigating the impacts of climate change; and promoting innovation in a knowledge-based society. These thematic approaches will shape and form the foundation on which specific strategies are developed over the period of two five-year plans (Sixth and Seventh Five Year Plans) which includes Institutional foundations, towards middle income economy, agriculture and rural development, industrial development, trade policy regime, opportunities from globalization, foreign investment, multilateralism, regional cooperation, digital Bangladesh, energy security, transport and communication, urban challenge, human development, poverty reduction and sustainable development.

Challenges

- ✓ Agricultural land is limited and is reducing at 1 per cent per annum. Modern methods of production, including water resource management, high yielding drought and submergence resistant seeds, increase in land productivity through efficient irrigation, flood control and drainage, are among the key factors in achieving a higher level of self-sufficiency in food production to feed the ever-increasing population and to save foreign exchange for food imports.
- ✓ With the decline in soil fertility and loss of land and water resources as well as a spread in the contamination by arsenic of drinking water, agronomic techniques should be used to increase water efficiency towards a System of Rice Intensification.
- ✓ Large and middle-sized farmers are abandoning farming in favour of non-farm activities leaving cultivation of land by marginal land owners, *bargadar* (share-croppers) and agricultural labourers. In the absence of land reforms and due to a shortage of savings, there is very little incentive to private investment to increase productivity and production.

- ✓ Steps will be taken for distribution of khas land to the landless and the marginal farmers easing the rental system, computerized land records and transfer, safeguards against eviction of the bargadars and granting them the right of pre-emption in land transfer.
- ✓ Motivate farmers to use recommended/balanced doses of chemical fertilizers, extensive production and use of organic fertilizer, and proper utilization of soil guide and soil testing facilities to enhance soil fertility.
- ✓ Recorded state-owned forest land (not necessarily supporting tree cover), and potential forest/tree growing areas, has been identified at 7 million acres, which is 20 per cent of the land area. Trees are reported to cover 12 per cent of the land where considerable prospects for improvement exists. Ecological balance and bio-diversity conservation are in critical state. In Hill forests, the most common problems are erosion, over-exploitation and loss of soil fertility. In mangrove forests, the main problems are poor water and pests and in the mixed broad-leaved/bamboo forests, erosion and over-exploitation. In the plantations, the key environmental problems are loss of soil fertility, erosion, over grazing, flooding, poor water and drought.
- ✓ The agrarian economy of Bangladesh having an area of only 147,750 km with acute problem of allocation of land to agriculture, industry, and human settlement is experiencing a very high rate of urbanization. In 1974 people living in urban areas accounted for only 8.8% of the population, which rose to 23.1% by 2001.
- ✓ Economic advancement, accompanied with rapid urbanization and industrialization, had also left its toll on Bangladesh's own ecosystem. This was evident from natural calamities, loss of bio-diversity, deforestation, destruction of wetlands and inland fisheries, arsenic contamination in the ground water in the southern part of the country, soil nutrient depletion and inland salinity intrusion in the South West region, and creeping desertification in the Northern region. Bangladesh is also one of the most natural disaster prone areas that suffer from ravages of floods, cyclones, storm surges and drought. In urban areas, air pollution, sound pollution and waste load from industries, hospitals, and municipalities are a matter of great concern.
- ✓ The adverse interactions of environmental degradation and climate change could have severe consequences for citizen's welfare, especially for the poorer segment that may not have adequate access to coping mechanisms. Indeed degradation of land, water pollution and arsenic in water, floods and cyclones, rising levels of sea water can easily threaten the sustainability of poverty reduction strategies unless appropriate measures are taken to protect the environment and address the climate change issues. Equally important is the need to have an effective disaster management strategy to tackle associated challenges when natural disasters happen.

3.3.6 Bangladesh Climate Change Strategy and Action Plan, 2009

The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) is based on Government's vision as mentioned in the Vision 2021 regarding management of climate change for uninterrupted and sustainable development are to eradicate poverty, increase employment opportunities, ensure food security, provide access to energy & power, and achieve economic and social well-being of all citizens of the country. The strategies are to:

- Ensure adequate water supplies and improved sanitation
- Plan for and invest in additional water supply and sanitation facilities
- Livelihood protection in ecologically fragile areas
- Address adverse impacts on livelihoods in ecologically vulnerable areas
- Comprehensive and participatory planning and investment for climate resilience against erosion in income, employment and human health in coastal, char, hilly and wetland regions.

3.3.7 Master Plan for Agricultural Development in Southern Region of Bangladesh

The agricultural master plan has the following objectives:

- increasing agricultural production and productivity;
- improving water management and infrastructure for surface water irrigation;

- improving productivity of brackish water shrimp and capture fisheries;
- promoting smallholder poultry and dairy development.

The Master Plan formulated a set of programmes and activities across all branches of agriculture and other related fields. A list of interventions is identified under following thematic and sub-thematic areas:

- Crops, horticulture and agro-fishery ;
- Fisheries ;
- Livestock ;
- Water management;
- Polder management;
- Drainage improvement; and
- Capacity building

3.3.8 Master Plan of Haor Area

Master plan of Haor report provides a detailed description of the individual investment projects that have been developed based on Development Area (DAS). Each project has been formulated to achieve the specific objectives of its relevant DA as well as the overall objectives of the master plan in an integrated way.

The Master Plan envisages 154 projects under 17 Development Areas. Many of the projects will be linked operationally or conceptually or implemented in parallel with other projects. Implementation of the plan will be carried out in three phases, beginning from the financial year 2012-2013 and reaching completion at the end of the financial year 2031-2032. The three phases are Short Term (1-5 years), Medium Term (6-10 years) and Long Term (11-20 years).

3.4 UN Millenium Development Goals

The Millennium Development Goals (MDGs) consist of eight development goals adopted by 192 nations of the 192 United Nations member including Bangladesh which states that at least 23 international organizations have agreed to achieve by the year 2015. The 8 MDGs are to (i) eradicate extreme poverty and hunger; (ii) achieve universal primary education; (iii) promote gender equality and empower women; (iv) reduce child mortality; (v) improve maternal health; (vi) combat HIV AIDS, malaria and other diseases; (vii) ensure environmental sustainability; and (viii) ensure environmental sustainability; and (viii) develop a global partnership for development.

The themes under the BDP will address some or all of these goals in its own way, either directly or indirectly, with respect to land resource management.

3.5 National Development Goals

The National Water Policy (NWPo) and National Water Management Plan (NWMP) have set six(6) clearly defined National Goals These are (i) Economic Development, (ii) Public Health and Safety, (iii) Poverty Alleviation, (iv) Decent standard of living for the people, (v) Food Security, and (vi)Protection of the Natural Environment.

The Household Income and Expenditure Survey of 2010 data show that the incidence of poverty is declining at a rate of 2.47 percent per year since 1991-92 in Bangladesh. It can be said that the target of halving the population living below the poverty line has already been achieved in 2012.Three different implementation rates for each remaining option were then considered in order to reflect various strategic prioritization of the National Development Goals

3.6 Compatibility, Contradictions and Synergies

The policies discussed in the above review are generally compatible in terms of their declared goals for land use efficiency, creating income and employment opportunities, especially for rural women, for rapid poverty reduction through implementation of development plans. The major thrusts of these policies are largely consistent with the Millennium Development Goals (MDGs), as well as the strategies and future policy priorities of land resources management and rural development policy matrix in the Poverty Reduction Strategy Paper (PRSP). These have the important synergies within the broad objectives of attaining to translate into building blocks for Delta Vision and development, as well as the Seventh FY Plan.

All of the policies as mentioned, underscore efficient use of land, labour, water and other natural resources with special emphasis on women's participation and environmental protection. Research-extension linkages and coordination amongst the ministries and agencies in the design, approval and implementation of projects through strengthening with all the policies, are the common concerns of the policies.

In the policies, there are areas which are inadequately treated or missed out altogether. Thus, issues like the following, need to be: dominance of cereal food production, loose treatment of diversification and commercialization, bypassing crop-fish conflicts, lack of insights about poultry waste utilization, ignoring floriculture, inadequate private sector focus, commercialization of soil and water quality tests, silence on contract farming and development of supply chain for high value agricultural products, lack of linkage between farming and non-farming activities and misconstruction of subsidy issue. The policy is directed towards agriculture only and not to the rural economy as a whole. This unifocal perception misses understanding of farm vis-à-vis non-farm components of the rural economy in a coherent fashion.

National Land Use Policy prepared by the Ministry of Land, which often interferes with land use issues concerning crop production, fishery and forestry, for which there are three different ministries. A well known case of conflicting interests is the delay in leasing of water bodies belonging to the Ministry of Land to the Ministry of Fishery and Livestock for fish production. The problem is further compounded by the provisions of the National Water Policy of the Ministry of Water Resources and the Environment Policy of the Ministry of Environment and Forests. Thus, demarcating the domain of each ministry and establishing accountability in adhering to the defined limits of domain seems a serious issue to be addressed in formulating and implementing policy. Most of the problems in policy formulation and implementation arise, because the domains of the ministries are not clearly defined and the demarcated and in some cases the defined limits of ministry's domain are knowingly or unknowingly ignored.

Inadequate attention to land resources management has been focused. For proper land use management, land reclamation, industrialization, urbanization, land zoning, coastal land utilization, Haor and Wetlands Policy needs to be developed further. This policy should include challenges, strengths, weakness, opportunities, and threats in proper land and water use in these regions for sustainable agricultural crop production. Appropriate technology supports for crop production have to be included. The policy documents are generally devoid of any serious policy analyses, due to lack of reliable data. Often, the objectives and strategies are mixed up and the programs are not checked against their implementation. All critical planning, policy and decision making functions and authorities are located in the apex level offices. Lower level offices are basically responsibilities for implementing the plans and the policies made at the top-level would help for decentralization of public administration which needs immediate action.

Data deficiencies are chronic and policies are framed on flimsy database. The ministries hardly use their own database collected through their capacity and planning units and they hardly explore the potential of up scaling their capacity in data handling and prepare policy commentary based on hard facts, crossed-checked with other sources of data. The NAP, PoA, Actionable Policy Brief (APB) and other major land resources sector policy documents, focus on food production, especially rice production, giving lesser attention to crop production rather than urbanization /settlements, industrialization. As one would expect policy prescriptions for input distribution and input levels,

extension services, credit delivery and output marketing are all directed to major cereal food crop, rice, not much to dry land crops like Wheat, Maize etc.

In Bangladesh, discussions on blue economy started after the settlement of maritime boundary delimitation dispute with Myanmar and India. The total area of Bangladesh water territory has expanded over 121,110 square kilometers comprising territorial sea, exclusive economic zone extending out to 200 nautical miles (NM) in the sea. Proliferation of marine resources in this area offers Bangladesh scope for sustainable economic development, which needs an integrated maritime policy.

4 Land and Soil Resources

4.1 Brief Background on Land Resources Classification and Land Use in Bangladesh

Land is a physical entity in terms of its topography and spatial nature thus, including natural resources like the soil, minerals, water and biota existing on the land. These components provide a variety of services essential to the maintenance of life-support systems and the productive capacity of the environment.

4.1.1 Land Use Classification

To measure land and its impact on ecosystem, land use classification is required. On the basis of vegetation, there are nine –fold land use classification. These are:

- Forests;
- Land put to non-agricultural uses;
- Barren and uncultivable land;
- Permanent pastures and other grazing lands;
- Miscellaneous tree crops and groves, not included in the net area sown;
- Cultivable waste;
- Fallow land, other than current fallows;
- Current fallows;
- Net area.

4.1.2 Main Functions of Land Use

- Production function
- Space function for socio-economic and infrastructural development
- Human settlement space function
- Biotic environmental function
- Climate regulative function
- Hydrologic function
- Waste and pollution control function
- Storage function
- Archive or heritage function

4.1.3 Classification of Land Area

- Land Cover Classification
    - Physical appearance,
- Agro-Climatic / Agro-Ecological Classification
    - Technical attributes like soil profile, soil texture agro-climatic conditions etc.
- Land Use Classification

- Purpose for which it is being use.

These classifications do not fully meet the needs of integrated land use planning and the creation of environmental indicators.

4.1.4 Framework for Integrated Land Use Classification

- The land use classification should cover the total area of land that needs to be classified irrespective of the fact if it is being used for any economic activity.
- In segments having multiple activities, each activity need to be included
- The classification systems should not be confused with legends;
- The categories of the classification should not overlap;
- The classification should cover all activities;
- Very often land use data base need to be linked with policy relevant information.

A standardize land use classification system is a prerequisite for land resource management which is absent in Bangladesh. A land use is required to be classified under three broad headings.

a. Areas of conservation (natural resource of protection /areas with environmental concern like wetland, watershed, river, hills, disaster prone areas etc.
b. Agriculture and forestry production (includes agricultural land , forest areas, other production oriented resources and rural homesteads)
c. Under areas (developed areas, and areas needed for future development for residential, commercial, industrial and other urban areas).

4.2 Current Status of Land Resources Related to Productivity

Land management is strongly related to the land productivity of different land types. Soil is the medium for plant growth. The agro-edaphic and agro-climatic data of land resources are necessary for proper land use management for crop production in order to identify and delineate suitable area for growing particular crops. Various agro-edaphic factors such as soil permeability, effective soil depth, available soil moisture, nutrient status, soil reaction (pH), soil salinity, surface water recession, soil texture, soil consistency, drainage characteristics; depth of inundation, flood hazards; and landform. are considered for land suitability analysis. Agro-ecological zones (AEZ) have been established based on physiography, soil properties, soil salinity, depth and duration of flooding which are applicable for land use and assessment of agricultural potential. The agro-climatic factors influence crop growth. Besides agricultural crop production, lands are being used for non-agricultural purposes such as urbanization, industrialization and rural settlements. Some fertile agricultural lands are being eroded while new lands are accreted or reclaimed. Present setting of agricultural and non-agricultural along with current situation of agro-edaphic information are incorporated briefly in this chapter.

4.3 Agro-Ecological Zones (AEZ)

As part of Land Resources Appraisal of Bangladesh for agricultural development, Bangladesh has been subdivided into 30 agro-ecological regions and 88 sub regions. The major components of these regions and sub-regions are physiography, soil properties, soil salinity, depth and duration of flooding which are relevant for land use and for the assessment of present and future agricultural potential. Area, locations, percentage of coverage and land types of Agro-ecological Zones (AEZ) of Bangladesh is presented in *Appendix A* and locations in Figure. 3. It is observed from Table 1, thatmaximum area is covered by northern and eastern hills (12.31%) which are followed by High Ganges River Floodplain (10.13%). The Ganges Tidal Floodplain area covers about 8.23% of the entire area. Minimum area is covered with the agro-ecological region of St. Martin's Coral Island.

Old Himalayan Piedmont Plain (AEZ- 1)

This distinctive region is developed in Old Tista Alluvial Fan extending out from the foot of the Himalayas. It has complex relief pattern comprising broad and narrow floodplain ridges and linear depressions. Deep, rapidly permeable sandy loams and sandy clay loams are predominant in this region. Its top-soils are strongly acidic and sub-soils moderately acidic and rich in weatherable sand minerals. Seven General Soil Types occur in the region of which, Non-calcareous Brown Floodplain soils, Black Terai soils and Non-calcareous Dark Grey Floodplain soils predominate. Organic matter contents are relatively higher (Piedmont area) than the other floodplain areas. The natural fertility of the soil, except the course textured, is moderate but well sustained. Soil fertility problems include rapid leaching of N, K, S, Ca, Mg and B.

Active Tista Floodplain (AEZ- 2)

This region includes the active floodplains of the Tista, Dharla and Dudkumar rivers. It has complex patterns of low, generally smooth ridges, inter-ridge depressions, river channels and cut-off channels. The area has irregular patterns of grey stratified sands and silts. They are moderately acidic throughout and parent alluvium is rich in weatherable minerals. Four General Soil Types occur in the region of which, Non-calcareous Alluvium predominates. Organic matter content is low and CEC is medium. Soil fertility level, in general, including Mg and B status is low to medium.

Tista Meander Floodplain (AEZ-3)

This region occupies most of the Tista Floodplain. It includes the Atrai, Little Jamuna, and Karatoya Floodplains, as well as the older parts of the Dudhkumar and Gangadhar Floodplains. The boundaries with the adjoining Active Tista and Brahmaputra –Jamuna Floodplains are irregular and they are subject to change as the major rivers encroach by erosion or by depositing new alluvium over older soils. In the south-east, the unit merges into the Karatoya-Bangali Floodplain. The major portion of the areas have broad floodplain ridges and almost level basins. There is an overall pattern of olive brown, rapidly permeable, loamy soils on the high floodplain ridges, and grey or dark grey, slowly permeable, heavy silt loam or silty clay-loam soils on the lower land and parent materials rich in minerals. Eight general soil types occur in the region; of which, Non-calcareous Grey Floodplain and Non-calcareous Brown Floodplain soils predominate. They are moderately acidic throughout, low in organic matter content on the higher land, but moderate in the power parts. Fertility level in general, is low to medium. Soils in general have good moisture holding capacity.

Karatoya-Bangali Floodplain (AEZ-4)

The floodplain apparently comprises a mixture of Tista and Brahmaputra sediments. Most areas have smooth, broad, floodplain ridges and almost level basins. The soils are grey silt loams ans silty clay loams on ridges and grey or dark grey clays in basins. There are five general soil types occur in the region; of which, Non-carious Grey Floodplain and Noncalcareous Dark Floodplain soils predominate. They are moderately acidic throughout. Organic matter content is low in ridge soils and moderate in basins. General fertility is medium.

Lower Atrai Basin (AEZ-5)

This region comprises the low lying area between the Barind Tract and the Ganges River Floodplain. Smooth low lying basin land occupies most of the region. The basin area receives floodwater from the Atrai and Little Jamuna Rivers and from Ganges distributaries, as well as run off from the barind Tract. Flooding formerly was very deep, and large areas (Chalan Beel) remained wet through the dry season. Heavy clays occupy most of the land, but more silty and calcareous soils occupy some ridges adjoining the Ganges River Floodplain. Seven general soil types occur in the region; but Non-calcareous Dark Grey Floodplain soils cover most of the area. Organic matter and fertility status are moderate.

Lower Purnabhaba Floodplain (AEZ-6)

This region occupies a narrow strip of floodplain land along the lower course of the Purnabhaba River in the west of Naogaon and the north of Chapai Nawabganj Districts. The relief comprises broad ridges and basins, with beels occupying the basin centers. Most of the areas are deeply flooded in the rainy season, and is subject to flash floods descending the Purnabhaba River and running off the adjoining High Barind Tract during periods of heavy rainfall. The soils are heavy in nature occupying almost the whole landscape, ridges and basins alike. In this area soil are dark grey, mottled red and very strongly acid in nature. Organic matter content is medium to high. General fertility level is medium.

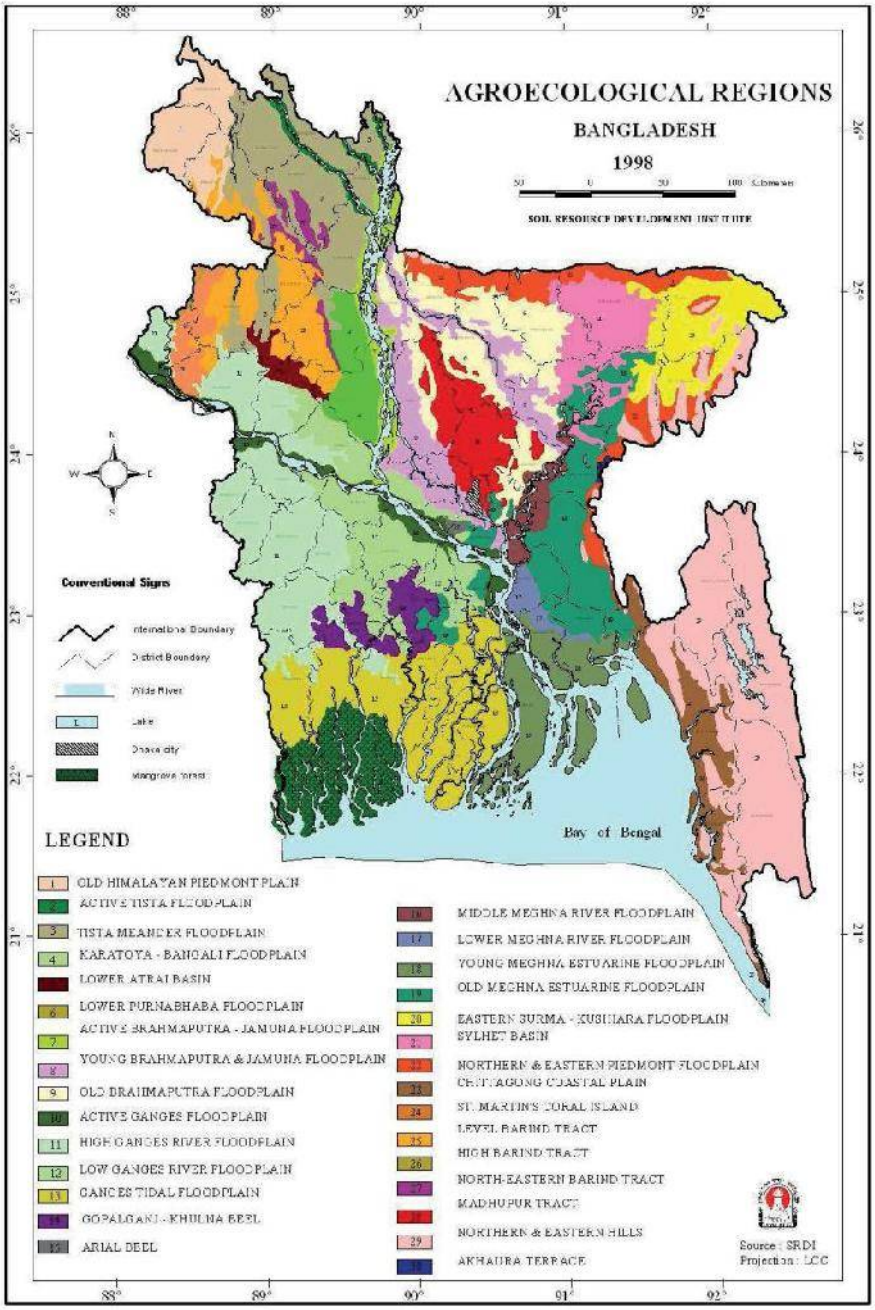

Figure 3 Locations of Agro-ecological Regions of Bangladesh

Active Brahmaputra-Jamuna Flood plain (AEZ-7)

This subunit, which underlies agro-ecological Region 7, comprises young, stratified, alluvial land within and adjoining the shifting channels of the Brahmaputra and Jumna Rivers, the Old Brahmaputra River and the Dhaleswari-Kaliganga River. The land formation (char) are liable to change shape each year as river banks are eroded,new alluvium is deposited within and alongside channels, and older deposits are buried by layers of new alluvium. The relief varies from smooth to irregular, with differences in elevation of 2-3 metres or more between adjoining ridges and depressions. The depth of flooding varies from shallow to deep on different sites, and the maximum depth may vary by a metre or more from year to year. The area is occupied by sandy and silty alluvium rich in minerals with slightly alkaline in reaction. The Brahmaputra sediments are greyer in color than the Ganges sediments. Six general soil types occupy the area; of which only Non-calcareous Alluvium predominates. Organic matter content is low and fertility status low to medium.

Young Brahmaputra and Jamuna Floodplain (AEZ- 8)

The region comprises the area of Brahmaputra sediments. It has a complex relief of broad and narrow ridges, inter-ridge depressions, partially in filled cut-off channels and basins. This area is occupied by permeable silt loam to silty clay loam soils on the ridges and impermeable clays in the basins; neutral to slightly acid in reaction. General Soil Types include predominantly Grey Floodplain soils. Organic matter content is low in ridges and moderate in basins. Soils are deficient in N, P and S but the status of K and Zn is medium.

Old Brahmaputra Floodplain (AEZ-9)

This region occupies a large area of Brahmaputra sediments before the river was diverted to its Present Jamuna channel was formed about 200 years ago. The region has broad ridges and basins. Soils of the area are predominantly silt loams to silty clay loams on the ridges and clay in the basins. General Soil Types predominantly includes Dark Grey Floodplain soil. Organic matter content is low on the ridges and moderate in the basins, top-soils moderately acidic and sub-soils neutral in reaction. General fertility level is low. However, the status of P and CEC is medium and the K status is low.

Active Ganges Floodplain (AEZ-10)

The agro-ecological regions of Active Ganges Floodplain falls under Subunit 10 and comprises young, stratified, alluvium land within and adjoining the shifting channels of the Ganges River and its two main distributaries, the Gorai- Madhumati and Arial khan. The alluvial formations (chars) are liable to change shape each year as river bank are eroded, new alluvium are deposited within and along channels and older deposits are buried by layers of new alluvium. The relief varies from smooth to irregular, with 2-3 metres or more difference in elevation between the adjacent ridges and depressions. Seasonal flooding varies from shallow to deep on different sites, and may vary in depth by more than a metre between years. The area has complex mixtures of calcareous sandy, silty and clayey alluvium. The general soil type's predominately include Calcareous Alluvium and Calcareous Brown Floodplain soils, which are low in organic matter and mildly alkaline in reaction. The fertility status is generally medium.

High Ganges River Floodplain (AEZ-11)

This region includes the western part of the Ganges River Floodplain which is predominately high land and medium high land. Most areas have a complex relief of broad and narrow ridges and inter-ridge depressions, separated by areas with smooth broad ridges and basins. There is an overall pattern of olive-brown silt loams and silty clay loams on the upper parts of the floodplain ridges and dark grey, mottled brown, mainly clay soils on ridge sites and in basins. Most ridge soils are calcareous throughout. General soil types predominately include Calcareous Grey Floodplain soils and Calcareous Brown Floodplain soils. Organic matter content in brown ridge soils is low and higher in dark grey soils. Soils are slightly alkaline in reaction. The fertility level is generally low.

Low Ganges River Floodplain (AEZ-12)

This region comprises the north-eastern, eastern and south-eastern parts of the Ganges Meander Floodplain which are lower –lying than the western part.The ridges are mainly shallowly flooded, but basins become moderately deeply or deeply flooded in the rainy season.

The soils of the Low Ganges River Floodplains are silt loams and silty clay loams on the ridges and silty clay loams to heavy clays on lower sites. General soil types predominately include Calcareous Dark Grey, Grey and Calcareous Brown Floodplain soils. Organic matter content is low in ridges and moderate in the basins. Soils are calcareous in nature having neutral to slightly alkaline in reaction. General fertility level is medium.

Ganges Tidal Floodplain (AEZ-13)

This region occupies an extensive area of tidal floodplain land in the south-west of the country.The Ganges Tidal Floodplain has low relief compared to the Ganges River Floodplain. The area is criss-crossed by innumerable tidal rivers and creeks whose banks generally stand less than a metre above the adjoining basins. The whole of this zone lies within the cyclone zone.Under natural conditions, this area is flooded at high tide, either throughout the year or during rainy season when rivers entering from the north brought in increased flows. In the southwest, the embankments have cut off this tidal flooding in places, but basin sites are flooded by rain water which accumulates in the monsoon season. The rivers are saline throughout the year in the west. In the east, they carry fresh water to the coast during rainy season, and only become saline in their lower courses during the dry season. Most of the eastern half of the unit is non-saline throughout the year, therefore, Tidal and seasonal flooding are mainly shallow, but basin centres in the north are moderately deeply flooded in the monsoon season. The Ganges Tidal Floodplain consists of three subunits namely, non-saline, saline and Sunderbans. There is pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, non-calcareous, heavy silty clays in the extensive basins. Non-calcareous Grey Floodplain soil is the major component of general soil types. Acid Sulphate soil also occupies significant part of the area where it is extensively acidic during dry season. In general, most of the top soils are acidic and sub-soils are neutral to mildly alkaline. Soils of Sundarbans area are strongly alkaline. The fertility level is generally high with medium to high organic matter content.

Gopalganj-Khulna Bils (AEZ-14)

This region occupies a low lying area between the Ganges River Floodplain and the Ganges Tidal Floodplain. Almost level, low–lying basins occupy most of the region with low ridges along rivers and creeks. The basin centres lie almost at sea-level. They are deeply or deeply flooded in the rainy season and remain wet or submerged throughout the dry season. In general, seasonal flooding is deeper in the north than in the south. Flooding is entirely by accumulated rainwater or the raised ground water table. The rivers are tidal, but not saline, in the dry season. Soils of this region are grey and dark grey acidic heavy clays overlying peat or muck at 25-100cm. Soft peat and muck occupy perennially wet basin centres. General soil types include mainly peat and Noncalcareous Dark Grey Floodplain soils. Organic matter content is medium to high. Fertility level is medium.

Arial Bil (AEZ-15)

This region occupies a low lying basin between the Ganges and Dhaleshwari rivers in the south of the former Dhaka district. The soils of this area are dark grey, acidic heavy clays. A non-calcareous Dark Grey Floodplain soil is the major General Soil Type. Organic matter content generally exceeds 2% in the top and subsoil. Available moisture holding capacity is inherently low. They have high CEC, and general fertility level is medium to high.

Middle Meghna River Floodplain (AEZ- 16)

This region occupies abandoned channel of the Brahmaputra river on the border between the greater Dhaka and Comilla districts. This region includes islands – former Brahmaputra chars, within the Meghna river as well as adjoining parts of the mainland. Soils of the area are grey, loamy on the ridges and grey to dark grey clays in the basins. Grey

sands to loamy sands with compact silty topsoil occupy areas of Old Brahmaputra char. Dominant General Soil type is Noncalcareous Grey Floodplain soils. Topsoils are strongly acidic and subsoils moderately acidic to slightly alkaline. General fertility level is medium with low N and organic matter contents. The P, Zn and B levels are low to medium.

Lower Meghna River Floodplain (AEZ -17)

This area occupies transitional area between the Middle Meghna River Floodplain and the Young Meghna Estuarine Floodplain. The region has slightly irregular relief, but with little difference in elevation between the ridges and depressions. Soils of this area are relatively uniform, silt loams occupy relatively higher areas and silty clay loams occupy the depressions. Noncalcareous Dark Grey Floodplain and Calcareous Grey Floodplain soils are major components of General Soil Types. Top-soils are moderately acidic and sub-soils neutral in reaction. General fertility level is medium to high with low to medium organic matter status and K-bearing minerals.

Young Meghna Estuarine Floodplain (AEZ-18)

This region occupies young alluvium land in and adjoining the Meghna Estuary. It is almost at level with very low ridges and broad depressions. The soils of this region are grey to olive, deep, calcareous silt loam and silty clay loams and are stratified either throughout or at shallow depth. Calcareous Alluvium and Non-calcareous Grey Floodplain soils are the dominant general type. The soils of the south become saline in dry season. Top soils and sub-soils of the area are mildly alkaline. General fertility is medium. The content of organic matter is low.

Old Meghna Estuarine Floodplain (AEZ-19)

This region occupies a large area, mainly low-lying between south of the Surma-Kusiyara Floodplain and northern edge of the Young Meghna Estuarine Floodplain. It comprises smooth, almost level, floodplain ridges and shallow basins. Seasonal flooding occurs due to accumulated rainwater. It is moderately deep or deep in the north and west, but it is shallow in the south east. Silt loam soils predominate on highlands and silty clay to caly in low lands. Non-calcareous Dark Grey Floodplain soils are the only general type of the area. Organic matter content of the soils is moderate. Moisture holding capacity is medium. Top-soils are moderately acidic, but sub-soils are neutral in reaction. General fertility level is medium.

Eastern Surma-Kushiyara Floodplain (AEZ -20)

This region occupies the relatively higher parts of the Surma-Kushiyara Floodplain formed on sediments of the rivers draining into the Meghna catchment area from the hills. The area is mainly smooth, broad ridges and basins. This area is occupied by grey, heavy silty clay loams on the ridges and clays in the basins. Non-calcareous Grey Floodplain soils are the only General Soil Type. Organic matter content of the soil is moderate. Soil reaction ranges from strongly acidic to neutral. Levels of CEC and Zn are medium while the status of P, K and B is low.

Sylhet Basin (AEZ -21)

The region occupies the lower, western side of the Surma-Kushiyara Floodplain. The area is mainly smooth, broad basins with narrow ridges of higher land along rivers. Soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basins. Non-calcareous Grey Floodplain soils and Acid Basin Clays are the major components of the general soil types. The soils have moderate content of organic matter and soil reaction is mainly acidic. Fertility level is medium to high with medium P and Zn contents.

Northern and Eastern Piedmont Plains (AEZ -22)

This is a discontinuous region occurring as a narrow strip of land at the foot of the northern and eastern hills. The area comprises merging alluvial fans which slope gently outward from the foot of the hills, into smooth, low lying basin. Grey Piedmont soils and Non-calcareous Grey Floodplain soils are the major General Soil Types of the area. Soils of the area are loams to clays in texture having slightly acidic to strongly acidic reaction. General fertility level is low to medium.

Chittagong Coastal Plains (AEZ- 23)

This region occupies the plain land in greater Chittagong district and the eastern part of Feni District. It is a compound unit of piedmont, river, tidal and estuarine floodplain landscapes. The major problem in these soils is high salinity during dry season (October to May).Grey silt loams and silty clay loam soils are predominant. Acid Sulphate soils which are potentially extremely acidic occur in mangrove tidal floodplains. Non-calcareous Grey Floodplain soils, Non-calcareous Alluvium and Acid Sulphate soils are the major components of the General Soil Types of the area. General fertility level of the soils is medium, and N and K are limiting. Status of S is high.

St. Martin`s Coral Island (AEZ- 24)

This small but distinctive region occupies the whole of St. Martin`s Island in the extreme south of the country. The area has very gently undulating old beach ridges and inter-ridge depressions, surrounded by sandy beaches. The soils are developed entirely on old and young coral beach sands. Calcareous Alluvium is the only General Soil Type of the area. General fertility level is low with poor moisture holding capacity. Organic matter content is low to moderate and the status of Zn and B is medium.

Level Barind Tract (AEZ-25)

The region is developed over Madhupur Clay. It occupies 80% of the whole tract. The landscape is almost level and locally irregular along river channels. The predominating soils have a grey silty paddled v top-soils with plough pan which either directly overlies grey heavy little weathered Madhupur Clay or merges with the porous silt loam or silty clay loam sub-soils having strongly acid clay at greater depth. Shallow Grey Terrace soils and Deep Grey Terrace soils are the major components of general soil types of the area. The soils are low in available moisture holding capacity and slightly acidic to acidic in reaction. Organic matter status is very low and most of the available nutrients are limiting.

High Barind Tract (AEZ-26)

This region includes the western part of Barind Tract where the underlying Madhupur Clay has been uplifted and cut into by deep valleys. The High Barind Tract occupies about 10% of the whole Barind Tract. It is underlaid by heavy Madhupur Clay which often contains large lime nodules. The soils include paddled silt loam to silty clay loam in the top-soils and porous silt loam with mottled plastic clay at varying depth. Deep Grey Terrace soils and Grey Valleys soils are the major components of general soil types of the area. General fertility status is low having low status of organic matter. Most of the ridge tops, valley sides and sloping valley bottoms have been terraced for paddy cultivation and have poorly drained grey soils with silty top-soils.

North Eastern Barind Tract (AEZ -27)

This region occupies several discontinuous areas on the north-eastern margins of the Barind Tract. It stands slightly higher than adjoining floodplain land. The region has silty or loamy topsoil and clay loams to clay sub-soils and grades into strongly mottled clay. The Madhupur Clay underlying this region is deeply weathered. Deep Red Brown Terrace soils and Deep Grey Terrace soils are the major components of the General Soil Types of the area. The soils are strongly acidic in reaction. Organic matter of the soils is low. General fertility level is poor with medium status of Zn.

Madhupur Tract (AEZ- 28)

This is a region of complex relief and soils are developed over the Madhupur Clay, The landscape comprises level upland, closely or broadly dissected terraces associated with either shallow or broad deep valleys. Eleven General Soil Types exist in the area of which, Deep Red Brown Terrace, Shallow Red Brown Terrace soils and Acid Basin Clays are the major ones. The soils on the terrace are better drained, friable clay loams to clays overlying friable clay substratum at varying depths. Soils in the valleys are dark grey heavy clays. They are strongly acidic in reaction with low status of

organic matter, low moisture holding capacity and low fertility level. The soils are mainly phosphate fixing, and low in P, K, S and B levels.

Northern and Eastern Hills (AEZ -29)

This region includes the country's hill areas. Relief is complex. Hills have been dissected to different degrees over different rocks. In general, slopes are very steep and few low hills have flat summits. The major hill soils are yellow-brown to strong brown, permeable, friable, loamy; very strongly acidic and low in moisture holding capacity. However, soil patterns generally are complex due to local differences in sand, silt and clay contents of the underlying sedimentary rocks and in the amount of erosion that has occurred. Brown Hill soils are the predominant General Soil Types of the area. Organic matter content and general fertility level are low.

Akhaura Terrace (AEZ-30)

This small region occupies the eastern border of Brahmanbaria and southwest corner of Habiganj district. In appearance, the region resembles Madhupur Tract with level upland, dissected by mainly deep broad valleys. The main soils on the upland have strong brown clay which grades into red mottled clay substratum. The valley soils range from silty clay loams to clays. Deep Red Brown Terrace soil, Grey Piedmont soils and Acid Basin Clays are the major components of the General Soil Types of the area. The general fertility including organic matter status is low. The soils are strongly acidic in reaction.

Agro-ecological Zones showing major land type, key character, land use and key constraints interventions have been shown in atrix (*Appendix A)*.

4.4 Land Form

A landform in the *earth sciences* comprises a *geomorphologic* unit, and is largely defined by its surface form and location in the landscape. There are about 14.84 million ha area of Bangladesh of which 80% is flood plain, 12% is hilly and the remaining 8% is under uplifted blocks (terraces). A portion of hilly areas are economically used with tea, rubber, pineapples and terrace cultivation, however, some areas are misused by *jhum* cultivation alone. Vast area of flood plain lands gets inundated during monsoon season and becomes intractable for cultivation. In summer, the swamp areas dry up and come under cultivation. Only one crop of short duration could be harvested in these swamps. Other swamps, which remain submerged all through the year, are rather in assessable for cultivation. The main land forms in Bangladesh are ridges, basins, Char lands, hills, terraces, rivers, and valleys.

4.5 Land Type

Land type classification is based on depth of inundation during monsoon season due to normal flooding on agriculture land. In terms of depth of flooding, the following five land types classes are recognized. Land type is a system of classifying cultivated land based on the seasonal inundation depth of flood water. The agricultural farming practices in Bangladesh are in an advantageous position as the majority of the country's lands are under F_0 and F_1 land types. The distribution of land types of Bangladesh is presented in Table 1 and Figure 4.

Table 1 Distribution of various land type of Bangladesh

Land Type	Description	Flooding characteristics	% of NCA
F_0	Highland	Non-flooded to intermittent or land which is above normal flood-level.	34
F_1	Medium Highland	Land which is normally flooded up to about 90 cm deep during the flood season. This class has been subdivided into two classes: MH-1, normally flooded upto about 30 cm deep; and MH-2, normally flooded between 30 and 90 cm deep	40
F_2	Medium Lowland	Land which is normally flooded up to between 90 cm and 180 cm deep during the flood season	15
F_3	Lowland	Land which is normally flooded to between 180 and 300 cm deep during the flood season.	10
F_4	Very Lowland	Land which is normally flooded deeper than 300 cm during flood season.	2

Source: CEGIS estimation from SOLARIS_SRDI (2006)

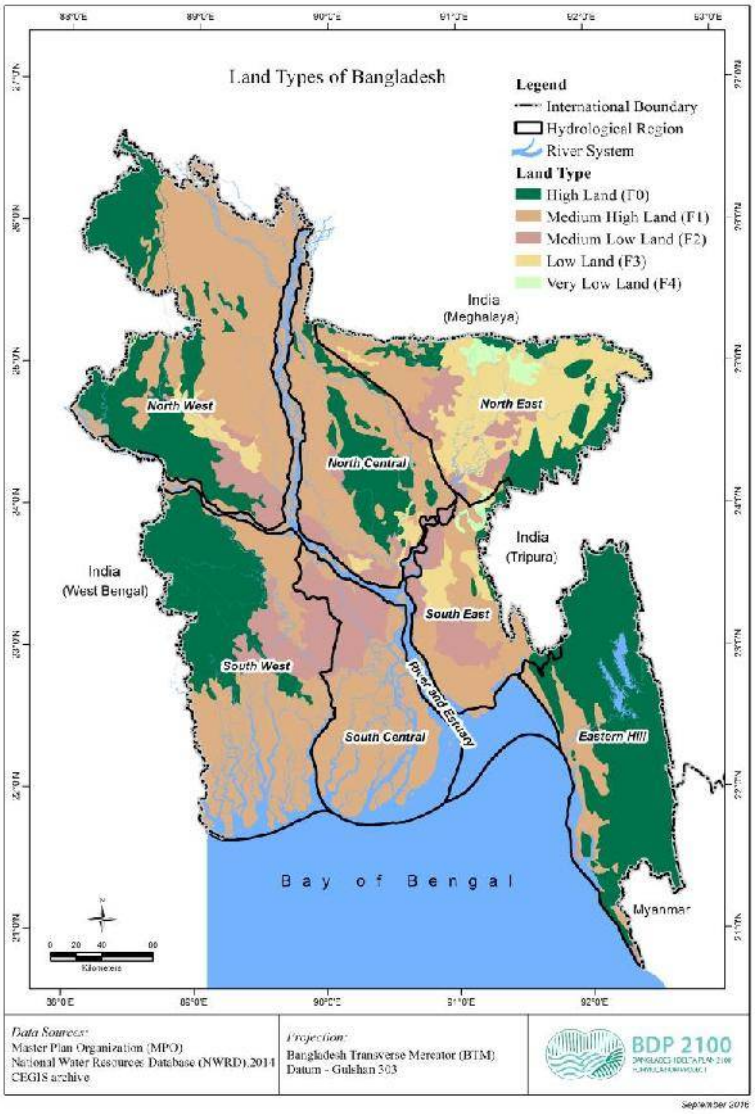

Figure 4 Land type of Bangladesh

4.6 Drainage Characteristics

Drainage plays a vital role in the management of soil in the country. As per the SRDI (1988), the drainage characteristics have been divided into six classes from the agriculture point of view. The coverage of different classes of drainage characteristics of the country is presented in Table 2 and Figure 5.

Table 2 Detailed distribution of different drainage characteristics of Bangladesh

Drainage classes	Characteristics	% coverage
Excessively drained	Water drained out rapidly from surface soil or soil. Water removed from soil immediately after rainfall or application of irrigation water. This soil is not favorable field crops.	10.2
Well drained	Water drained from soil instantly, but not so rapidly. It holds water for plant growth after rainfall or irrigation.	10.7
Moderately well drained	Water drained from soil slowly. So, soil remains wet for a certain time. In this case, slowly permeable layer or ground water remains within 1-2 metre of depth in rainy season.	9.5
Imperfectly drained	Water drained from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land more than 15 days at a stretch. In rainy season, groundwater stands within 1 metre at least for some time.	28.6
Poorly drained	The soil remains under water from 15 days to 7/8 months. Water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period of time after the rainy season.	38.6
Very poorly drained	The land remains submerged under water for more than 8 months and remains wet throughout the year.	2.4

Source: CEGIS estimation from SOLARIS-SRDI

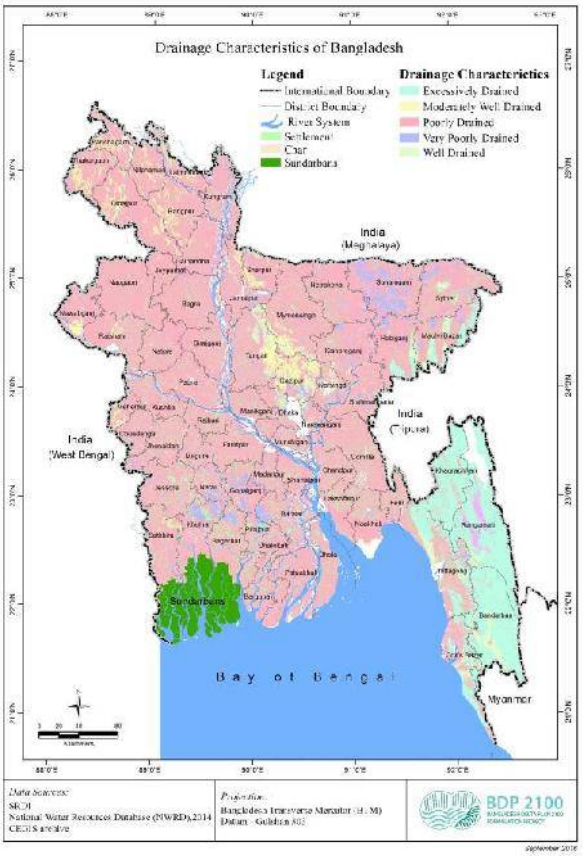

Figure 5 Detailed distribution of different drainage characteristics of Bangladesh

4.7 Surface Water Recession

The Rabi season starts from November and continues up to February. The recession of surface water is related to the connectivity with rivers which flow toward the sea. Surface rain/ floodwater recession at the end of the monsoon season depends on soils and topography. Cultivation of Rabi crops mainly depends on the recession of surface water from the field. As a result, cultivation of Rabi crops starts in different times in the country. According to SRDI (1988), surface water recession is categorized into the five following classes. Detailed distribution of surface water recession characteristic of Bangladesh is presented in Table 3 and Figure 6.

Table 3 Detailed surface water recession of Bangladesh

Categories of Water recession	Characteristics	% Coverage
Very Early	Recession of surface water before mid October	19
Early	Recession of surface water from mid October to mid November	24
Normal	Recession of surface water from mid November to mid December,	20
Late	Recession of surface water from mid December to end of December,	11
Very Late	Recession of surface water after December.	3
NA	-	23
Total		**100.0**

Source: CEGIS estimation from SOLARIS-SRDI (2006)

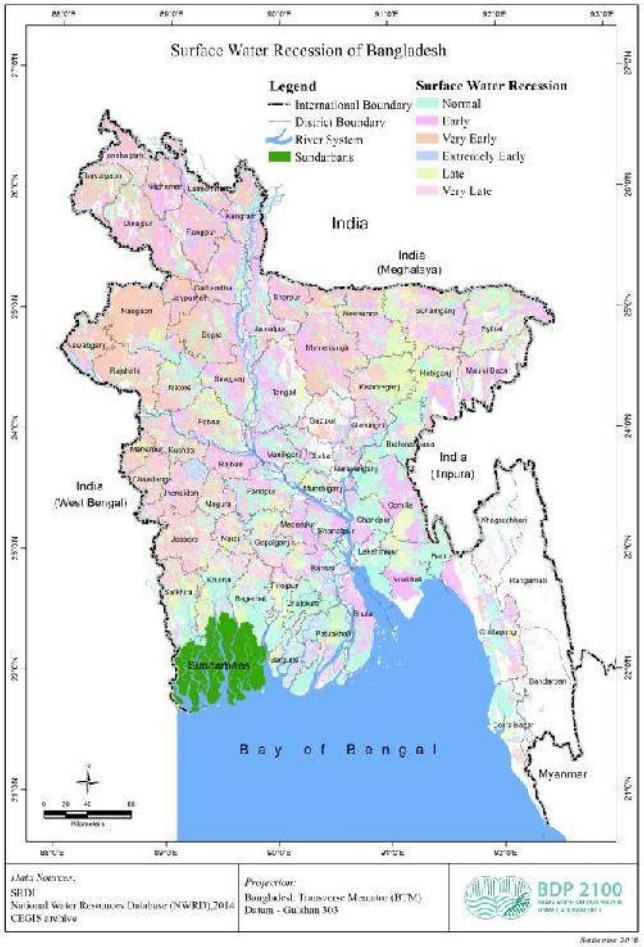

Figure 6 Distribution of surface water recession of Bangladesh

4.8 Soil Salinity

Soil salinity adversely affects the growth of most crops and the magnitude of the damage is related to the degree of salinity. In the tidal areas, the surface water salinity generally increases with the increase in dryness, and reaches to its maximum during April-May and then decreases due to the onset of monsoon rainfall. The flow of sweet water from upstream reduces resulting in intrusion of saline water toward coastal agriculture fields. In dry season, some areas of South Central and South West regions are affected by soil salinity due to capillary raise of saline ground water which is unfavorable for crop production during dry season and remain fallow.

The distribution of saline soils was assessed in 2009 through ground survey following reconnaissance soil survey technique using different base materials such as aerial photographs, topo sheets, Upazila Soil and Landform Maps, previously published soil salinity maps etc. Distribution of soils with different degrees of salinity is shown on the Soil Salinity Map of 2010 (SRDI, 2010). About 1.05 million out of 1.7 million hectares in the coastal areas are affected by soil salinity. About 0.328, 0.275, 0.189, 0.161 and 0.101 million hectares of land are affected by very slight (S1), slight (S2), moderate (S3), strong (S4), and very strong (S5) salinity respectively. Some of the new lands in Satkhira, Patuakhali, Borguna, Barisal, Jhallakathi, Pirojpur, Jessore, Narail, Gopalganj, and Madaripur districts have been affected significantly by different degrees of soil salinity during the last four decades.

A comparative study of soil salinity during the last four decades (1973-2009) in the coastal areas is presented in Table 4 & 5 and in Figure 7.

Table 4 Extent of soil salinity during the last four decades (1973-2009) in the study area

Salt affected area (000'ha)			Salinity class and area (000'ha)											
			S1 2.0-4.0 dS/m			S2 4.1-8.0dS/m			S3 8.1-16.0 dS/m			S4 >16.0 dS/ m		
1973	2000	2009	1973	2000	2009	1973	2000	2009	1973	2000	2009	1973	2000	2009
833.45	1020.75	1056.26	287.37	289.76	328.43	426.43	307.20	274.22	79.75	336.58	351.69	39.90	87.14	101.92

$S_{3= 8.1-12.0}$, $S_{4= 12.1-16.0\ dS/m}$; Source: SRDI, SRMAF Project, Ministry of Agriculture, 2010

A comparative study of the salt affected area between 1973 and 2009 shows that about 0.223 million ha (26.7%) of new land was affected by various degrees of salinity during the last four decades or so (Table 6). It was also found that about 0.0354 million hectares of new land was affected by various degrees of salinity during the last 9 years (2000-2009).

Table 5 Comparative study of the salt affected area between 1973 and 2009 in Bangladesh

Salt affected area (000'ha)			Salt affected area increased during last 9 years (000'ha) (2000-2009)	Salt affected area increased during last 36 years (000'ha) (1973-2009)
1973	2000	2009		
833.45	1020.75	1056.26	35.51 (3.5%)	222.81 (26.7%)

Source: SRDI, SRMAF Project, Ministry of Agriculture, 2010

Over the last nine years, salinity increased in 35,510 ha of land of which Khulna, Bagherhat and Satkhira comprised 14,730 ha; Jessore and Narail 6,790 ha; Pirajpur, Jhalakati, Barishal and Bhola 12,430 ha; Patuakhali and Barguna 7,230 ha and Chittaganj and Cox's Bazaar 370 ha. During this time, salinity decreased in 4,400 ha of land in Gopalganj and Madaripur and 1,640 ha of land in Feni and Naokhali districts.

The main causes of increase in salinity are decrease in upstream flow of fresh water and intrusion of saline sea water in the country through coastal rivers, creeks etc. The decrease in salinity in Gopalganj and Magura might be due to the increase of upstream flow through the Gorai River. The Gorai Off-take project was implemented during 1999-2000. The mouth of the Gorai was cleared through dredging which might have helped to increase upstream flow through the river. As a result, the salinity level decreased in Gopalganj and Magura districts. The salinity area in Laxipur, Feni and Naokhali also decreased by 1,640 ha perhaps due to the increase in flow of the Meghna River as a result of floods and increase of upstream flow through the Meghna which pushed the salinity toward the sea.

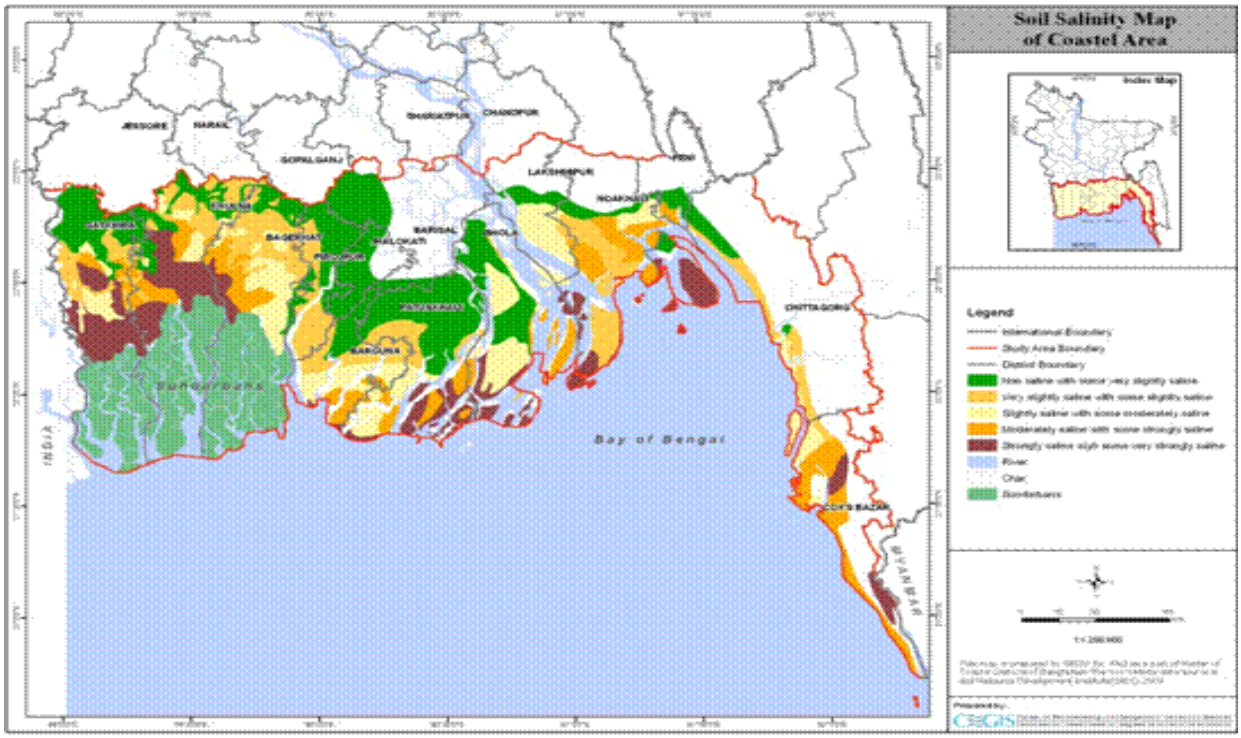

Figure 7 Distribution of soil salinity in Bangladesh

4.9 General Soil Type of Bangladesh Delta

There are 21 general soil types in Bangladesh which are differentiated at the highest level into three physiographic groups such as floodplain soils, hill soils and terrace soils. General soil type is presented in Figure 8.

4.9.1 Floodplain Soils

These soils have formed in the river and piedmont alluvium from very recent to several thousand years old. The original alluvial stratification generally has been broken up to a depth of 20-50 cm or more and three layers are recognized:

- Top-soils are disturbed by cultivation and may have a compact plough pan at the base;
- The subsoil of alluvial stratification is well broken and in which soil properties such as structure, porosity and mottles have developed;
- The substratum comprising raw or stratified alluvium, the substratum consists of one or more buried older soil profiles.

There is a general pattern of silt loam or sandy loam soils on the highest parts of the floodplain ridges grading through silty or sandy clay loams on intermediate sites to silty clays or clays in basins.

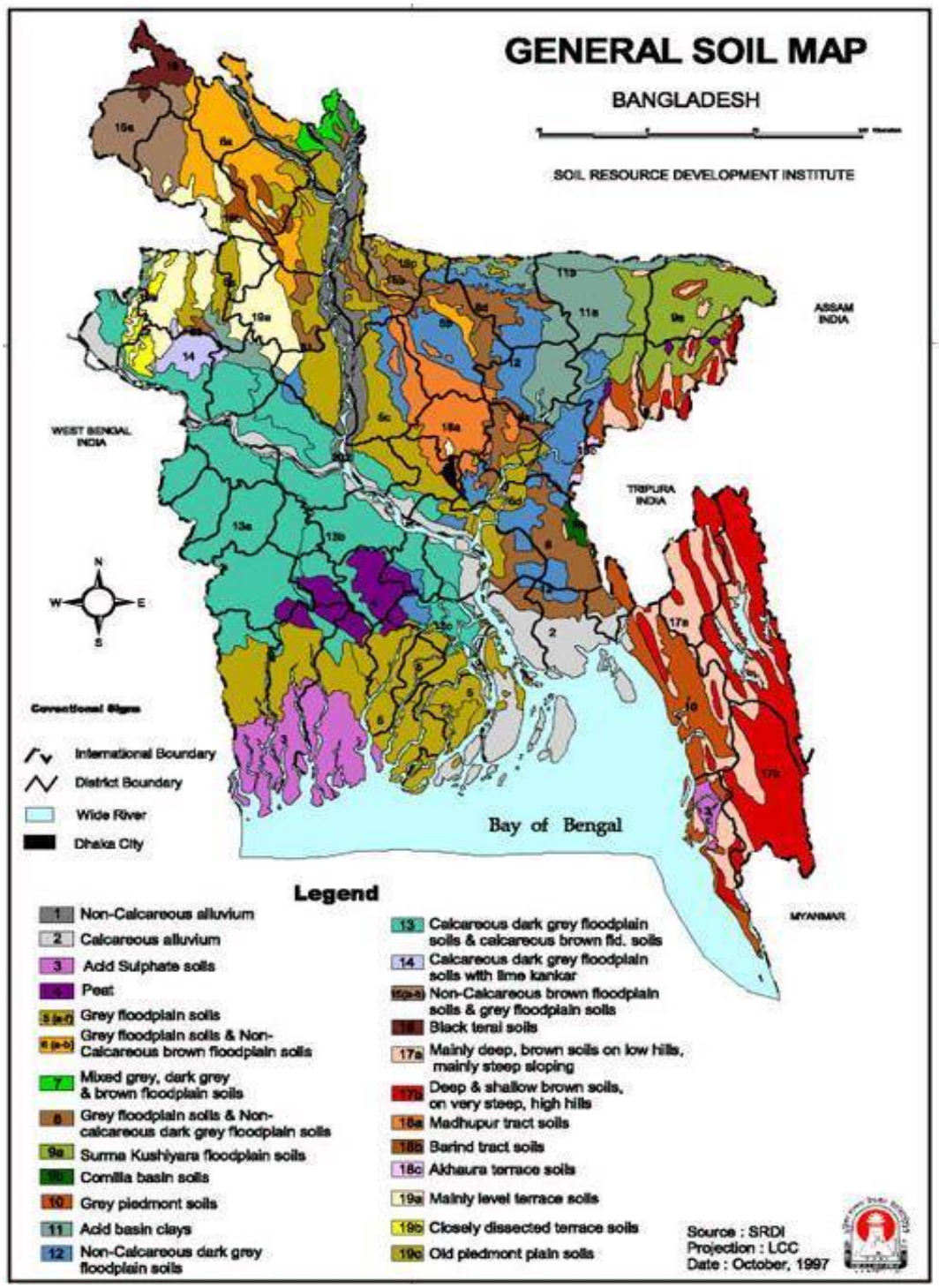

Figure 8 General soil map of Bangladesh

Source: BARC

Flooding is mainly accumulated by rain water or raise ground water table. Flooding is mainly on land close to major river channels, in hill foot areas, and on unembanked parts of tidal and young estuaries floodplains. Permeability is low in basin clays and in many loamy ridges soils which are puddle for paddy

cultivation due to presence of plough pan. Soil organic matter is low in recent alluvium and moderate in basin soils. Top soils generally are slightly to very strongly acidic except some calcareous Ganges River Floodplain and Young Meghna Estuarine Floodplain soils and in recent alluvium. Soils of the coast became somewhat saline in dry season, and there are some areas of toxic Acid Sulphate Soils in the same zone.

Alluvial soils are transported soils. They are formed by sediments which are brought down by rivers during the passage of their flow. As time passes, the sediments get deposited in the form of a layer one upon another. This increases the pressure on the low lying layers of sediments and the temperature in the layers forming the base increases. Then, the process continues for thousands of years and alluvial soil is formed. Major characteristics of alluvial soils are transported origin, alluvial soil as a whole is very fertile, and contain adequate proportion of Potash, Lime and Phosphoric acid, which are ideal for the growth of crops.

4.9.2 Hill Soils

These include a wide range of soils developed over consolidated and unconsolidated sandstones, siltstones, and shales which underline the Northern and Eastern Hills. They are mainly excessively to moderately well drained, strong brown or yellow-brown, friable, sandy loams to sandy clay loams occurring on steep slopes. On the level or rounded summits of some low hills there are redder soils overlying a strongly red-mottled substratum. Most of soils of hilly area are strongly to extremely acidic, moderately to rapidly permeable and low in moisture –holding capacity. Organic matter contents are moderate under older forest, and low in soils that have been repeatedly used for shifting cultivation (*Jum*).

4.9.3 Terrace Soils

These soils have formed over Madhupur Clay on uplifted fault blocks which mainly stand a few meters above flood levels of the adjacent floodplains. Soils characteristics are due to differences in drainage, depth and degree of weathering of parent Madhupur Clay.

Shallow terrace soils have grey, impervious, Madhupur clay (25-60cm). On poorly drained level sites, the overlying soil is a grey, variably mottled, silt loam or silty clay loam with a puddle cultivated layer and a compact ploughpan. Deep terrace soils have a dominantly red-mottled, pervious, clay substratum. Sub-soil colour varies with drainage. In valleys soils, associated within terrace areas ranges from deep, grey, silty soils in shallow, narrow valleys dark grey heavy clays in deep, broad valleys. Permeability is rapid in deep red and brown soils, and in the subsurface layers of grey terrace and valley soils. Moisture –holding capacity is generally low, except for deep-rooting crops on Deep Red-Brown Terrace Soils. Fertility is low, both in cultivated soils and in forested soils. Organic matter content is low but moderate in topsoil under forest. Most soils are strongly to very strongly acidic throughout, but acidity decreases in the heavy clay underlying shallow soils.

Agricultural potential is mainly moderate in poorly drained soils and in deep upland soils, but is low in shallow upland soils. Irrigation and optimum use of fertilizers are the main requirements for increasing productivity. Shallow Red-Brown Terrace soils have a low potential, both for agriculture and forestry.

4.10 Land Utilization/ Land Cover

Landuse/land cover has been collected from three sources; (a) Bangladesh Bureau of Statistics (BBS),

(b) Forest Department (FD), and (c) Soil Resourced Development Institute (SRDI).

4.10.1 Bangladesh Bureau of Statistics (BBS)

A Land Utilization consists of a set of technical specifications within a socio-economic setting. Different LUTs have different requirements for land quality. If the quality of a land unit matches the land use requirement of a defined LUT, its suitability is high. In the present study, entire area has been investigated to know the present status of land coverage. The land utilization/land coverage, includes forest, herb/shrubs, fallow/agricultural land, river and water bodies, settlements, and hill shades. Total area of Bangladesh is about 148, 40,000 ha of which 52.8% is net cultivable area (NCA). The single, double and triple cropped area is about 28.5%, 52.4% and 19%, respectively. The overall cropping intensity of Bangladesh is about 190%. Land use is presented in Table 6 and Figure 9.

Table 6 Present land utilization/land cover of Bangladesh

Land cover	**Area ('000' ha)**	**%**
Total Area	14,840	-
Forest Area	2,578	17.4*
Not Available for cultivation area	3,739	25.2
Culturable waste area	220	1.5
Current fallow area	467	3.1
Single cropped area	2,237	0.0
Double cropped area	4,108	0.0
Triple cropped area	1,486	0.0
Quardruple cropped area	10	0.1
Net cropped area	7,838	52.8
Total cropped area	14,944	100.0

Source: (1) Bangladesh Bureau of Statistics (BBS), 2011 ; (2) Forest area has been reported from the office of the Chief Conservator of Forest (private forest area is not included here, and (3) Total area may slightly differ due to rounding.

4.10.2 Forest Department (FD)

Of the total area of Bangladesh, forest lands account for almost 17%. The total forestland includes classified and unclassified state lands and homestead forests and tea/rubber gardens (Table 7). In case of private forests, the data represent the tree-covered areas. Of the 2.52 million hectare forest land, Forest Department manages 1.52 million hectare which includes Reserved, Protected and Acquired forest and Mangrove forest on the newly accreted land in estuaries of major rivers. The remaining 0.73 million hectare of land designated as Unclassified State Forest (USF) are under the control of Ministry of Land. Village forests (homestead land) form the most productive tree resource base in the country and accounts for 0.27 million hectare (Tanzim, 2011).

Table 7 Present forest land cover in Bangladesh

Category of Forests	**Area (Million ha)**	**% of total area**
Forest Department Managed Forests (Reserved, Protected and Acquired forest and Mangrove forest on the newly accreted land in estuaries of major rivers).	1.52	10.30
Unclassified State Forest (Control by ministry of land)	0.73	4.95
Village/Homestead Forest: (most productive tree resource base in the country)	0.27	1.83
Total	**2.52**	**17.08**

Source: Tanzim (2011)

4.10.3 Soil Resource Development Institute (SRDI)

As per SRDI, the land coverage of Bangladesh may be broadly divided into two types: (i) Agricultural land which includes crop land, forest, mangrove forest, river, lake(Kaptai), beel and haor, aquaculture, tea estate, salt pan etc. and (ii) Non-agricultural which includes rural settlements, urban and industrial and accreted land(SRDI, 2013). In this land coverage, about 262,229 ha land could not been identified which is about 1.8% of the gross area of the country. Land use of Bangladesh as described by Hasan. *et. al*. (2013) is presented in Table 8.

Table 8 Present land utilization/land cover of Bangladesh

Land cover type	**Year2010**	
Gross area (ha)	**Area(ha)**	**% of total**
Agricultural land:	**121,76,,904**	**82.1**
Crop land	87,51,937	59.0
Forest	14,34,136	9.7
Mangrove forest	4,41,455	3.0
River	9,39,073	6.3
Lake	51,739	0.3
Beel and Haor	2,50,727	1.7
Aquaculture	175,663	1.2
Tea estate	96,152	0.6
Salt pan	36,022	0.2
Non-agricultural land:	**26,63,096**	**17.9**
Rural settlement	17,66,123	11.9
Urban & Industrial	87,616	0.6
Accreted land	5,47,128	3.7
Others(unidentified)	2,62,229	1.8
Total	**1,48,40,000**	**100.0**

Source: Hasan. et.al. (2013)

4.10.4 Marine land

Institute of Marine Sciences and Fisheries of Chittagong University (CU) published a new and complete map of the country's water territory but the map is yet to be circulated through competent authority.

In its published new map, the Institute of Marine Sciences and Fisheries showed the total area of Bangladesh water territory spreading over 1,21,110 square kilometers comprising territorial sea, exclusive economic zone extending out to 200 nautical mile (NM) in the sea. There are 24,077 square kilometers of river estuaries, shallow and internal water within depth of 10 meters. There is 42.007 sqkms of shallow continental shelf region with depth ranging from 10 meters to 200 meters. There is 44,383 sqkms of deep sea water within depth ranging from 200 meters to 2100 meters. The rest of the water territory comprises 10,644 square kilometers of sea with the depth ranging from 2100 meters to 2500 meters. The map also shows probable resources in different areas of the water territory (Professor Saidur Rahman Chowdhury who led the team that prepared the map). Detailed information, along with map of marine land, is yet to be circulated by the competent authority (Government Source).

4.11 Land Reclamation and Development in the Estuary and Coastal Areas

Land reclamation through spatial planning may be very useful, especially in a poor country like Bangladesh, where land scarcity is so acute and millions of families are landless. Land reclamation is the creation of new land for human activities. Land reclamation is the process to create new land from ocean, riverbeds, canals, or lakes. The land reclaimed in this process is known as reclamation ground or landfill. Land reclamation from sea can be done in Bangladesh Delta to increase its land area. It can be done through appropriate selection of spots for reclamation in various places in the coastal belt and can be reclaiming substantial amount of land from the sea. A significant area has already been reclaimed from sea in the coastal area of the country.

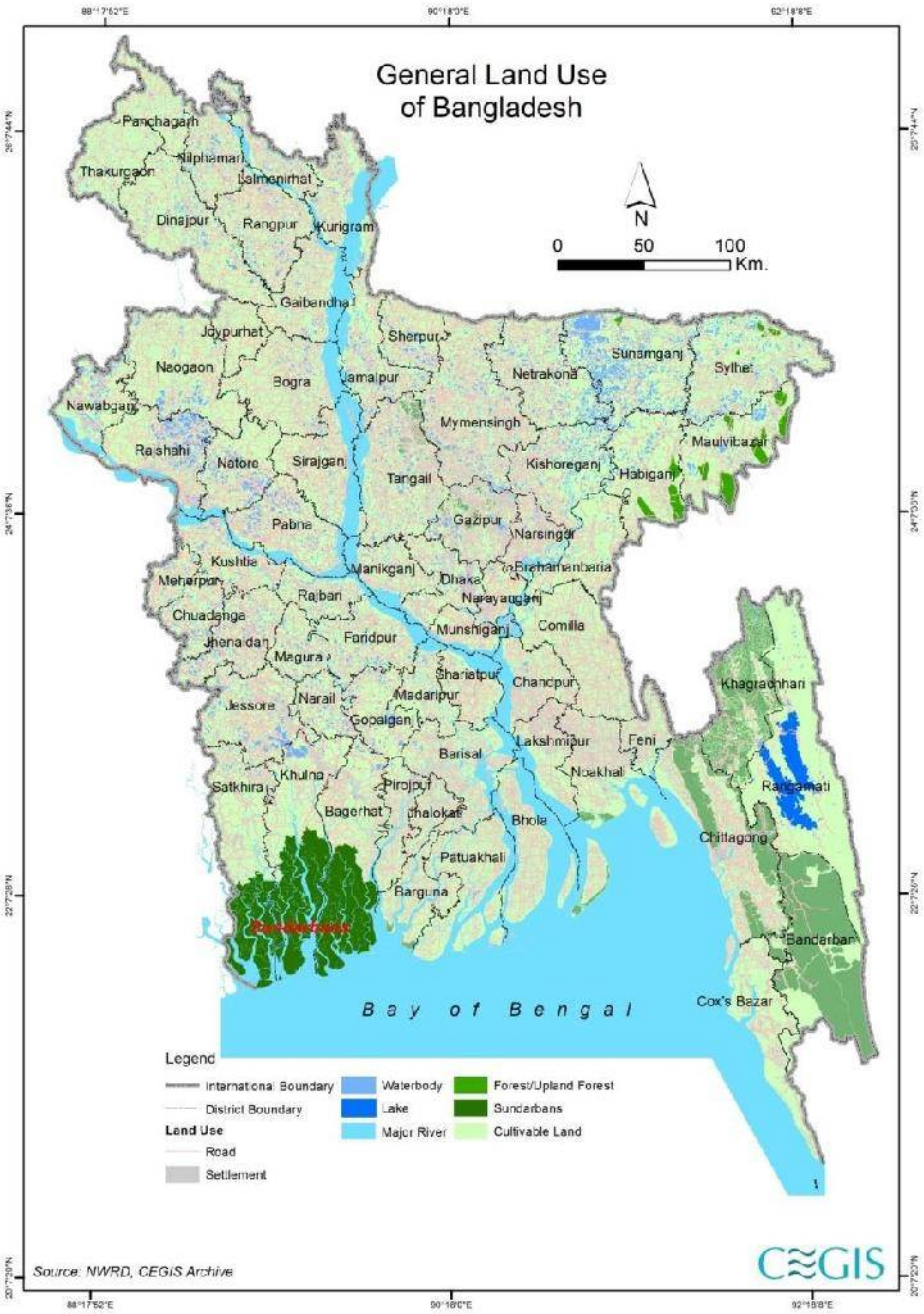

Figure 9 Land use of Bangladesh

4.11.1 Erosion and accretion in the Mighty Rivers of Bangladesh

Land reclamation in Bangladesh is generally occurring in the banks of the principal rivers (Ganges, Jamuna and Padma) by erosion. In the coastal regions, especially in the Meghna Estuaries, land is reclaiming continuously in a limited scale.During 1973-2013, a total 153,438 ha of lands have been eroded whereas total area of accreted lands was 52,998 ha in the same period (CEGIS, 2013). Detailed erosion and accretion in the above mentioned rivers is presented in Table 9 and Figure 10.

Table 9 Distribution of Erosion & Accretion in the Mighty Rivers of Bangladesh (1973-2013)

Name of River	Erosion (1973-2013)	Accretion(1973-2013)
Ganges	29,842	25,009
Jamuna	90,367	16,444
Padma	33,229	11,545
Total	1,53,438	52,998

Source: CEGIS, 2013.

It is observed that the area of eroded land is much more than that of the accreted lands

4.11.2 Land reclamation and development in the Meghna Estuary

It is observed that the areas of accretion and erosion were 3219.5 Sq.km and 2734.36 Sq.Km respectively during 1973-2010 in the Meghna Estuaries. Net accretion area is about 485.13 Sq. Km during last 37 years. The overall rate of accretion was about 13.11 Sq. Km / year. It is also seen that the erosion was more than that of accretion in the Ganges, Jamuna and Padma rivers areas, whereas accretion was more than that of erosion in the Meghna Estuaries areas. It is assumed that land development may be possible in the Meghna Estuaries and in the coastal regions. Land reclamation and Development in the Meghna Estuaries during 1973-2010 has been presented in Figure 10 and Table 11.

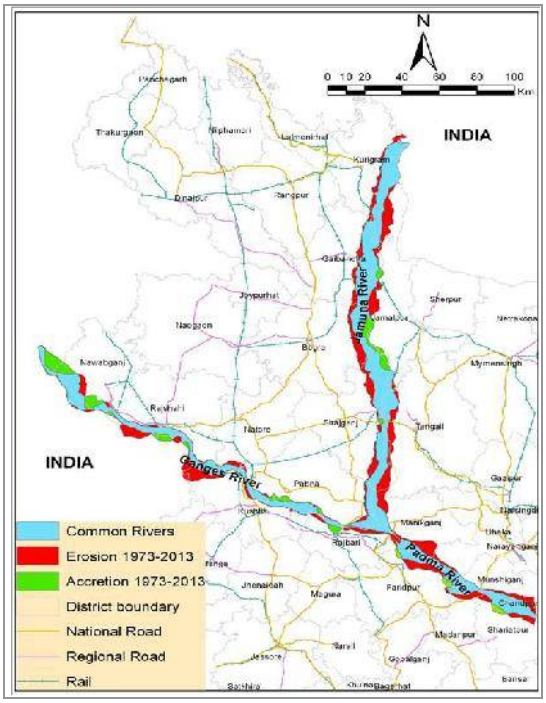

Figure 10 Distribution of Erosion & Accretion in the Mighty Rivers of Bangladesh (1973-2013)

Source: CEGIS, 2013

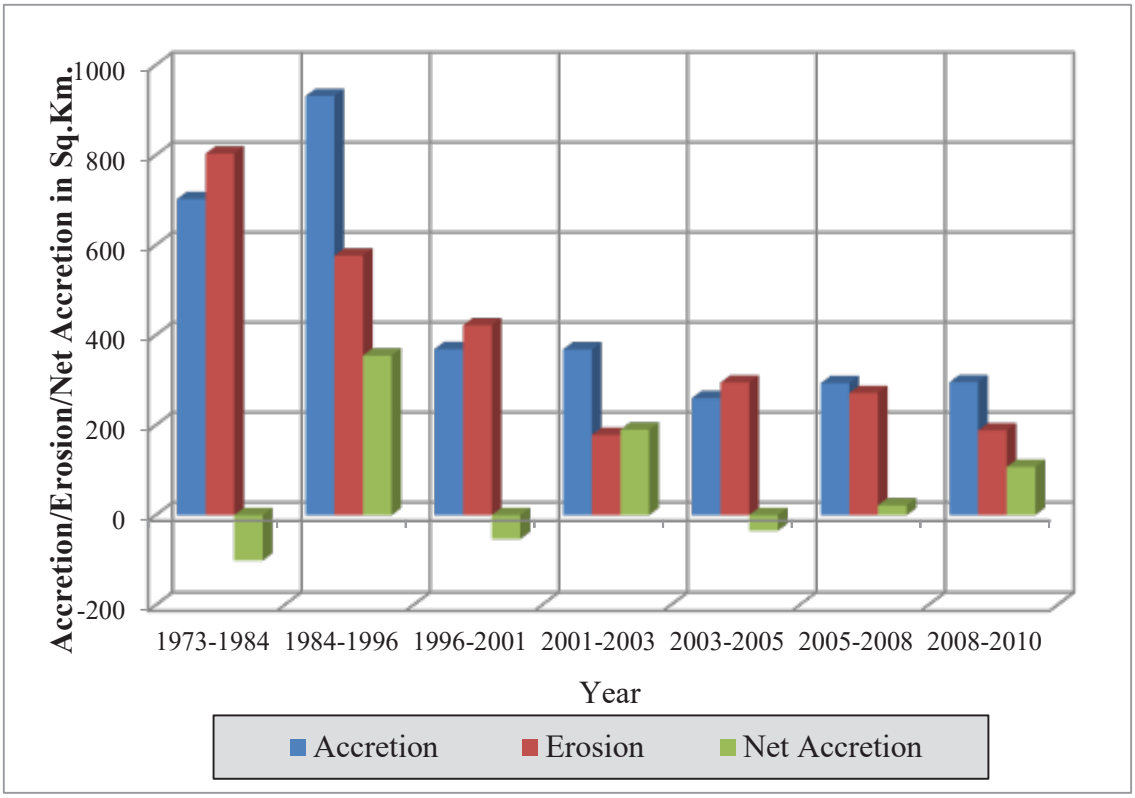

Figure 11 Land Reclamation and Development in the Meghna Estuaries during 1973-2010

Source: CEGIS, 2013.

Table 10 Land Reclamation and Development in the Meghna Estuary and Coastal Areas (1973-2010) of Bangladesh.

Year	Accretion (Sq.Km)	Erosion (Sq.Km)	Net Accretion (Sq.Km)	Rate of Net Accretion (Sq.Km/Yr.)
1973-1984	702.38	803.06	-100.68	-9.15
1984-1996	931.24	576.67	354.57	29.54
1996-2001	369.02	421.97	-52.95	-10.6
2001-2003	368.38	178.302	190.078	95.04
2003-2005	260.02	294.75	-34.73	-17.365
2005-2008	293.21	271.43	21.78	7.26
2008-2010	295.25	188.18	107.07	53.53
	3219.5	2734.362.	485.138	13.11
Remarks: The overall rate of net accretion (Sq.Km/yr)=13.11				

Source: CEGIS(2012) Estimation in the Meghna estuary area

4.11.3 Land reclamation and development in different places of the rivers Jamuna, Ganges, Padma, and Lower Meghna

River bank erosion and accretion of the rivers Jamuna, Ganges, Padma and the Lower Meghna along with districts are presented in Table 11, 12, 13 and 14 during 1973-2013 which were predicted by CEGIS in 2014.

Table 11 Bank erosion and accretion along the Jamuna River during the period 1973 – 2013

District	Eroded area (ha)	Accreted area (ha)
Kurigram	17927	165
Gaibandha	8560	983
Jamalpur	10000	5617
Bogra	10454	5010
Sirajganj	21670	4633
Tangail	8488	30
Pabna	2980	2
Manikganj	5634	4
Total	**87,713**	**16,444**

Source: CEGIS Erosion Prediction 2014

Table 12 Bank erosion and accretion along the Ganges River during the period 1973 – 2013

District	Eroded area (ha)	Accreted area (ha)
Nawabganj	5146	11364
Rajshahi	1408	1684
Natore	1950	121
Kushtia	11826	1600
Pabna	2318	8290
Rajbari	7450	2653
Total	**30,100**	**25,712**

Source: CEGIS Erosion Prediction 2014

Table 13 Bank erosion and accretion along the Padma River during the period 1973 – 2013

District	Eroded area (ha)	Accreted area (ha)
Manikganj	8549	
Rajbari	1156	
Faridpur	8350	3197
Dhaka	2254	
Munshiganj	6210	
Madaripur	4468	
Shariatpur	10664	4015
Total	**41,650**	**7,212**

Source: CEGIS Erosion Prediction 2014

Table 14 Bank erosion along the Lower Meghna River during the period 1973 – 2012

District	Eroded area (ha)	Accreted area (ha)
Barisal	16062	15310
Bhola	35330	42183
Chandpur	8111	3669
Lakshmipur	11506	5908
Noakhali	12488	10710
Patuakhali	12141	22633
Shariatpur	2439	2589
Total	**98,079**	**1,03,003**

Source: CEGIS Erosion Prediction 2014

It is observed that the eroded area of different places of the rivers of the Jumuna, Ganges and Padma are more than that of the accretion (Table 11, 12, and 13). In the Lower Meghna River, the area of accreted area has been found more that the eroded areas (Table 14).

4.12 Fertility Status of Soils

Soil is the main supplier of plant nutrient. There are 16 essential elements of plants of which plants derives 13 elements from soils and the rest three (C, H and O) comes from air and water. Food production in Bangladesh has increased keeping with pace with increase of the population due to the development of HYV crop cultivars under irrigated and use of inorganic fertilizers. The intensive cropping with HYVs, the inherent capacities of soils gradually decline over time. Insignificant use of organic materials and improper soil and crop management are also affecting production. For these, crops suffer from inadequate supply of nutrient resulting in poor yield and quality. In order to get desire yield, it is necessary to know the present fertility status of soil. This information will help for land use management whether there will be any need of addition nutrients to the soil through fertilizers for optimum level of crop production.

Response of a crop added fertilizer nutrients on soil-crop-climate varies due to and production practices. A positive response is only expected if nutrient supplying capacity of a soil falls short of the nutrient demand of a crop under a particular set of condition. The effectiveness of fertilizer application depends on the time and method of fertilizer placement. Nitrogenous fertilizers are very soluble and easily lost from the soil various ways. As such as 60-70%of the applied N my be lost from soil and became unavailable to crop. To get desired benefits from fertilizers, it is important to apply fertilizer efficiently and timely in appropriate doses Three points need to be considered to optimize fertilizer efficiency, (a) crop requirement,; (b) selection of appropriate fertilizer and(c) timing and method of application. To increase the land use efficiency, present status of soil fertility especially N, P, K, S, Zn and B should be known in respect of crop production.

Soil Organic Matter Content

Soil organic matter plays a vital role for crop production. It comes from plant and animal remains (cow dung, farm-yard manure, compost, green manure, press mud etc.). It influences the physical, chemical and biological properties of soil. It improves the various physical parameters of soil viz. soil structure, water holding capacity, aeration, porosity, bulk-density, soil erosion, permeability etc. It is the store house of plant nutrients, mainly N, P and S. Organic matter also serves as a food and energy for micro-organisms (N2 fixing bacteria-Rhizobium, Azotobacter), earthworms. A good agricultural soil should contain about 2.0% organic matter but in Bangladesh, most of the soils have less than 2.00% organic matter, and some soils have less than 1% organic matter. Maximum area (55.5%) of the net cultivable area (NCA) is under medium level of soil organic matter (OM) which is followed by low (30%).

Phosphorus (P)

The status of P has been found low to very low in the AEZs of Eastern Surma-Kushiyara Floodplain, Syhlet basin, Ganges Tidal Floodplain and Northern and Eastern Hills areas. The high level of Phosphorus content is found in old Himalayan Piedmont Plain, Active Tista Floodplain, Tista Meander Floodplain and Old Meghna Estuarine Floodplain areas. The availability of P is low in Rabi season due to low temperature; it increases in Kharif season with the rise of temperature. Phosphorus recovery is usually low (15-25%) and has considerable residual effect. The coverage of very low, low and medium classes of soil P is about 12.5%, 26.2% and 21.2% respectively of the NCA. The optimum level of P status (18.1-24.0 µgm-1) is about 11.4% of the NCA. The high (24.1-30.0 µgm-1) and very high (>30.0 µgm-1) level of P is found about 8.2% and 20.6% respectively of the NCA of the country (BARC, 2012).

Potassium (K)

Very low and low content of K has been found mostly in AEZs of Old Himalayan Piedmont Plain, Tista Meander Floodplain, Eastern Surma-Kushiyara Floodplain and Sylhet Basin areas, while high to very high levels of K is mostly

found in High and Low Ganges River Floodplain and Ganges Tidal Floodplain areas. Generally, K supplying ability of light textured soil is low, but K requirement of crops, particularly rice and tubers crops is high. Potassium application should be considered as maintenance dose. About 25% of K can be reduced with subsequent crops after potato, tobacco, sugarcane, vegetables and spices where high doses K fertilizer are generally used. The coverage of very low, low and medium classes of soil K status are about 2.9%, 25.4% and 22.2% respectively of the NCA of the country. The area of optimum level of K status (0.225-0.30µgm-1) is about 20.3% of NCA. The coverage of high (0.31-0.375µgm-1) and very high (>0.375 µgm-1) level of K is found about 8.2% and 21.2%, respectively of the NCA of the Bangladesh Delta.

Sulphur(S)

The S deficiency has been found mainly in AEZs of Northern and Eastern Hills, Old Himalayan Piedmont, Active Tista and Tista Meander Floodplain areas. The high and very high content of S is available in the High and low Ganges River Floodplain and Ganges Tidal Floodplain areas of Bangladesh. Sulphur availability is high under upland culture and low under wetland rice culture and has substantial residual effect. Sulphur release from the soil organic matter, is higher in Kharif season due to high temperature. In the coverage of very low, low and medium classes of soil, S is about 7.5%, 26.9% and 18.6%, respectively of the NCA. The area of optimum level of S (27.1-36.0 µgm-1) status is about 11.4% of the total area. The high (36.1- 45.05µgm-1) and very high (>45.0µgm-1) level of S is found about 8.0% and 27.5%, respectively of the NCA of the country.

Zinc(Zn)

The very low and low content of Zn status has been found mainly in AEZs of Tista Meander, Ganges Tidal Floodplains and Northern and Eastern Hills of the country. Zn deficiency generally appeared where intensive cultivation with rice based crops is being practiced under irrigated condition. The coverage of very low, low and medium classes of soil Zn is about 8%, 21% and 19%, respectively of the NCA of the country. The area of optimum level of Zn (1.351-1.80µgm-1), is covered about 15% of the NCA. The high (1.81-2.255µgm-1) and very high (>2.25µgm-1) level of Zn is found about 11% and 27% respectively of the NCA of the country. About 5-10% of the added Zn is recovered by a single crop. Zinc fertilizer is recommended only once for every fourth crop.

Boron Status (B)

Boron deficiency appears mainly in sandy soils, high pH and dry soil. The coverage of very low and low contents of B has been found mostly in AEZs of Active Tista and Old Bramaputra Floodplain areas. The high and very high content of B is available mostly in the Ganges Tidal Floodplain, High Ganges River Floodplain, Sylhet basin, low Ganges Floodplain and Gopalganj-Khulna Bils.

4.13 Farm sizes pattern in Bangladesh

Land ownership (farm size) is very important for the land use management. For every person, the basic requirement is food, fibre and housing. So, land ownership pattern will help to plan his/ her land use pattern. It is very difficult to collect the land ownership as per mauza map. In Mauza map, actual ownership has not been updated with the change in ownerships. There are many big landowners in Bangladesh, especially in the Haor and coastal areas. The big landowners are not interested in improving farming practices because of the huge investments required. Most of them appoint share croppers or tenants. The tenants or share croppers are not generally so solvent to meet the expenditure of labor, fertilizers, and other inputs. On the other hand, they are not interested in using new production technologies as the increased output would be shared with the land owner. This situation is not favourable for improved land use in respect of crop production. Detailed farm size of household ownership pattern in Bangladesh is presented in Table 15 and 16.

Table 15 Farm size pattern in Bangladesh

Zila	All Holdings	Non-Farm holdings			Farm holdings							Total Farm holdings
					Small					Marginal	Large	
		With no operating area	With no cultivated area	0.01-0.04 acre cultivated area	0.05-0.49 acre	0.50-0.99 acre	1.00-1.49 acre	1.50-2.49 acre	Total small	(2.50-7.50) acre	(7.50+) acres	
Barisal Division	1,731,282	20,591	381,628	152,220	423,233	213,789	165,638	175,719	1,001,379	157,501	17,963	1,176,843
Chittagong Division	4,883,132	134,072	1,932,402	301,453	291,753	664,569	392,727	359,527	2,234,576	252,688	27,959	2,515,205
Dhaka Division	9,456,838	1,188,079	3,873,358	237,849	1,092,014	1,070,385	727,066	702,816	3,592,281	521,001	44,270	4,157,552
Khulna Division	3,435,470	46,013	1,107,184	177,343	593,484	469,401	348,221	351,123	1,762,229	313,293	29,408	2,104,930
Rajshahi Division	7,663,035	104,350	3,018,357	140,701	1,103,599	1,006,612	733,631	735,276	3,579,118	731,852	88,657	4,399,627
Sylhet Division	1,526,006	24,112	568,862	104,006	217,590	162,375	117,123	145,701	642,789	160,080	26,157	829,026
BANGLADEH	28,695,763	1,517,217	10,881,791	1,113,572	4,247,673	3,610,131	2,484,406	2,470,162	12,812,372	2,136,415	234,396	15,183,183

Source: BBS, 2008

Table 16 Percentages of farm size pattern in Bangladesh

District	All Holdings	Non-Farm holdings			Farm holdings (%)						
		With no operating Area (%)	With no cultivated area(%)	0.01-0.04 acre cultivated area (%)	Small 0.05-0.49 acre	0.50-0.99 acre	1.00-1.49 acre	1.50-2.49 acre	Total small	Marginal (2.50-7.50) acre	Large (7.50+) acres
Barisal Division	1,731,282	1.4	3.5	13.7	10.0	5.9	6.7	7.1	7.8	7.4	7.7
Chittagong Division	4,883,132	8.8	17.8	27.1	6.9	18.4	15.8	14.6	17.4	11.8	11.9
Dhaka Division	9,456,838	78.3	35.6	21.4	25.7	29.6	29.3	28.5	28.0	24.4	18.9
Khulna Division	3,435,470	3.0	10.2	15.9	14.0	13.0	14.0	14.2	13.8	14.7	12.5
Rajshahi Division	7,663,035	6.9	27.7	12.6	26.0	27.9	29.5	29.8	27.9	34.3	37.8
Sylhet Division	1,526,006	1.6	5.2	9.3	5.1	4.5	4.7	5.9	5.0	7.5	11.2
BANGLADEH	28,695,763	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100	100.0	100.0

Source: BBS, 2008

5 Land Use Related Constraints in Bangladesh

Land comprises natural resources like the soils, minerals, water, etc. which are organized in ecosystems to provide a variety of services essential to the maintenance of life-support systems and the productive capacity of the environment. Agro-ecological Zones based on ecologically constraints area of Bangladesh is presented in Figure 12.

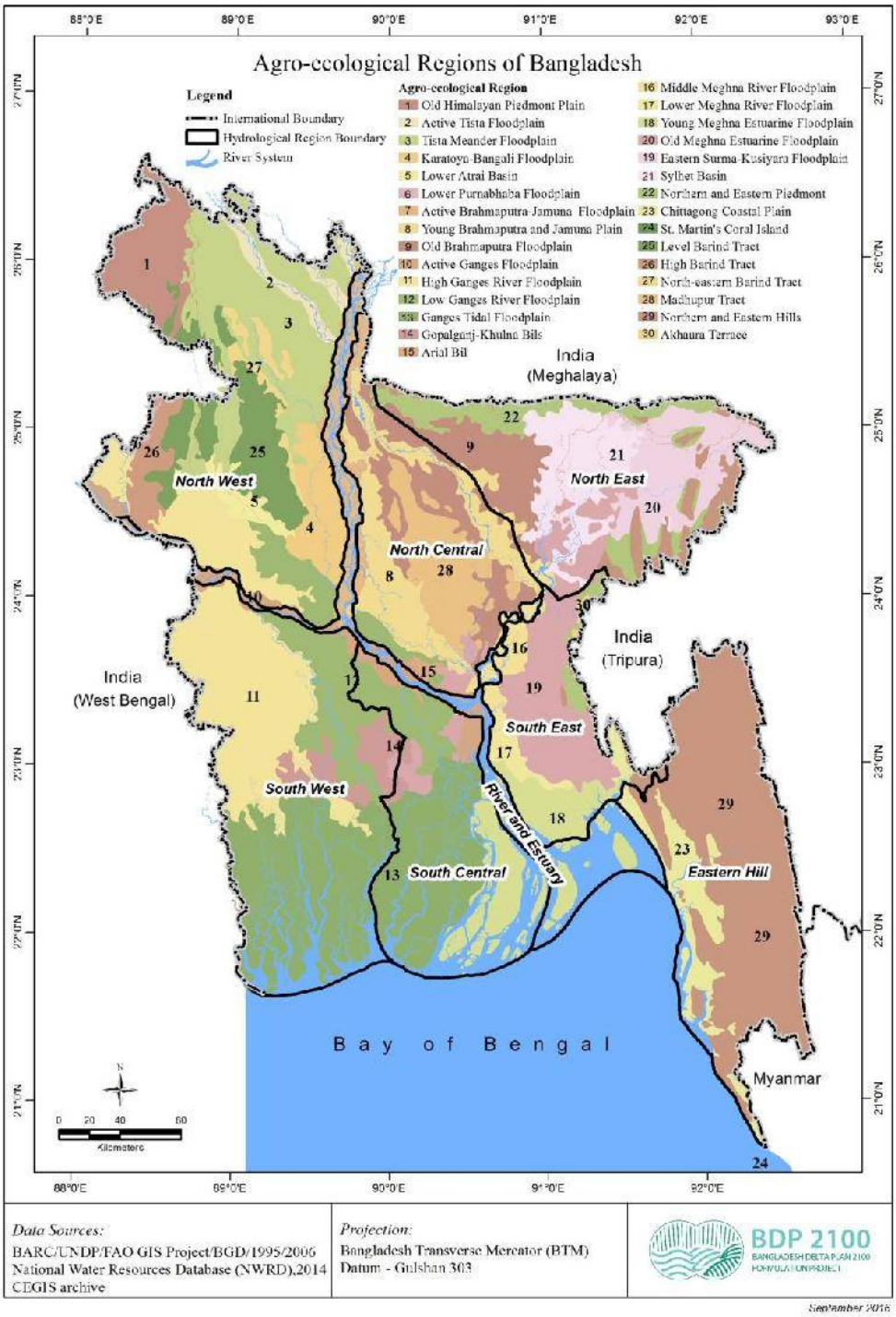

Figure 12 Agro-ecological Zones based on ecologically constraints area

Land resources are used in ways that take advantages of all these characteristics. The supports of natural resources can vary over time due to management Systems. The economic activities are creating pressures on land resources severely due to increase demand of human. This situation creates competition and conflicts for both land and land resources. Land use does not consider agricultural uses only. It encompasses natural areas, forests, watercourses and urban areas among others. The management of land resources should be an integrated approach. Land resources management may be concentrated to agricultural and non-agricultural sectors. For smooth land resources management in Bangladesh delta, the following constraints need to be addressed:

- ✓ Flood (flash flood, river/monsoon flood, rain flood),
- ✓ Drainage congestion/ water logging,
- ✓ Drought,
- ✓ Coastal/tidal surge,
- ✓ Soil salinity,
- ✓ River bank erosion,
- ✓ Land degradation,
- ✓ Soil erosion,
- ✓ Soil fertility depletion,
- ✓ Decrease of land productivity,
- ✓ Siltation on river bed and khals,
- ✓ Rise of sea water due to climate change,
- ✓ Increase of population and settlements,
- ✓ Decrease of crop land, and
- ✓ Problem of farm mechanization

The main constraints which are affecting land use management are discussed briefly as follows:

5.1 Flood

Floods are annual phenomena with the most severe occurring during the months of July and August. Regular river floods affect 20% of the country increasing up to 68% in extreme years. The floods of 1988, 1998 and 2004 were particularly catastrophic, resulting in large-scale destruction and loss of lives. Four types of flooding occur in Bangladesh. These are:

- ✓ Flash floods caused by overflowing of hilly rivers of eastern and northern Bangladesh (in April-May and September-November)
- ✓ Rain floods caused by drainage congestion and heavy rain falls.
- ✓ Monsoon floods caused by major rivers usually in the monsoon (during June-September).
- ✓ Coastal floods caused by storm /tidal surges

Agricultural crop production, specifically, rice crop, is lost frequently due to flash floods and drainage congestion. Flash floods are created mainly from the adjacent hills during pre-monsoon and monsoon seasons. About 20-25% of Boro crops are damaged by flood in most of the years in the north-eastern regions. Due to the devastating flood, the extent of crop damage may exceed 75%. Presently, about 55% of Boro crop area is highly vulnerable due to flash flood mostly in the Haor area. About 20% of Boro crop area is moderately vulnerable at the location of Brahmanbaria and Habiganj distrct, and 25% Boro crop area is less vulnerable in the Netrokona and Kishoreganj district due to flash flood. Early floods and rapid rise of flood level, submerge mature Aus, jute, vegetables and spices and cause damage of these crops. Early floods destroy young plants of T Aman within few days of inundation. The damage also takes place in the seed beds and during early vegetative to tillering stage of growth throughout the country. The 1988 flood affected about two-third area of the country. The 1998 flood alone caused 1,100 deaths, rendered 30 million people homeless, damaged 500,000 homes and caused heavy loss to infrastructure. The 1998 flood lasted for 65 days from

July 12 to September 14 and affected about 67% area of the country. This devastating flood had an enormous impact on the national economy, in addition to causing hardships for people, and disrupting livelihood systems in urban and rural areas

Flood Affected Areas of Selected Years in Bangladesh

In the year 2000, Bangladesh faced an unusual flood over its usually flood-free south western plain, which also caused loss of life and massive damage to property. In 2004, floods inundated about 38% of the country (WARPO, 2005). About 747 people lost their lives. About 2500 kilometres of embankment were damaged. About 74 primary school buildings were washed away. Floods continue to be major hazards in Bangladesh (Figure 13).

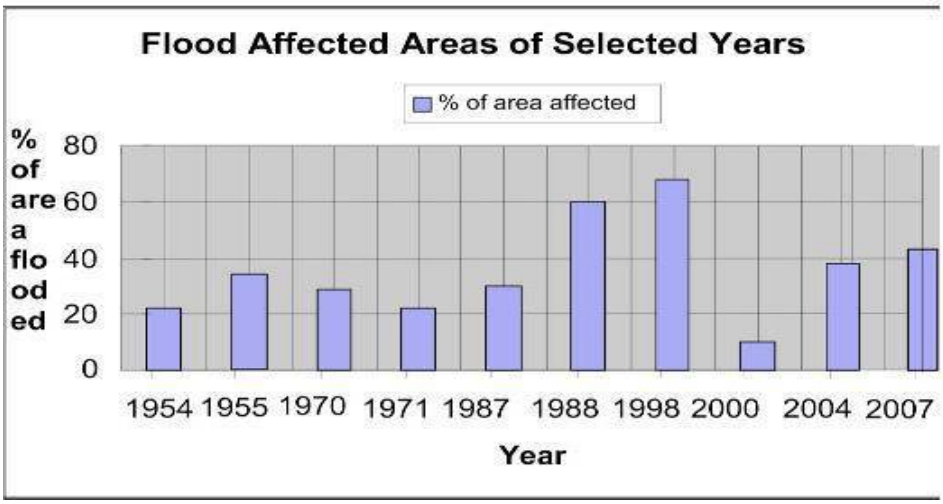

Figure 13 Year wise Flood Affected Areas in Bangladesh

Source: WAR PO, 2005

Remedial measures

To mitigate the adverse impacts of flood, the government has been developing and implementing various measures to better equip the country to deal with floods. The Ministry of Water Resources (MoWR) is leading the country on flood mitigation initiatives. Important initiatives include Flood Action Plan (FAP), Flood Hydrology Study, Flood Management Model Study, National Water Management Plan, National Water Policy, Water Act, and Flood Early Warning System Study. Besides these, following may be considered.

- Construction of submergible embankment might protect the Boro crops from pre-monsoon flood/ flash flood in the north-eastern region.
- Practice / develop short duration, cold tolerant Boro rice cultivars in the haor region area.
- Construction of new embankments and strengthening and the existing embankments, structures, and
- Excavation and re-excavation of rivers and khals might help to reduce flood, etc.

5.2 Water-Logging/ Drainage congestion of Soils

Water logged soils are not favourable for crop production. Inundation of land for long period is harmful even for wet land crops, especially if the standing water is stagnant. Water logging restricts erosion of the soil creating an oxygen free environment in the root zone. The activities of most of the microorganisms are hampered and the availability of S and Zn is reduced. Wetland rice is likely to respond to S and Zn fertilizers even in soils that are rich in these nutrients. The soil should be allowed to dry between two wetland rice crops. Water-logging enhances the formation of gases such as methane, H_2S etc. which pollute the atmosphereThe floodplains of Bangladesh are formed due to the

Ganges,, the Brahmaputra and the Meghna and their tributaries and distributaries. Flood and seasonal inundation are regular phenomena. About 2.6 million ha area is affected by water logging, of which 6.32% covers haor area. Water logging is common in the bils, Jhils, haors and baors. The Chalan bil, Gopalganj-Khulna bil, Arial bil and Bil Dakatia are severely affected. Haors occupy Surma-Kushiyara floodplain and Sylhet basin areas. It extends in AEZ -21.

Siltation in rivers and khals is the main reason of drainage congestion/ water logging situation, mainly in the south and south-western regions of the Bangladesh Delta. The lands cannot be utilized for crop production or even for settlements. The soils are strong acidic upon drying, heavy soil texture and nutrient deficient which create unfavorable environment for crop production. Water logging restricts aeration of the soil, creating oxygen-deficit environment in the root zone. Activities of aerobic organisms are ceased and the availability of N, S, and Zn are reduced considerably.

The entire river system of the southwest delta of Bangladesh is vulnerable to excessive sedimentation by incoming silts. After polderization in the early 70s, and decrease of flushing fresh water flow from upstream during last few decades, the rivers in this part started to silt up. As a result of this continuous siltation process over the years, the conveyance of the peripheral rivers of the coastal polders reduced significantly leading to large scale water logging problems inside the polders. The construction of costal polders that de-linked the floodplains from the rivers, and diminished upstream flow during the dry season deteriorated the sedimentation problem in this region.

Remedial measures

The entire river system of the south-west delta of Bangladesh is vulnerable to excessive sedimentation by the incoming silts. After polderization in the early 70's and decrease of flushing fresh water flow from upstream during last few decades , the rivers in that part started to silt up. To solve the long-standing problems, a popular concept based on the generation of indigenous water management practices, formally known as Tidal River Management (TRM) was adopted. This approach uses the energy of tidal flow for natural dredging of river bed and the sedimentation in the beels areas. TRM would allow natural movement of sediment-borne tidal water into a beel (tidal basin) and allow deposition of the sediments in the beels. Thus, land type would be improved and the tidal river will be activated.

The practices of TRM have been found very effective in the Tidal Ganges Flood plain areas. TRM would allow natural movement of sediment borne tidal water into a beel and allow deposition of sediments in the beels. Excavation / re-excavation of rivers, khals, drainage channels for movement of drained water. Thus, land type would be improved; crop production would be possible and tidal river would be activated.

5.3 River Bank Erosion

River bank erosion is common in Bangladesh. Every year, a significant area of fertile lands and settlements are being lost due to river bank erosion. The rivers of Bangladesh are morphologically highly dynamic. The main rivers are braided, and form islands or chars between the braiding channels. These chars, of which many are inhabited, "move with the flow" and are extremely sensitive to changes in the river conditions. Erosion processes are highly unpredictable, and not compensated by accretion. These processes also have dramatic consequences in the lives of people living in those areas.

A study concluded in 1991 reported that: out of the 462 administrative units in the country, 100 were subject to some form of riverbank erosion, of which 35 were serious, and affected about 1 million people on a yearly basis. Around 10,000 hectares land is eroded by river per year in Bangladesh (NWMP, 2001).

Kurigram, Gaibandha, Jamalpur, Bogra, Sirajganj, Tangail, Pabna and Manikganj districts lie in the erosion prone area along the Jamuna River. Erosion of total area and settlement is higher along the left bank than that of the right bank. Along the Padma River, there are the districts of Rajbari, Faridpur, Manikganj, Dhaka, Munshiganj, Shariatpur and Chandpur.

A recent study of CEGIS (2005) shows that bank erosion along the Padma River during 1973 – 2004, was 29,390 hectares and along Jamuna River during 1973 – 2004, it was 87,790 hectares. As relevant to this study, loss of land, settlements, roads and embankments due to erosion in 2004 in Sirajganj and Faridpur districts is shown in Table 17.

Table 17 Erosion of agricultural land, roads, embankments and settlements along the banks of the Jamuna and Padma in 2004 in Sirajganj and Faridpur districts

District	Upazila	Total Land (ha)	Eroded Infrastructures				
			Settlement (ha)	District Road (m)	Upazila Road (m)	Rural Road(m)	Embankment (m)
Sirajganj	Kazipur	177	50		176	84	1617
	Sirajganj Sadar	170	13	1		164	2107
	Belkuchi	0	0				
	Chauhali	207	45		395		
	Shahjadpur	148	31	159			
	Total	**702**	**139**	**160**	**571**	**248**	**3724**
Faridpur	Faridpur Sadar	200	57		1175	370	
	Char Bhadrasan	78	17	320			
	Sadarpur	3	1				
	Total	**281**	**75**	**320**	**1175**	**370**	

Source: CEGIS, 2005

*Remedial measure**s***

Erosion may be mitigated with minimum cost by placing geo-bags and R.C.C. blocks. The river bank protection using geo-bags have been found very effective in the Pabna Irrigation and Rural Development Project (PIRDP) in Pabna, and Meghna-Dhonaghodha Irrigation Project (MDIP), Chadpur. In these projects, river bank erosion of the mighty rivers Jamuna and Meghna were protected.

5.4 Char Lands

Char lands occur along the major river systems. It has complex topography. The main problems are instability of land, coarse soil texture, low water holding capacity and low nutrient availability, river bank erosion, and flood. About 0.72 million ha exits in Bangladesh mainly in Kurigram, Lalmonirhat, Sirajganj, Pabna, Jamalpur, Manikganj, Faridpur, Sharitpur, Madaripur, Chandpur, and Bhola. Coarse soil textures, low water holding capacity, and low fertility are responsible for poor crop yield. Burial of standing crops by fresh sediments of sandy deposits (sand carpeting) is also destroying crops.

Remedial measures

Bangladesh has experienced stabilization of newly accreted lands from tidal and storm surges through afforestation and polderization. A programme of participatory approach of mangrove plantation, involving nearby coastal communities, which has proved successful in other countries, could be a sustainable mechanism to protect mangrove forests. This mechanism is being actively considered within the Forest Department. Recently, lands reclaimed through construction of embankment at Undarchar (newly accreted land) was developed by plantation of green belt in the Patuakhali district.

Formations of new chars are not favourable for land use management. Addition of organic matter through green manuring with Dhancha/ leguminous crop might help to improve physical and chemical properties of the char lands. Rabi crops, especially groundnuts, pulses, mustard, etc may be practiced.

Big chars may be protected for development of settlements / industrial areas by taking protective measures from river bank erosion. Industrialization and urbanization threaten the land resources. These may be extended in newly accreted char lands, dredged spoils platforms area, preferably in non-agricultural fallow lands taking necessary step for the protection from river bank erosion.

5.5 Drought

Drought occurs when evaporation and transpiration exceed the amount of precipitation for a reasonable period. It is very difficult for land use management in the drought prone areas due to scarcity of availability of drinking and irrigation water. Drought causes the earth to parch and a considerable hydrologic (water) imbalance, resulting into water shortages, drying up of wells, depletion of groundwater and soil moisture, stream flow reduction, withering crops leading to crop failure, and scarcity of fodder for livestock. Drought is a major natural hazard faced by communities directly dependent on rainfall for drinking water, crop production and rearing of animals.

In Bangladesh, drought mostly affects in pre-monsoon and post-monsoon periods. The hydrological and climatic conditions of Bangladesh are characterized by too much water in the wet monsoon season and too little in the dry months. The drought environment is further aggravated by the cross boundary anthropogenic interventions. The drought prone areas of Bangladesh (Kharif-I and Rabi) are presented in Figures 14 and 15. The chronology of droughts of historical significance of Bangladesh is shown in Table 18.

Table 18 Chronology of droughts of historical significance

1951	Severe drought in northwest Bangladesh and substantially reduced rice production.
1973	One of the severest in the past century and was responsible for the 1974 famine in northern Bangladesh.
1975	This drought affected 47% of the entire country and caused sufferings to about 53% of the total population.
1978-79	Severe drought causing widespread damage to crops. Reduced rice production by about 2 million tons and directly affected about 42% of the cultivated land and 44% of the population. It was one of the severest in recent times.
1981	Severe drought adversely affected crop production.
1982	Caused a total loss of rice production amounting to about 53,000 tons. In the same year flood damaged about 36,000 tons of rice.
1989	Most of the rivers in NW Bangladesh dried up and dust syndrome occurred for a prolonged period due to drying up the topsoil.
1994-95	The drought of 1995-96, caused immense damage to crops, especially in the case of rice and jute, the main crops of NW Bangladesh. These are followed by bamboo-clumps, a major cash earning crop of many farmers in the region. In the recent times, this was most persistent drought in Bangladesh.

*Remedial measure**s***

Dry land crops such as wheat, maize, potatoes, mustard etc. may be practiced than that of wet land crops (irrigated rice) in dry season. Rain water may be harvested during rainy season in closed ditches;

Drought resistant crop cultivars (both rice and non-rice) may be practiced which may be developed by the crop scientists. Proper water management may be practiced with minimum water having maximum coverage.

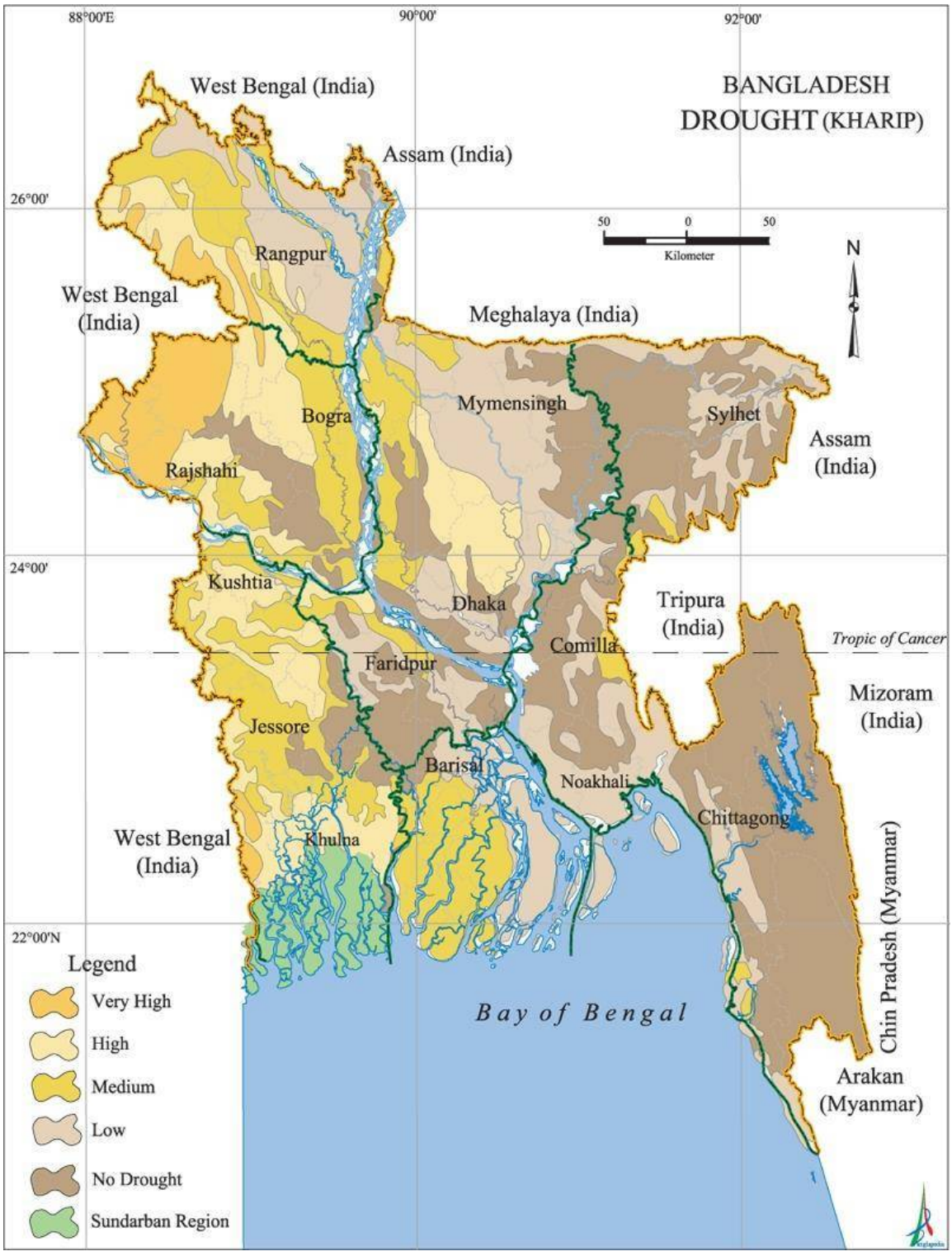

Figure 14: Drought (Kharif) in Bangladesh

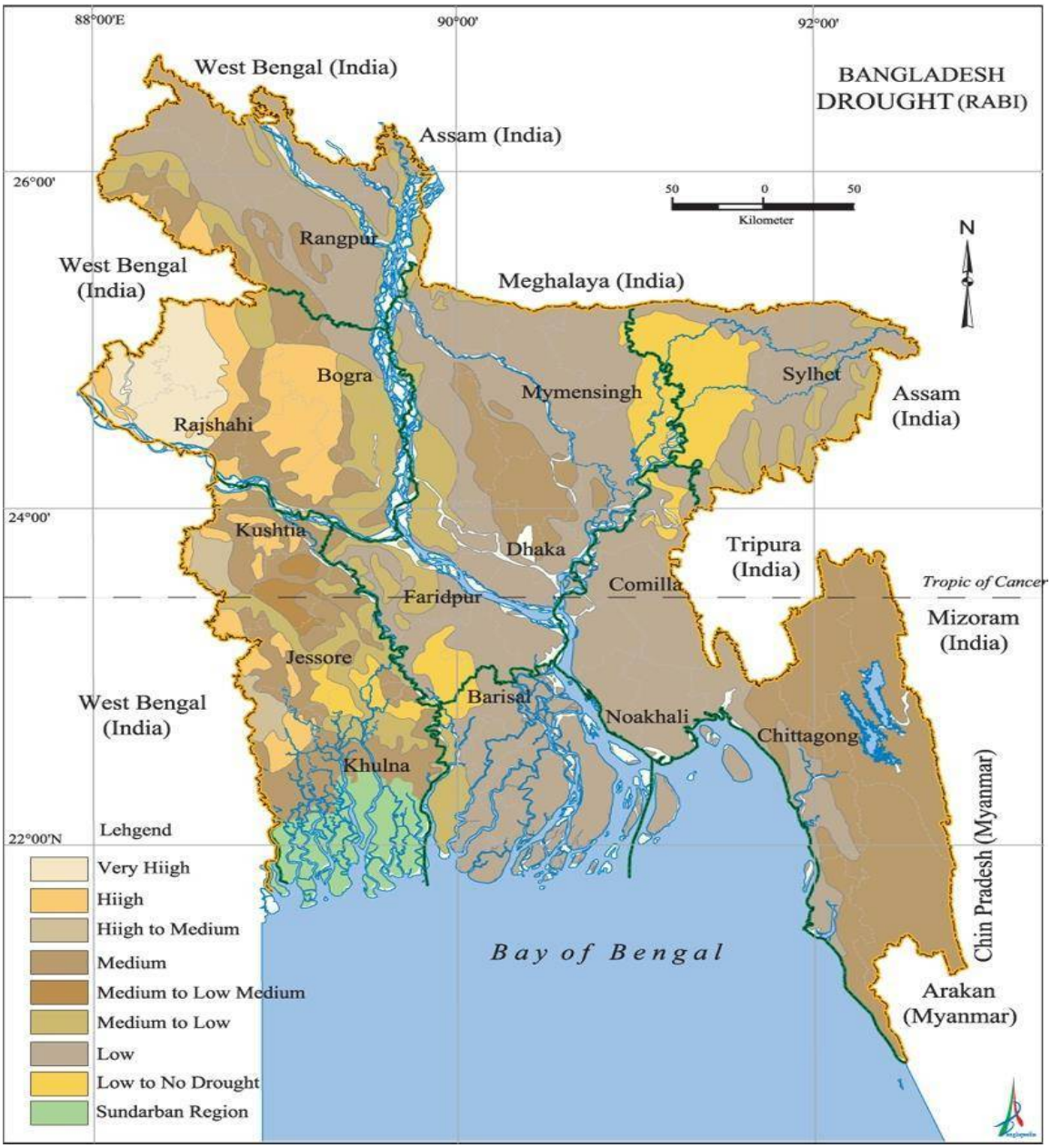

Figure 15: Drought (Rabi) in Bangladesh

5.6 Land Degradation

Land degradation processes are induced naturally or by the humans. Deforerestation, cultivation on steep slopes, shifting cultivation, over-exploitation of ground water, unbalanced use of fertilizers, improper crop rotations, are responsible for land degradation induced by humans. Lands are also degraded by soil erosion, soil erosion both in floodplains and in hilly areas, salinization, acidification, fertility depletion, water –logging/ drainage congestion, heavy metal pollution, industrial effluents etc.

5.6.1 Soil erosion

Soil erosion is the process by which soil and rock are removed from the earth's surface by natural process such as wind, or water flow, and then transported and deposited in other locations. Human activities have drastically increased the rate at which erosion is occurring, globally. Excessive erosion causes desertification, decreases in agricultural productivity due to land degradation, sedimentation of water ways, and ecological collapse due to loss of the nutrient-rich upper layers. Water and wind erosion causes 84% of land degradation. They are responsible for degraded acreage, making excessive erosion is one of the most significant global environmental problems (Blanco et al, 2010; Toy et al, 2002). The soil of sloppy lands and light textured soils are vulnerable to erosion by water and wind especially in hill areas. The heavy rainfall of rainy season and storm of summer causes compressive soil erosion in Bangladesh. The sheet erosion is dominant in country. Hilly and terraced areas are susceptible to soil erosion. Soil Resources and Development Institute (SRDI) carried out survey to find out the erosive area of the country. It is observed that about 76% area is under erosive as compared to the whole hilly area of the country. Soil erosion /wind erosion are responsible for depletion of soil fertility. So, land use management in respect of crop production is very difficult.

5.6.2 Soil erosion in hilly areas

The sloppy / hills lands are not favourable for land use management. The soil of sloppy lands and light textured soils are vulnerable to erosion by water and wind, especially in hill areas. The heavy rainfall of rainy season and storm of summer causes compressive soil erosion in Bangladesh. The sheet erosion is dominant in country. Hilly and terrace areas are susceptible to soil erosion. Wind erosion occurs in the dry months in drought prone areas like Rajshahi and Dinajpur districts, charlands and seashore sandy beaches. Land susceptible to different degrees of soil erosion in the hilly areas is presented in Table 19.

Table 19 Land susceptible to different degrees of soil erosion in the hilly areas

Hilly area	Area(Km^2)			
	Moderately susceptible	**Highly susceptible**	**Very highly susceptible**	**Total**
Chittagong Hill Tracts	350	1814	10765	12929
Chittagong & Cox's Bazar	414	949	954	2317
Greater Sylhet district	161	462	964	1587
Others (Comilla, Brahmanbaria, Netrokona, Jamalpur)	-	35	102	137
Total	925(5%)	3260(20%)	12785(75%)	16970(100%)
Source: SRDI				

Soil erosion /wind erosion are responsible for depletion of soil fertility. So, land use management, in respect of crop production, is very difficult.

*Remedial measure**s***

An integrated soil conservation and water shed management system need to be developed for the CHT to ensure a sustainable development in agriculture, forestry, horticulture, fisheries, etc. Soil conservation practices through plantation, inter-cropping, use of cover crops and use of mulches to protect the soil surface and appropriate kinds of control structures.

5.7 Soil Salinity in the Coastal Region

Saline soils have high content of soluble salts. A soil is said to be saline when the EC value of saturated extracted is >4.00 dS/m at 25^0C, ESP<15 and pH<8.5. Salinity develops in various ways: continuous accumulation of salts from tidal flooding reduced upstream flow due to human activities, cyclone and tidal surge, shrimp culture and irrigation with saline ground water, and capillary rise from ground water. The salinity content starts to increase from December and attains maximum level in the months of April and- May and then decrease due to onset of monsoon rainfall.

The crop production constraints include reduction of absorption of water and nutrients due to high osmotic pressure, poor soil structure, and shallow saline ground water; these affect plants at an early stage of their growth. Fertility status is low.

The coastal lands of the southern delta are generally low and flat and as such get frequently inundated with saline tidal waters from nearby estuaries and therefore, soil salinity is rampant. The entire area is almost traditionally mono-cropped during monsoon under rainfed condition with local rice having moderate to poor yields. The shallow underground water table contributes to soil salinity during dry season and, hence becomes ill-suited for cultivation. Besides, due to the scarcity of quality irrigation water during winter and summer the cultivation of Boro, Aus rice and wheat is not practically possible. Soil drainage is an important factor for optimal production. No feasible drainage system has yet been envisaged practically for improving these soils. All these together limit the production of crops in the southern coastal saline soil to a low level, though these soils have been reported to be potentially fertile.

The main constraints to crop production in the coastal embankment projects are:

- Although soil salinity has reduced somewhat, it is still very high.
- Crop diversification could not be achieved as degradation of soil occurred in some areas of the polders where intensive HYV rice was practiced previously. The soil of the reclaimed land is very difficult to plough as it is too loose and muddy for farmers or bullocks or power tillers to plough. On the other hand, when it dries up it becomes very hard with the surface showing cracks as deep as 30 cm. The soil below, however, remains muddy with over saturation.
- Due to the construction of embankments, the sediments are deposited outside the polders i.e in rivers, canals, khals etc. As a result, water logging/ drainage congestion occur inside the polder areas due to heavy rainfall. It has been observed that the riverbeds have become higher than the beds of agriculture land. The rate of deposition of silt increases with the decrease of upstream flow of sweet water. Presently, water logging has become severe in the southern districts especially in Satkhira, Khulna, Bagherhat, part of Jessore, Gopalganj, Narail, Barishal, and Noakhali.
- The regulators which were constructed in the embankments/ polders are not functioning well due to the deposition of silt around the structure. The situation is prone to drainage congestion and as a result, crop production is seriously restricted.
- Introduction of brackish water for shrimp cultivation has deteriorated soil quality which affects agriculture land for crop production.

In fact, the measures have not yielded the desired effects. Preventive measures to arrest land type/ soil deterioration and salinity have to be taken into consideration. The soil deterioration has to be arrested, the quality has to be improved and land reclaimed for better land use.

Photo A: View of salinity affected crop land

Vast areas of the coastal region are mono-cropped with wet season rice, and remain fallow throughout Rabi and Kharif-I seasons. These lands should be brought under cultivation by applying suitable means in order to increase crop production.

*Remedial measure**s***

The following may be considered to mitigate the adverse impact of salinity:

- Water storage through construction of Ganges barrage;
- Sustainable use of ground water through active groundwater recharge in monsoon season;
- Salt-tolerant crop cultivars need to be developed;
- Soil amendments, selection of crops, improved design of drainage both surface and sub-surface could help the potential utilization of the problem'
- Application of gypsum, lime and organic matter could possibly suppress the uptake of Na, protect the root and enhance the uptake of other macro-nutrients, plant grain and finally the yield;
- The beneficiaries need to be trained through establishment of demonstration plots about application of soil amendments in salt-affected soils for enhanced crop production; the structures need to be maintained properly for smooth functioning.

5.8 Soil Acidification

Acid soils are responsible for adverse effect on soil fertility and crop productivity. It is estimated that soils of 0.25 mha lands across the country are very strongly acidic (pH<4.5), 3.70mha lands are strongly acidic (pH4.5-5.5) and 2.74 m ha lands are slightly acidic (pH 5.6-6.5). Acid soils may constraints crop production more than 30% of lands in the country. Acid soils possess toxic concentration of Al^{+3}, Fe $+^{3}$, Mn $^{+2}$, lower concentration of P and low availability of bases which cause reduction in crop yield.

Remedial measures

Lime reduces soil acidity by reacting primarily with the reserve acidity that results from hydrogen and aluminum ions absorbed on colloidal surfaces. Calcium carbonate, when dissolved in water, forms a calcium ion and a bicarbonate ion. The Ca ion is absorbed by the soil colloid. The hydrogen ions react with hydroxyl ions from the calcium carbonate and bicarbonate, producing water plus some carbon dioxide. Subsequently, the amount of reserve acidity is reduced and the soil pH is increased. Thus, soil acidity would reduce and would be favourable for crop production.

5.9 Peat Soils

About 0.13 million ha land occupy peat soils. It mainly occurs in Gopalganj-Khulna Bils (AEZ14).The area remains wet throughout the year. It contains sufficient organic matter. The soils are deeply flooded during rainy season, strongly acidic and have low P, Zn and Cu availability. Peat soil when dries, it shrinks and cracks making the soils very hard.

5.10 Heavy Metal Contamination of Soils

Major sources of heavy metal contamination in soil are industrial effluents, fossils fuels, sewage sludge and municipal wastes. Industrial wastes and effluents are being discharged randomly on soils, into canals, rivers, along the road sides without any treatment. Lead, cadmium, arsenic, mercury, chromium and nickel are the significant contaminants. There are huge tracts of agricultural lands adjacent to the industrial areas where polluted river water is being used for irrigation purpose in rice and vegetables cultivation. High concentrations of heavy metals in water have been reported to reduce fish growth (BARC, 2012). Uptake of heavy metals by crops, may ultimately enter into the food chain and lead to long term health hazards.

Remedial measures

Industrial effluents should not be disposited into water bodies, river, and crop lands without treatments. Pollulated water should not be used in irrigation, as well as domestic and livestock rearing activities.

5.11 Soil Fertility Depletion

Soil fertility has being depleted due to intensive land use without appropriate soil management. The situation has become worsen in those areas where HYV crop cultivars are being practiced using unbalanced inorganic fertilizers having insignificant or no organic recycling. It is reported that the overall N balances of soils have been found negative depending on the nutrient management and cropping systems, P balances are near zero and K balances are highly negative (BARC, 2012). Recently, six nutrient elements (N, P, K, S, Zn and B) are commonly deficit in soils of Bangladesh. Zn deficit is common in calcareous and wetland rice soils, B deficiency has been found in Rabi crops. Mg deficiency is found in Old Himalayan Piedmont Plain and Tista flood plain soils. There is sporadic information of Cu, Mo and Mn deficiencies in crops (BARC, 2012).

Fertility constraints (very low to low) have been identified in respect of organic matter (OM), nitrogen, phosphorus, potassium, sulphur, zinc and boron based on agro-ecological – constrained area (BARC, 2012a), as described below:

- Organic matter (OM): Mainly in AEZs of Tista Meander Floodplain, Active Ganges and High Ganges River Floodplains.
- Nitrogen (N): Most of AEZs are deficit in N. N availability depends on availability of OM content in soils.
- Phosphorus (P): Mainly in AEZs of Eastern Surma-Kushiyara Floodplain, Syhlet basin, Ganges Tidal Floodplain and Northern and Eastern Hills areas.
- Potassium (K): Mainly in AEZs of Old Himalayan Piedmont Plain, Tista Meander Floodplain, Eastern Surma-Kushiyara Floodplain and Sylhet Basin areas.
- Sulphur (S): Mainly in AEZs of Northern and Eastern Hills, Old Himalayan Piedmont, Active Tista and Tista Meander Floodplain areas.
- Zinc (Zn): Mainly in AEZs of Tista Meander, Ganges Tidal Floodplains and Northern and Eastern Hills.
- Boron (B): Mainly in AEZs of Active Tista and Old Bramaputra Floodplain areas. Boron deficiency appears mainly in sandy soils, high pH and dry soils.

Remedial measures

The following measures may be considered for the prevention of soil fertility depletion:

- Fertilizer recommendation should consider short-term as well as long-term crop response to fertilizers applied;

- Changes of soil nutrients need to be evaluated for determining nutrient management strategies by estimating the system level nutrient use efficiency;
- Addition of organic matter to soil would be very effective. Fertilizer recommendation guide (BARC, 2012) may be followed to overcome the soil fertility depletion problem.
- Crop rotation with multi-crops need to be practiced.

5.12 Land Productivity

Land productivity is the condition and capacity of land, including its soil, climate, topography and biological properties, for production, conservation, and environmental management. Agriculture is one of the most important activities supporting human life. The land resources regeneration is very slow while the population growth is very fast, leading to an imbalance. Potential land use assessment is likely to be the prediction of land potential for productive land use types. This case is of high importance in guiding decisions on land uses in terms of potential and conserving natural resources for future generations.

The land productive capacity can be evaluated directly or indirectly. Direct evaluations are carried out in the field, greenhouses or laboratory by means of some experiments under given climatic and management conditions. Indirect evaluations consist basically in developing and applying models of varying complexity, thereby, attempting to estimate land productivity. Land productivity capacity or land quality is a comprehension, at the same time a precise concept in terms of agricultural activities. It is a measure of capability of land to perform specific functions. The land productivity deteriorated due to land degradation.

5.12.1 Crop Suitability

The agro-edaphic and agro-climatic data of Land Resources Information System of BARC (2012) and Hussain et. al (2012) were used for land suitability assessment in order to identify and delineate suitable area for growing particular crops. Eleven agro-edaphic factors (Soil: Soil Permeability, Effective Soil Depth, Available Soil Moisture, Nutrient Status, Soil Reaction (pH), Soil Salinity, Soil Consistency, Drainage; Inundation: Depth of inundation, Flood hazards; and Landform: Slope) were considered for land suitability analysis. And the agro-climatic factors (length of kharif growing period, pre-kharif transition period, thermal zone and extreme temperature) which influence crop growth in relation to crop phonology and photosynthesis were also considered for climatic suitability analysis of different crops. The crop suitability maps, thus, produced show the potential areas under different class which are as follows.

Very suitable: > 80 percent of maximum attainable yield (MAT); Suitable: 60-80 percent of MAT; moderately suitable: 40-60 percent of MAT; marginally suitable: 20-40 percent of MAT

Not suitable: < 20 percent of MAT. The crop suitability maps of T Aman, T Aus, Boro, Wheat and Potato are shown in the Figure 16, Figure 17, Figure 18, Figure 19, and Figure 20 respectively.

5.12.2 Crop Zoning

The crop zoning maps were produced considering the percentage of the total cultivable area of the upazila under each crop suitability classes. Criterea followed in classifying the crop zone, are described in the book "Land Suitability Assessment and Crop Zoning of Bangladesh"(BARC, 2012; Hussain et. al, 2012)). The crop zoning provides the opportunity to grow the selected crops in different zones according to suitability. The upazila wise area coverage of 17 crops under different suitability classes and zones, were generated in tabular form. They will help devising appropriate policy for implementation of crop zoning at the upazilla level.

The crop zoning provides basic information for growing potential crops and deriving maximum economic benefit. The crop zoning facilitates better utilization of land and water resources, thus, providing opportunities to harvest full potential of the crops if grown in areas specified as suitable. The maximum yield would be achievable by following the crop zoning map. It is recognized that the crop can be grown in suitable areas with lower production cost. If the same crop is grown in non suitable areas, the cost of cultivation will be higher compared to suitable areas.

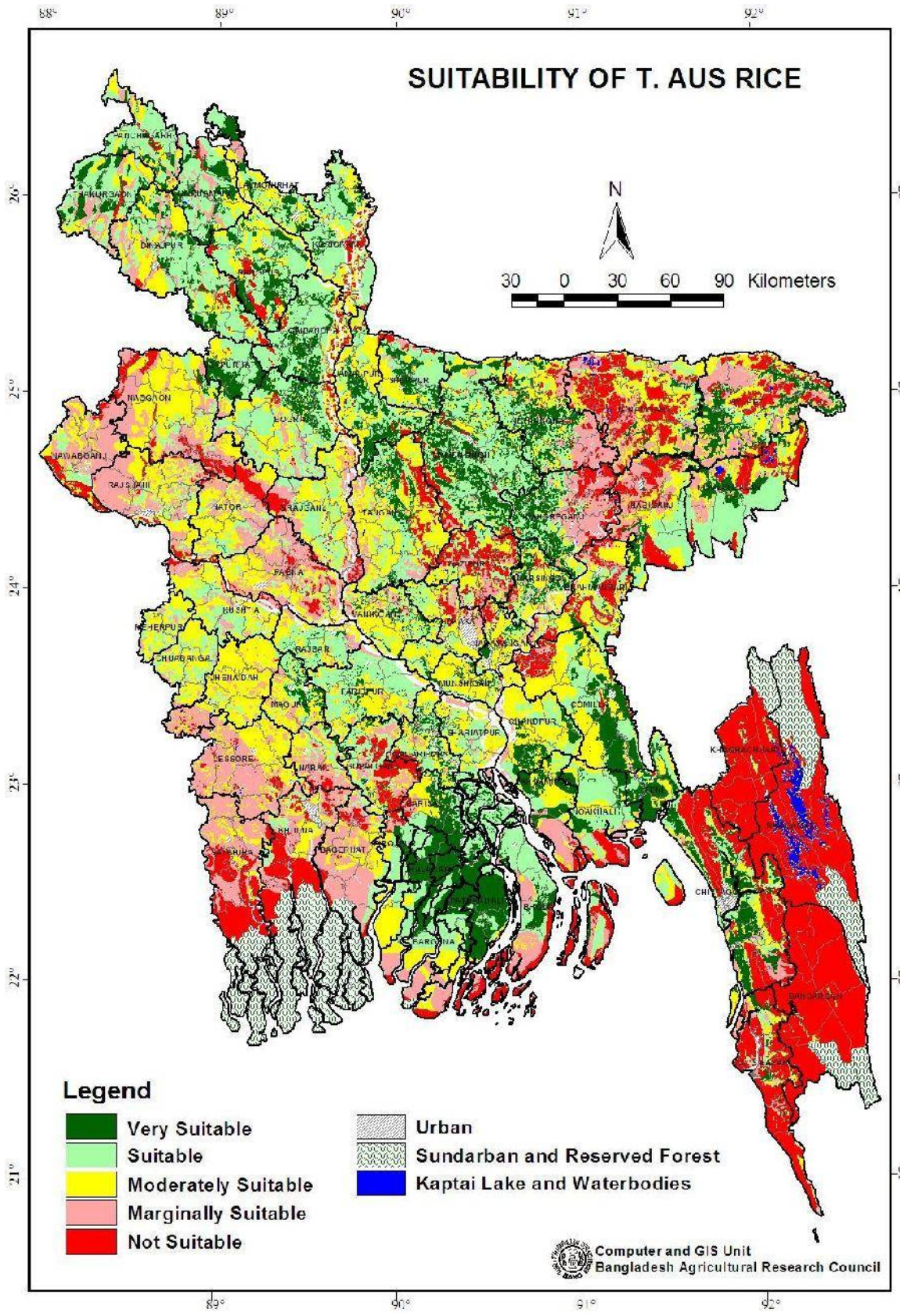

Figure 16 Distribution of Suitability of T Aus crop in Bangladesh

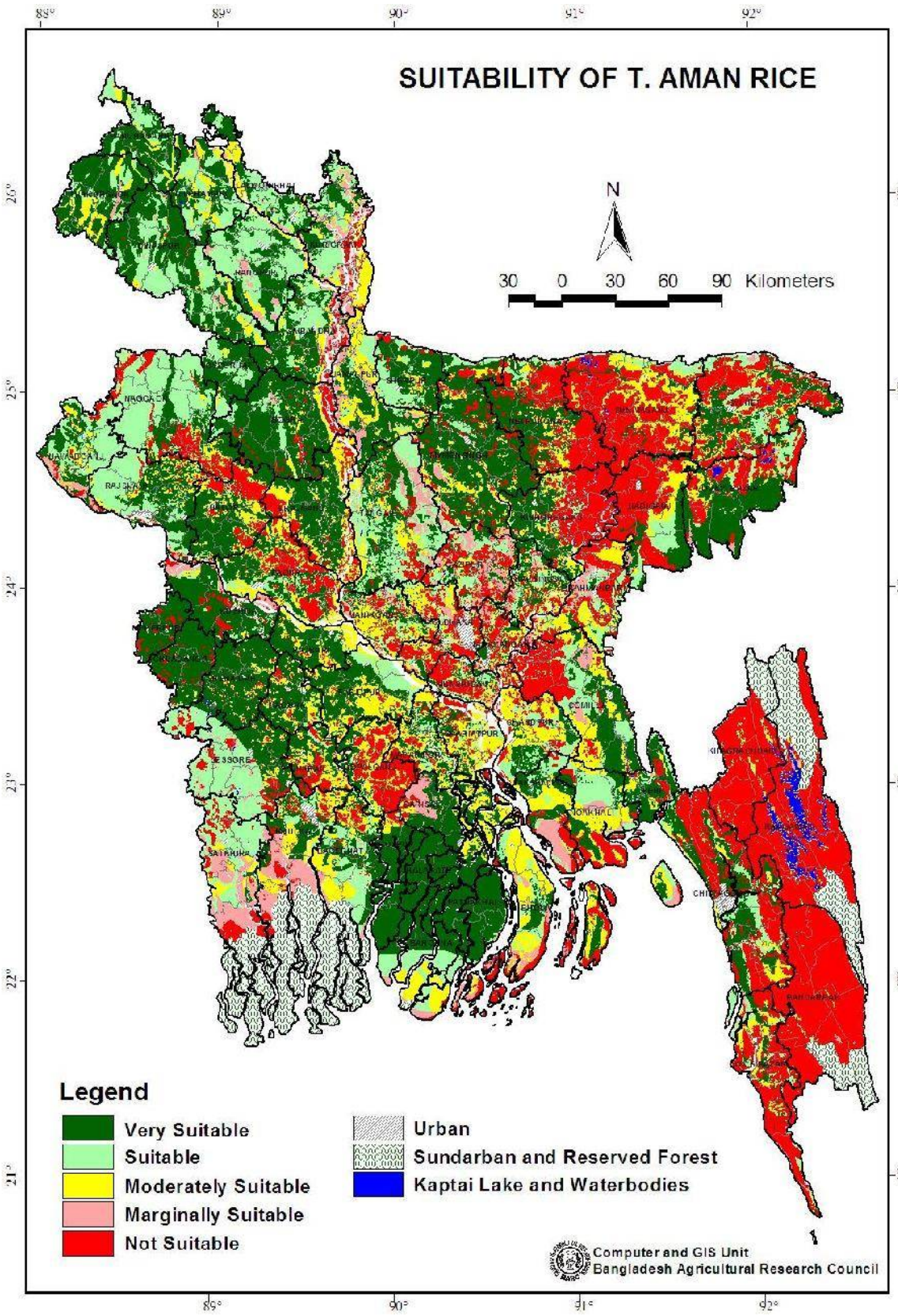

Figure 17 Distribution of Suitability of T Aman crop in Bangladesh

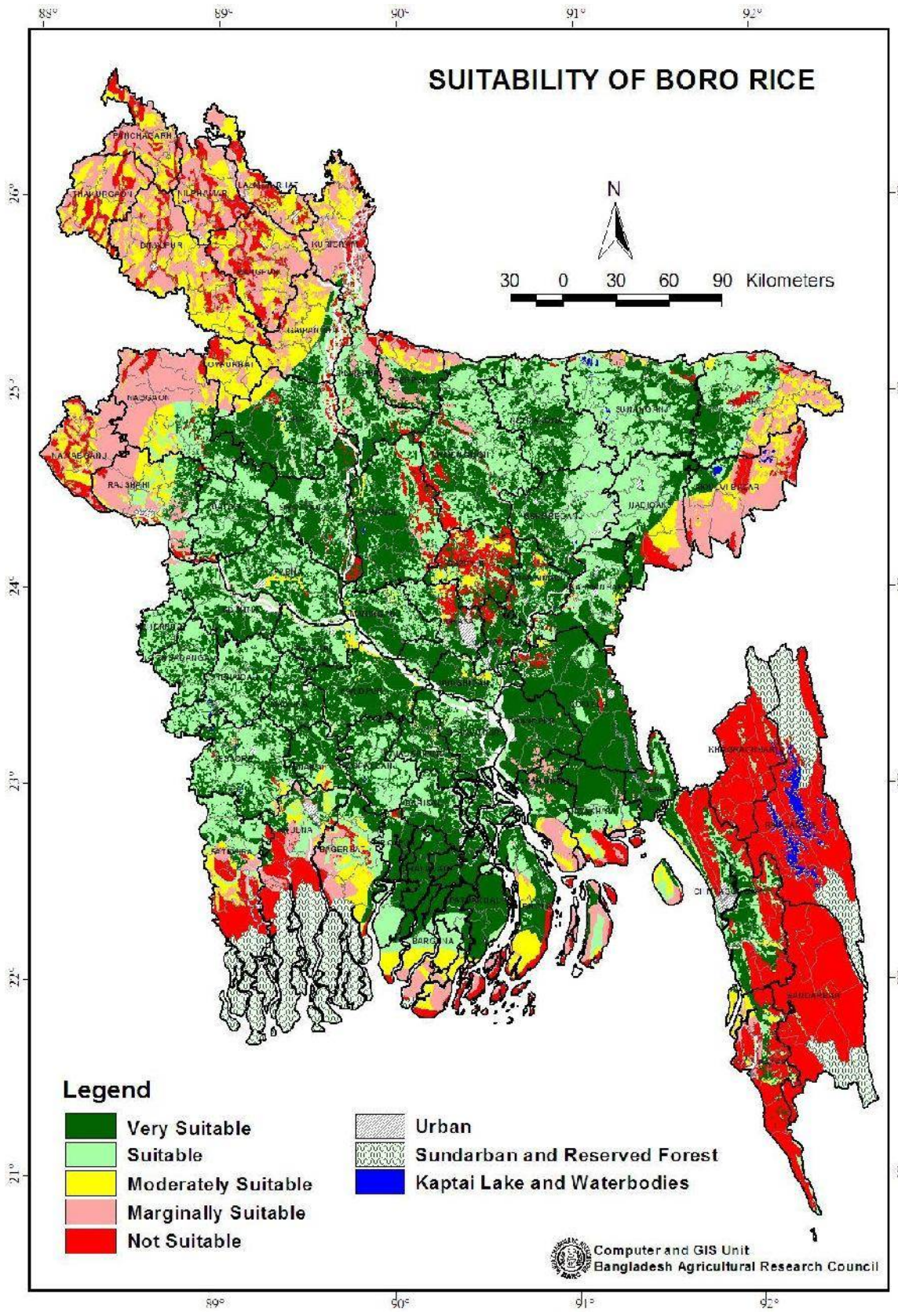

Figure 18 Distribution of Suitability of Boro crop in Bangladesh

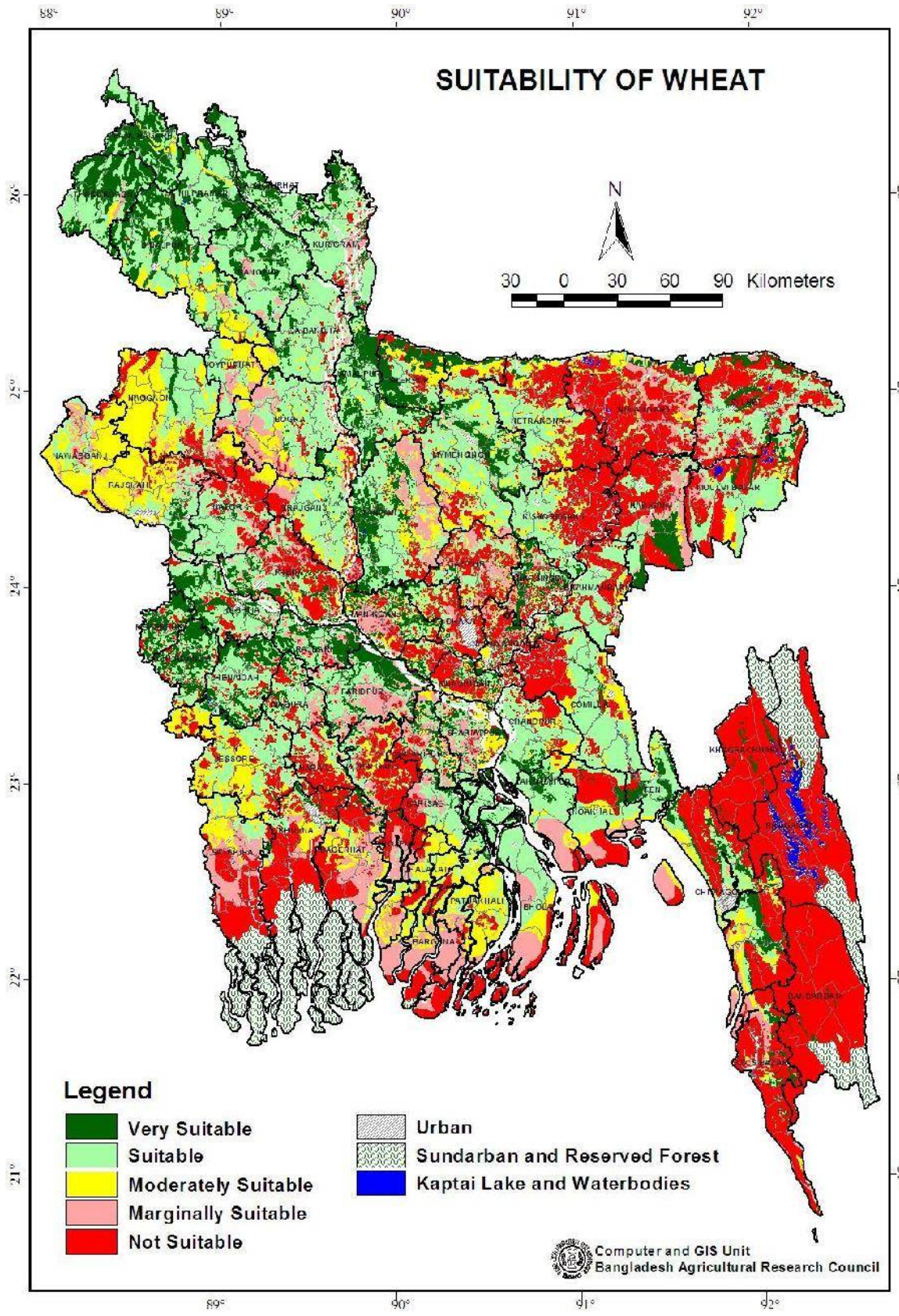

Figure 19 Distribution of Suitability of Wheat crop in Bangladesh

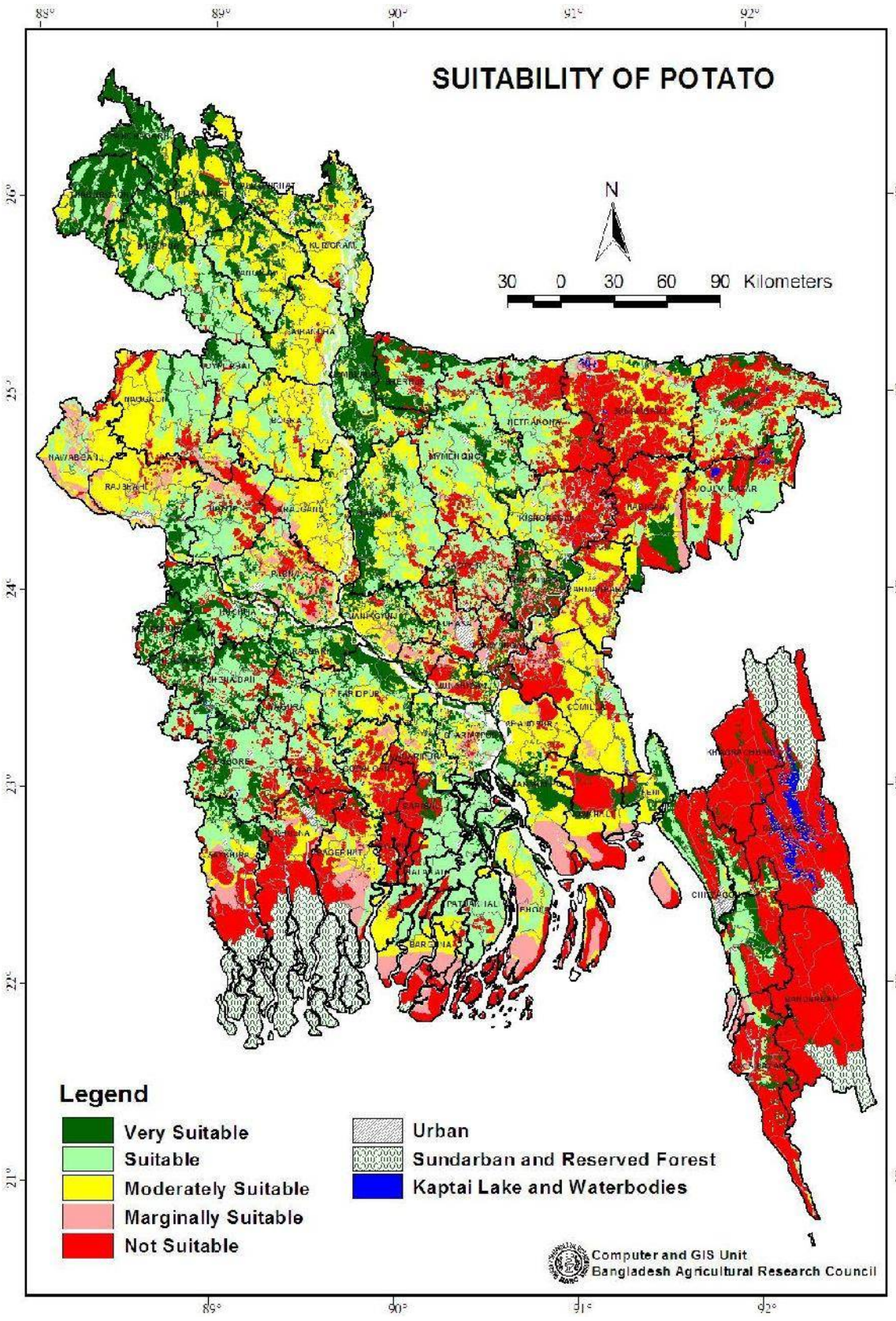

Figure 20 Distribution of Suitability of Potato crop in Bangladesh

5.13 Climate Change

Climate is simply the weather that is dominant or normal in a particular region. The term climate includes rainfall, temperature, sunshine hours, evaporation, humidity and wind patterns. Climate change has an important role on integrated agriculture (agriculture, fisheries, livestock & forestry). Extreme climatic factors increase environmental hazards like landslides, droughts and soil erosion. Heavy rainfall damages crops in the field and washes out the top soil nutrient from the barren land. The erratic behavior of rainfall distribution poses a threat for timely agricultural crop production. Droughts also hamper crop production with reduction in yield level. Its severity reduces the amount of available water for domestic and drinking purposes and places the community in a more vulnerable situation. Each of these changes is likely to seriously impact on land resources management. The higher temperature, and changing rainfalls by time and amount, rising salinity in the coastal belt, and drought are likely to change in land use management of the country. Increased river bank erosion and saline water intrusion in coastal areas are likely to displace thousands of people who might migrate to big cities or new places which would create problem in land use. If sea level rise is higher than currently expected and coastal polders are not strengthened and/or new ones are not built, six to eight million people could be displaced by 2050. They should be resettled in suitable places like new land mass. All the changes mentioned, threaten the proper management of land resources

5.14 Responses and Action to Climate Change and Adaptation in Bangladesh

5.14.1 Climate change Impact on Agriculture

The major impacts of climate change on agriculture are:

- Summers are becoming hotter (High temperature)
- Monsoon timing irregular with untimely rainfall
- Increased river flow and inundation during monsoon
- Heavy rainfall over short period causing water logging
- Increased frequency, intensity and recurrency of flood
- Crop damage due to flash flood
- Very little rainfall in dry period
- Crop failure due to drought
- Prolong cold spell
- Salinity intrusion along the coastal region
- Severe pest infestation

5.14.2 Climate change adaption on agriculture

Rice Cultivation Technology

Early harvest (short duration) rice varieties are BRRI dhan-33, BRRI dhan-39, BINA dhan-7. These varieties can be harvested in 100 days instead of 140-150 days as required for traditional varieties of paddy.

Salt tolerant rice varieties

BRRI dhan 40, BBRIdhan 41, BRRIdhan 47 have been developed. Achievable yield at farmers' fields is 4.0 –5.5 t ha-1.Salt tolerant rice varieties for Boro season (November-March) are: BRRIdhan 47 can tolerate EC 12 dS /m at seedling stage and 8 – 10 at maturity stage with 6.5 t/ha yield potentiality. BINAdhan 8 can tolerate EC 8-10dS/m at maturity stage with 6.0 t/ha yield potentiality.

Submergence tolerant rice varieties

Two flood tolerant varieties (BRRI dhan 51, BRRI dhan 52) that can sustain at least two weeks of submersed condition. These varieties can help the farmers fight the effect of climate change.

Suitable adaptation others options

- Water Saving Technologies: Alternate Wetting and Drying (AWD);
- Drought tolerant rice variety
- Drought tolerant crops (jujube, pineapple and other fruits, maize, country bean etc) innovative practices (viz. zero tillage, priming of seeds during sowing , mulching relay cropping, dry seeding, rain water harvest, short duration varieties etc);
- Mini pond for supplementary irrigation during drought spells.
- Homestead gardening.
- Rice-Fish Culture
- T. Aman, Chick pea/pulse cropping pattern
- Mung Bean cultivation for Green Manuring

Local Adaptation Practices

- Floating vegetable cultivation on water hyacinth mass
- Sarjan cultivatation
- Floating seedbeds

5.14.3 Key lessons and messages

Adaptation to climate change is a social learning process:

- Learning how to adapt (better) takes time.
- Adaptation to climate change is very location specific – not all options fit everywhere / every seasons.
- Awareness of institutions relevant to the agricultural sector is of critical importance.
- Responsibilities of concerned institutions should be clearly determined in promoting climate change adaptation
- Promoting public – private partnerships is vital for large scale promotion and adoption of technologies.
- Farmers' acceptance of the CCA options is also a function of their awareness of Climate Change Impact.
- Need more support to promote CCA Technologies

5.14.4 Effect of climate change in Sea level rise

Climate changes might create problems on land resources management in the country.

- Sea level rise leading to submergence of low lying coastal areas and saline water intrusion up in the coastal rivers and ground water aquifers, reducing freshwater availability; and drainage congestion inside the coastal polders which adversely affect on land resource management.
- Increase frequent and severe tropical cyclone leading to unfavorable situation for land resources management.
- Heavy erratic rainfall in the Ganges-Brahmaputra–Meghna system as well as low and erratic rainfall cause in increasing droughts in the north-western region of the country in the country will impact land use;
- Higher river flows causing over-topping and breaching of embankments widespread flooding in rural and urban areas are creating adverse impact on land resources;
- Increase sedimentation in river beds leading to drainage congestion and water logging which will impact on land resources management.
- River bank erosion resulting loss of settlements and fertile agricultural lands to the rivers;
- Melting of Himalayan glaciers, leading to higher river flows in the warmer months of the year followed by lower river flows and increase intrusion of saline after glaciers have disappeared.

5.14.5 Climate change Adaptation in Sea level rise

At the local level, farmers continuously adapt to climate variability. They change crops or varieties, choose different harvest and sowing dates, alter land management, and employ water efficiency techniques (FAO 2007). Long-term climate change poses a new set of challenges to farmers dependent on land resources, and so at the national and international levels, governments and development agencies play a fundamental role in building the capacity of farmers to cope with and adapt to a changing environment.

5.14.6 Climate change adaptation on gender equity

Households that are better equipped to cope with the impacts of climate change or extreme weather events can better use, manage, and conserve land resources. Efficient, cost-effective, and relevant interventions take place. Gender analysis helps clarify the specific and often different needs, vulnerabilities, and coping strategies of women and men, so that they can be more adequately addressed in response to the impacts of climate change and variability related to land resources.

Land ownership and entitlement to land signify economic as well as social identity and reflect empowerment and dignity. Control over income and assets like land, are an indicator of women and men's empowerment.

5.15 Problem of Farm Mechanization

Recently, most of the agricultural lands are tilled with power tiller. In the past, country plough, spade, etc. were used for cultural operation. In Bangladesh Delta, farmers are not equiped with modern implements for working on agricultural land. Labor scarcity is common during transplanting and harvesting time (peak period). The intensity of flash flood/flood is very high, especially in the north-eastern of the country. Farmers cannot harvest their matured paddy with very limited time. The situation is severe in Boro and Aman harvesting time. People face difficulties for harvesting crops timely. At times,, delayed harvesting of Boro and Aus cause crop damage due to shortage of labor. The intensity of rainfall also affects post harvesting activities i.e., threshing and cleaning of harvested paddy. If the land management could be done mechanically through use of combined harvester, mechanical dryer in harvesting, threshing, drying as well as cleaning, it would save labor requirement timely, post harvest loss will be minimized, quality of grain will be maintained. The cultural practices of farm mechanization will help to improve land resources management in respect of crop production.

5.15.1 Farm size pattern in Bangladesh

There are many big landowners in Bangladesh, especially in the Haor and coastal areas. The big landowners are not interested in improving farming practices because of requirement of huge investments. Most of them appoint share croppers or tenants. The tenants or share croppers are not generally solvent to meet the expenditure of labor, fertilizers, and other inputs. On the other hand, they are not interested in using new production technologies as the increased output would be shared with the land owner. This situation is not favourable for improved land use in respect of crop production.

The main challenges are:

- Large and middle-sized farmers are abandoning farming in favour of non-farm activities leaving cultivation of land to marginal land owners, bargadar (share-croppers) and agricultural labourers.
- In the absence of land reforms and due to a shortage of savings, there is very little incentive to private investment to increase productivity and production.

5.16 Socio-economic Growth and Political Development related Problems

Bangladesh suffers from endemic poverty, slow economic growth, unequal distribution of income and wealth, low levels of agricultural and industrial investment, and ineffective government services. Contribution of agriculture to the growth in gross domestic product (GDP) 'is gradually declining' and it was 18.36 percent in 2009-10 and reached 16.33 percent in 2013-14. On the other hand, industrial sector's share in the growth rose to 29.61 percent from 26.78 percent during the period. The service sector's contribution declined to 54.05 percent in 2013-14 from 54.83 percent in 2009-10. There are many causes/barriers hindering the growth and economic development of Bangladesh. Major factors/ barriers affecting socio-economic growth of Bangladesh are population, natural calamities and environmental problems, political instability, inequality, and corruption which are described briefly as follows:

5.16.1 Population

Population of Bangladesh is one of the major problems to economic growth despite policies and programmes by GOB, and NGOs constantly trying to reduce the birth and growth rate. Detailed population is described in section 6.3.4. The country is over populated and thus, heavily strains the national economy. If the population growth rate is not lowered, according to the steady growth calculation, the population is expected to be more than 300 million people by 2050. Maximum national budget is spent in education and health sectors. It is lack of land for cultivation and search for better opportunities to live a better life, part of the rural areas is migrating to the urban areas and creating a strain on the cities. Increase in population has contributed to the deficit of the national budget and social unrest. The unemployed population are restoring to different types of anti-social activities which are threat to social and domestic security. The oversized population creates challenges for the future development of the country's economy exerting huge pressures on environment and available resources, limiting agricultural growth found grain production through reduction of arable land for housing and non-agricultural purposes, thus slowing down the rate of poverty reduction (BJS, 2011).

5.16.2 Natural calamities and environment problem

Natural calamities and environment problem play a vital role against the economic and infrastructure development of Bangladesh. The disastrous effect of cyclone and tidal surge are imparting pressure on the national economy. Bangladesh is a land of different natural calamities such as floods, storms, droughts, erosion etc. In 1998, flood had devastation effect on the economy and the agriculture of Bangladesh, where 75% of the land was submerged, loss of crops in 700,000 hectares cultivated land and infrastructure damages were experienced (BBC, 1998). The loss of navigability of rivers and sudden flow of water from upstream are main reasons for erosion. Development of salt and submergence tolerant rice cultivars would be useful. Bangladesh has fallen into risk zone of earthquake, arsenic poisoning in the northern part of Bangladesh , deteriorating level of ground water and arsenic rich materials in the region's river system has caused a being alarm to the world community.

To combat and minimize the effect of national calamities

The geographical location of Bangladesh is the major reason for its proneness to natural hazards that turn into disasters due to its huge population. Three major systems- the Ganges, the Brahmaputra and the Meghna -flood, cyclones and tornadoes occur every year, damaging lives and properties causing deterioration of the economic growth.

Global warming is one of the reasons for continuous occurrence of natural disasters in Bangladesh. Industrialists and financial institutional while financing any projects, must agree jointly to prevent the effect of carbon emission and other industrials hazards to environment. Bangladesh is an agriculture based economy; the share of agriculture in output is heavily related to any national economic growth.

Rice research scientists have been trying to develop a unique variety of rice which can stand the flood and saline water. These findings would help to save tons of loss of crops washed away by flood water every year.

Proper dredging and construction of embankment might reduce river erosion. Construction of cyclone and flood shelter could minimize the effect of loss which can to shelter people and their livestock.

According to Seismologists, one earthquake with a magnitude of 7.5(on Richter Scale) could devastate the capital city of Dhaka. Precautions are being taken through cautioning the builders against violating building code which includes making the structures earthquake proof, and through creating awareness among people about surviving an earthquake.

5.16.3 Political Instability

The instability of politics of Bangladesh impacted severe problems especially in education, economy and poverty reduction. Looking back into the history of Bangladesh, one could find it as a legacy of blood. After the independence of Bangladesh in 1971, Bangladesh Awami League (AL) first formed government. After the assassination of the Father of the Nation, in 1975, Ziaur Rahman, founder of BNP and then Army Chief, instituted state of emergency under martial law and became the president in Bangladesh. In 1981, Ziaur Rahman was assassinated and H.M.Ershad, Army Chief during President Ziaur Rahman became the president of the nation in 1982. Since the formation of the nation's first government, till bringing down of H.M.Ershad's military era, through revolution in 1990, the country had to go over several coups and counter-coups, resulting into 19 years of social, political and economical unrest. In 1991, the first democratic government was formed by BNP.

Political instability has cost Bangladesh a lot. The statistics shows Bangladesh as political instable nation. Two economic costs are involved with political instability, one direct cost and an indirect cost. The direct cost includes strike or hartal. Hartal brings violence, destruction of properties, and loss of production as well of working hours. Indirect cost includes the loss of confidence in foreign and local investors. Political instability has created negative impression in the minds of foreign investors about Bangladesh and local investors are uncertain about the future of their investment.

Political instability is the greatest threat to the economy of Bangladesh. The prime minister of Bangladesh enjoys absolute power which is guarded by the constitution. Reducing of prime minister's power and diversifying few to the opposition could reduce political tensions. Political parties never initiated any steps soothe the political tensions. National Parliaments has to have certain power to control the political dispute, although the Parliament is dominated by government where oppositions are marginalized as a result they prefer streets rather than parliament to press its demand. The dynastic politics needs to an end.

Political parties are heavily influenced by foreign elements. The foreign elements can come forward and play a vital role in reducing the rate of political instability through increasing the social interaction between leaders of different political parties. Government should take opposition into confidence and pursue for solving disputes through discussion and dialogues instead of showing heavy handed attitude. Thus, it may help in economic development in the country.

5.16.4 Inequality

Growth and inequality are important factors for economic growth. There is relationship among growth, income distribution and poverty. The rate of poverty reduction is positively related to the rate of growth. Sometimes slow growth is accompanied by relatively higher reduction in poverty or fast growth, going hand –in-hand with slower reduction in poverty. It is well-known that broad-based growth and low initial equality are the two factors which are quite critical to accelerating progress towards the poverty goal. Several under developed nations successfully managed to reduce poverty, but progress of Bangladesh in poverty reduction is quite moderate (Ahmed, 2011). The growing gap between the rich and the poor has created vulnerability in the country. Rich are getting richer and the

poor are getting poorer, and thus, have put the middle class, virtually non-existent. Thus, it created social unrest. Poverty has forced most poor people to take up work and as a result, education, health etc have been put into the backseat. Huge number of population mostly children and women are being exploited in all the fronts such as in workplace, home etc. In Bangladesh, less than 2% population pays tax which because limited internal resources. The growing tendency of tax evasion resulted into rampant roll of black money in the economy. The growing black money economy has made a lot of people ultra rich.

Inequality solution in the country could be very complex and unwelcoming since GOB has to take tough and unpopular decisions this regard. Proper formulation and implementation of Monetary and Fiscal Policy is very crucial to narrow the gap between rich and poor. Government has to be very careful regarding controlling the money supply in the economy. Fiscal policy can be explained as policies of Government towards taxation, expenditure and public sector borrowing. It is an important tool to affect the loan of demand which in turn affect the level of employment (Ahmed, K. S (2011).

5.16.5 Corruption

Corruption is one of the major barriers to economic development of a nation. It is a global problem but in under developed and developing nations, it is everywhere. Corruption is the result of weak state management and it exists where individual or organizations have monopoly power over a job or service , discretion over making decisions, limited or no accountability and low-level of income. Corruption is one of the greatest obstacles to development. It hinders allocation of resources as well as performance of government.

The anti-corruption strategy advocated on four pillars, are (a) economic development, (b) democratic reform,(c) a strong civil society with access to information and mandate to oversee the state , and (d) presence of rule .

Four basic arenas can take part against corruption in the country (Ahmed, 2011).

(i) Institution of good governance needs to be strengthened. Judiciary is the Guardian of Law and integrity. But, if the Judiciary is itself corrupt, the problem is commended and public at large might suffer without rule and law.
(ii) The capacity and integrity of enforcement need to be enhanced. The best law is valueless, if it is not enforced.
(iii) A government needs to put in place solid set of preventive tools. Political leaders in all branches of government, legislative and judiciary can be required to have transparency in their own financial dealings through asset disclosure for themselves and their family members.
(iv) The public need to be educated on the advantages of good governance and participate in promoting it. The public itself became a large share of responsibility for insisting on honesty and integrity in general and business. The public needs to learn:

    (a) Not to let anybody their role
    (b) Not to pay bribes themselves,
    (c) To report incidences of complain to the authorities, and.
    (d) To teach their children the right value, e. g., integrity is good and corruption is bad.

5.16.6 Tools for reduction of corruption in Bangladesh

i. Education : If the people are educated, they would be able to know their rights and relevant laws
ii. Reforms: Bringing reforms in the electoral process shall result in bringing down corruption.
iii. Access to information and civil –society can bridge the gap between the government and the public.
iv. Punishment: Government should make anti-corruption cell-stronger and appoint impartial administrator to investigate corruption committed by any politicians and officials, finding such people guilty shall result sprightly into imprisonment, wealth and properties seizure.
v. Formation of special team representing the foreign donors to observe the movement of the donated funds for the development of the nation must be acquired to ensure its proper utilization for which it has been intended (Ahmed, 2011).

5.17 Stakeholders in land market

To sustain an urban population, the increased high rates of urbanization have created pressure on land use for housing developments and all other related services. These situations are exerted a tremendous pressure for the use of non-agricultural activities including housing, industries and business on agricultural land. The area of non-agricultural land was 1.18 million *ha* in 1976, it has been reached to 2.4 million ha in 2010. This trend is linked to the diversification of the economy and the consequent effect is the astronomical increase in land prices with the connected speculator practices that normally accompany high growth periods in land markets. The cost of operating a business in Dhaka and other urban areas goes beyond affordability of private entrepreneurs. This situation affects the possibility of the Government to acquire lands for development projects.

5.18 Major Hotspots in different regions of Bangladesh

On the basis of geographic situations, main six main Hotspot areas where similar characteristics and problems converge (such as flood vulnerabilities, water shortages, drought, siltation constraints, etc.) have been identified. The Hotspots are:

i. Coastal region
ii. Haor and Wetlands
iii. Drought Prone Areas (Barind Tract)
iv. Mighty rivers and Adjoining Areas
v. Urban areas
vi. Chittagong Hill Tracts(CHT)

The geographic extents and generic concerns within each hotspot have been discussed briefly below and presented in Figure 21.

5.18.1 Hotspot 1: Coastal zone

The Coastal Zone covers the south-west, south-central and south-east regions of Bangladesh, which in its natural state, is often subjected to inundation by high tides, salinity intrusion, cyclonic storms associated tidal surges. The coastal region is vulnerable to hazards such as flood, riverbank erosion, salinity intrusion, drought, cyclones and storm surge.

Inundation due to flooding and storm surge differs based on the land elevation and surface form. Coastal zone refers to the area where the land and sea meets. Bangladesh has a 710 km long coastline. Delineation of the coastal zone was done based on three distinctive features which are: tidal fluctuations; salinity condition in both surface and ground water; and risks of cyclone and storm surge. Under the Integrated Coastal Zone Management Project (ICZMP), 19 districts have been identified as the coastal districts where crop production is severely hampered due to salinity and lack of quality irrigation water.

Figure 21 Identified hotspots under Bangladesh Delta Plan 2100

5.18.2 Hotspot 2: Haor and Wetlands

The haor and wetlands are mostly located in the north-eastern region of Bangladesh, covering the districts of Sunamganj, Habiganj, Netrakona, Kishoreganj, Sylhet, Maulvibazaar and Brahmanbaria having about 8590 sq km of area and accommodating about 19.37 million people. Characterized by unique physical and hydrological settings, Haor region is one of the main economic zones of the country. The haors are large bowl-shaped floodplain depressions. This region dries up in dry season except some beels and low lyingpockets, and remains completely inundated during the monsoon. This haor region experiences flash floods and shortage of water during the pre-monsoon, floods during the monsoon and drainage congestion during pre- and post-monsoon. Agriculture and fisheries, key source of economic development of haor region is lagging behind due to constraints such as scarcity of land, lack of marketing facilities, inadequate purchasing power, unsteady maintenance of food stock etc. The cropping intensity is far less in this region due to mostly mono-cropped with rice in dry season. The people living in the haor and adjoining haor areas are mostly affected population due to flash flood and most of them live below poverty level. The average rainfall annually ranges from 2200 mm along the western boundary to 5800 mm in its north east corner. Key constraints (Technological gap) on the basis of AEZ are:

- Early flash flood destroys maturing Boro, young Aus & deepwater B. Aman.
- Heavy rainfall hamper harvesting, drying and storage of crops.
- Slow drainage of basin centres.
- Much large (& often absentee) land ownership.
- Conflict between fishing & agricultural interests for use the water remaining in haors after rainy season.

5.18.3 Hotspot 3: Barind Tract

Barind Tract is located in the centre and western part of Rajshahi division and the north-west region of Bangladesh, including the districts of Natore, Sirajganj, Naogaon, Nawabganj, Rajshahi, Gaibandha, Jaipurhat, Dinajpur, Rangpur and Bogra. The area experiences frequent droughts and water scarcity, which immensely hamper dry season irrigation initiatives. The area is covering a total area of approximately 7,770 km^2 .The greater part of the tract is almost plain

and is crisscrossed by only a few minor rivers. This tract is considered an ecologically fragile ecosystem with extremely low vegetation cover. Key constraints (Technological gap) on the basis of AEZ are:

- Soils which are flooded in the rainy season become very dry in the dry season.
- Low organic matter content and low soil fertility.
- Uncertain groundwater supplies in some areas.
- Poor rural road communication, especially in the rainy season.
- Unreliable pre-monsoon and post-monsoon rainfall, occasionally dry breaks within the rainy season.
- Soils poorly drained in rainy season, but very dry in dry season. Inadequate surface and ground water which limits irrigation,
- Big land ownership (generally absentee) which makes difficult to organize activities e.g., maintenance of irrigation/drainage channels, IPM etc.
- Generally inadequate surface water.
- Large –scale irrigation would be difficult to provide as the high lift from the adjoining perennial rivers (Ganges, Mahananda) due to undulated topography.

5.18.4 Hotspot 4: Major Rivers and Adjoining Areas

The hotspots in the rivers and their adjoining areas may be termed as one of the most principal hotspots of Bangladesh Delta. Bangladesh's extensive network of rivers, around 405 rivers and their tributaries, act as a major domain to shape up the country's abundant natural resources. The hydrological characteristics of the Ganges-Brahmaputra-Meghna basin is influenced by the climate changed induced situations like temperature rise which affect the timing and snow melting in upper Himalayan ridges. This change tends to raise the average water level of lower riparian rivers and causes serious flooding. Every year these rivers system are carrying one trillion cubic meter of water with more than one billion ton of sediments from ninety-two percent catchment area beyond the Bangladesh border to the Bay of Bengal. The major rivers of Bangladesh are morphologically very active and thus influence the hydrological and morphological characteristics of other rivers significantly. Bangladesh Delta discharges about 90% of the water from GBM river system through with its only 7% area of total GBM catchment. Eventually, problems concerning drainage congestion are exacerbated due to increased volumes of water coming through cross boundary river system. River bank erosion causes several settlements, fertile lands every year.

5.18.5 Hotspot 5: Urban Areas

The hotspot of urban centres comprises the divisional head-quarters of the country i.e. Dhaka, Chittagong, Khulna, Rajshahi, Sylhet, and Barisal, with emphasis on city corporation areas, and their influence zones. These urban areas frequently experience floods, drainage congestion, water logging, water shortage, environmental degradation as well as high incidences of water, air, soil, noise and thermal pollution.

5.18.6 Hotspot 6: Chittagong Hill Tracts

The hotspot of Chittagong hill tracts is confined within the districts of Khagrachari, Rangamati and Bandarban. The region experiences cyclonic rainfall, flash flood and landslides during the monsoon and water shortage during the dry season both for domestic and agriculture purposes. The region has the potential for development of mini-hydropower. Key constraints (Technological gap) on the basis of AEZ are:

- Steep sloppy land.
- Roads are expensive to build because of long, linear, hill ranges with steep slopes.
- Verystrongly acidic soils.
- Fertilizer nitrogen is rapidly leached during heavy monsoon rainfall.
- Area exposed to cyclones.
- Flash floods are prominent.
- Risk of landslip erosion.
- Remoteness of areas.
- Tribal land ownership or illegal land ownership by plains people.

6 Challenges and Land Use Trends

Land scarcity and ensuring wise use of land is the major challenge for Bangladesh. Soil degradation due to over-exploitation is another major challenge to sustainable agriculture. The current population dynamics are affecting human development particularly in the light of the post Millennium Development Goals (MDGs) and the Government of Bangladesh's Sixth Five Year Plan. It is expected to enable the participants to see the current situation critically, identify the gaps in the existing policies and the problems in the implementation of the program. The key challenges are:

- Food security and shelters;
- Optimization of land use;
- Restoration of soil health;
- Increasing land area of the country along the rivers and coast;
- Meeting increase in demand of food for increasing population,
- Intensive cultivation would be required to meet the additional food requirement, which would deplete nutrient status of soil.
- Reducing conflicts in coastal land use;
- Integrated management of coastal and hilly land resources.
- Conversion of potential agricultural land to brackish water shrimp culture;
- Recovering organic matter content in agricultural land which is declining;
- Climate change would affect on land degradation and sea level rise which would enhance land loss, salinity intrusion and migration/adaption of settlements, etc. Climate induced changes aggravating drought and desertification to the detriment of proper land use for crop production.

6.1 Analysis of land use patterns (trends), secnarios with drivers of changes

As the population increases in the country, the food supply-demand balance may become less stable. So, food production systems are now an important policy issue. It is not assured that Bangladesh can keep an adequate and continuous supply of food at an affordable price under the influence of climate change situation in future, local food production situation, and changing of food supply-demand balance. Careful analyses of the changing of land use pattern and environment is an essential first step towards understanding current and future long term food security issues of Bangladesh. The Delta of Bangladesh requires collecting agricultural systems to develop a comprehensive strategy in order to ensure secured food supplies, settlements and maintain peace and stability by 2100. Therefore, it is necessary to find out the trend/pattern of land use areas in different aspects (agricultural, forest, mangrove, river, lake, beel/haor, aquaculture, tea estate, saltpan, rural settlement, urban and industry etc.) for the preparation of development plans (short, mid and long term) aiming to mitigate the adverse impact of challenges. The findings of trend analyses (Hasan. *et. al*., 2013) are as follows:

6.1.1 Agricultural land use

Agricultural land includes cropland, forest, mangrove forest, river, lake (Kaptai), beel and haor, tea estate and salt pan. The trends of land use related to agriculture are discussed as per Hasan et.al. (2013) below:

Agricultural land

The area under agricultural land was 133, 03,654 ha which was about 91.83% of the country in 1976. This agricultural land has decreased to 127, 42,274 ha with the annual loss of 23,391 ha in 2000. It reached to 121, 76,904 ha in 2010 with annual loss of 56,537 ha. The annual loss of agricultural land during the study period (1976-2010) was 33,140 ha. This indicates that the availability of agricultural land was in decreasing trend with much faster during the period from 2000 to 2010. However, the percentages of the total land mass area lost annually from agricultural land are 0.172, 0.244 and 0.416 during 1976-2000, 1976-2010 and 2000-2010 respectively. Again, considering acreage of agricultural land in 1976 as the base, then annual land lost from agriculture is 0.176, 0.249 and 0.444 % during 1976- 2000, 1976-2010 and 2000-2010 respectively(Table 21 & 22 & Figure 22 & 31).

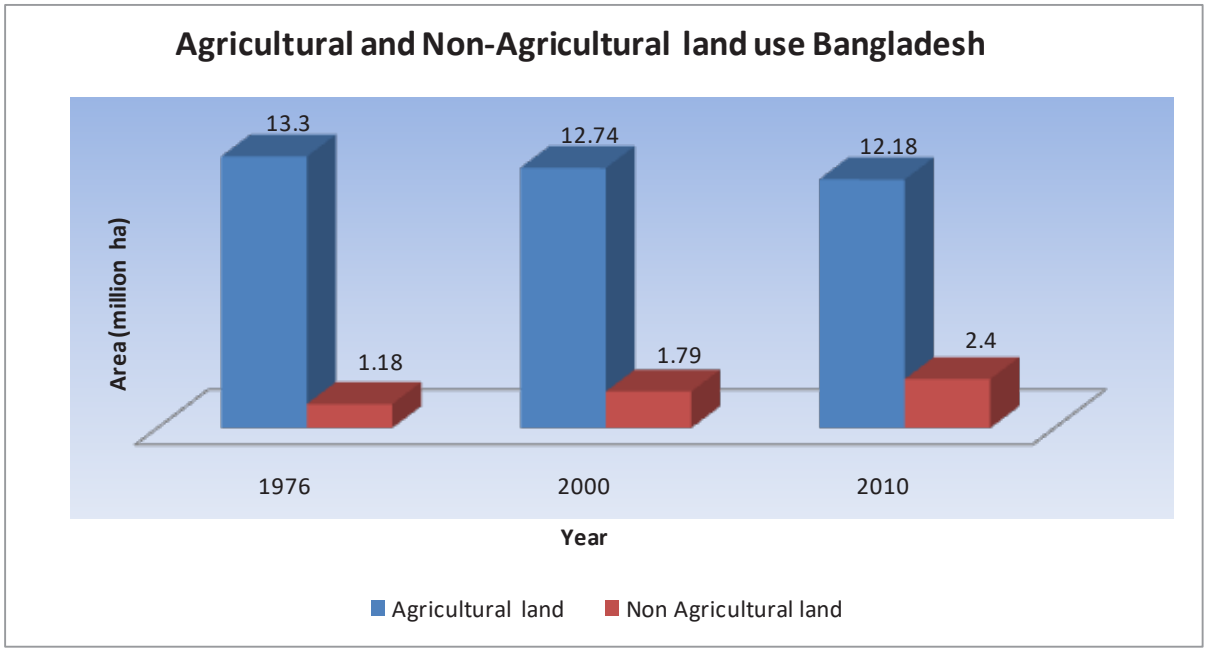

Figure 22 Trends of Agricultural and Non-agricultural Land Cover during 1976 -2010.

Source Hasan .et. al (2013)

6.1.2 Crop land

Crop land includes land that are cultivated, cultivable waste and current fallow. Crop land covering maps of Bangladesh produced by using Landsat MSS 1976 and Landsat TM 2000 and Landsat TM 2010 showed that the total area under crop land was estimated at 9,761,450 ha in 1976, in 2000 it was 9,439,541 ha and 8,751,937 ha in 2010 corresponding to 67.4%, 64.9% and 60.0% of the total land area in Bangladesh (Table 22). This indicates that crop land decreased over time. The annual land loss from crop land was estimated at 0.137% during 1976-2000 and 0.728% during 2000-2010, considering the area (ha) under crop land in 1976 and 2000 as the base. The overall rate of decrease in crop land was 0.304% during 1976-2010 (Table 23). The shifting rate is far below the estimation done by Planning Commission (2009), i.e., 82,000 hectare/year, still it is very alarming, as because food security is the main economic and political concern of Bangladesh.

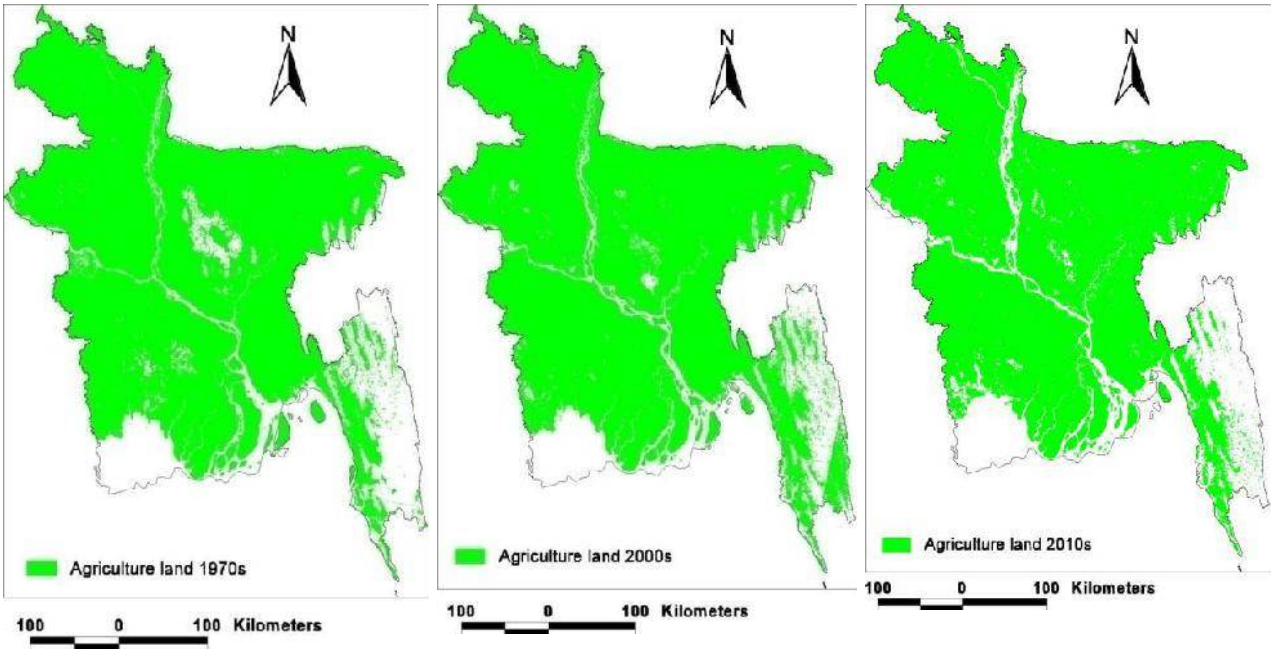

Figure 23 Crop land cover maps of Bangladesh

Source: Hasan .et. al (2013)

6.1.3 Forest

The area occupied by forest was 17, 54,917 ha in 1976 which was 12.11% of the total land mass of the country. In 2000, the forest area decreased to 9.02% and then increased to 9.84% of Bangladesh in 2010. The annual trend of decreasing forest area was 1.054% from 1976 to 2000 and that of increasing trend was 0.0938% from 2000 to 2010(Table 21 & 22 Figure 23 & 31).

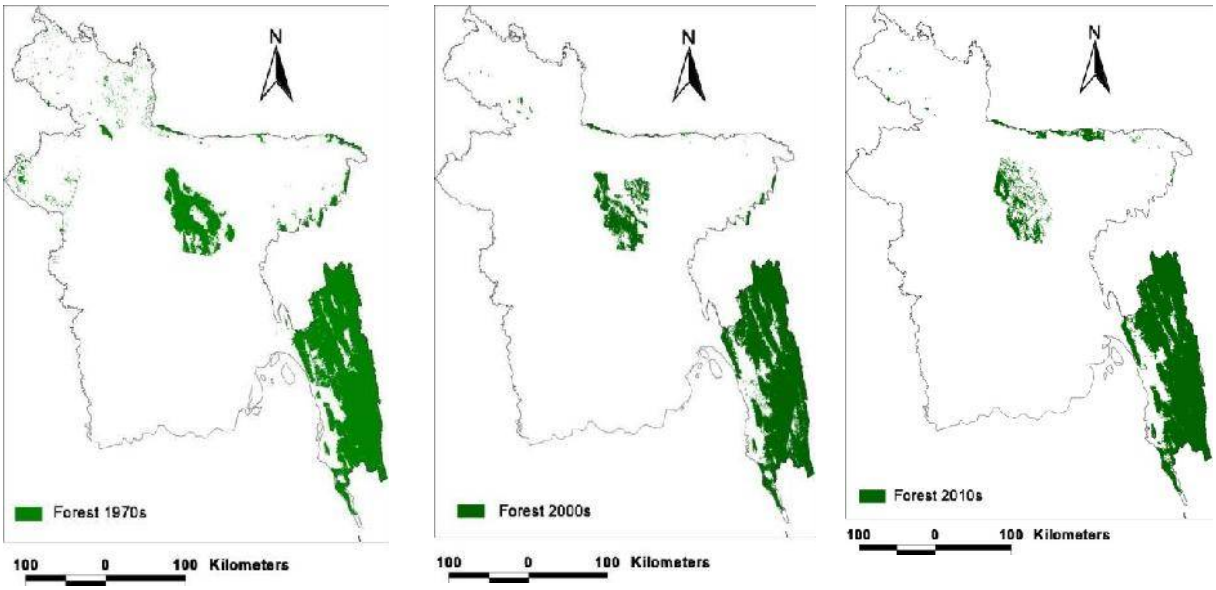

Figure 24 Forest land cover maps of Bangladesh

Source: Hasan .et. al (2013)

6.1.4 Mangrove

The area under mangrove was 452,444 ha i.e. 3.12% of the total area of Bangladesh in 1976. This study revealed that the area slightly increased (1431 ha annually) and become 3.35% in 2000, and thereafter, decreased significantly to 3.03% in 2010. Annual decrease rate is 4,534 ha. It was estimated that the annual rate of increase in mangrove area was 0.01% during the period 1976 to 2000. This increase of mangrove forest may be due to mangrove plantation of 1, 32,000 ha of land along the shore land of coastal districts up to 2000 as reported by BFD (2011). During 2000-2010, mangrove area decreased at the rate of 0.032%, although the overall rate of such decrease was 0.003% from 1976 to 2010 (Table 21 & 22).

6.1.5 Lake

Area under lake was estimated 50,829 ha (0.35 % of the total area) in 1976 and remained almost same area having 51,739 ha in 2010 and estimated about 0.35% of the total area of the country. However, lake area had been somewhat over estimated i.e. 58,261 ha (0.40%) in 2000 probably due to higher seasonal flooding (Table 21& 22).

6.1.6 River

The area under river remained almost static during the period from 1976 to 2010 with very slight decrease from 1976 to 2000 and slight increase from 2000 to 2010. The total river area was 911,819 ha in 1976 that very slightly decreased to 8, 88,441 ha in 2000, and then slightly increased to 9, 39,073 ha in 2010 indicating 6.29 percent, 6.11percent and 6.44 percent of the total area of Bangladesh in the year 1976, 2000 and 2010, respectively. The annual decrease and increase of river area were 974 ha and 5,063 ha during 1976-2000 and 2000-2010, respectively. From this it is estimated that the rate of annual decrease in river area was 0.007 percent from 1976 to 2000 and that of increase 0.033 percent from 2000 to 2010 with overall increase 0.004 percent from 1976 to 2010 (Table 22 & 23).

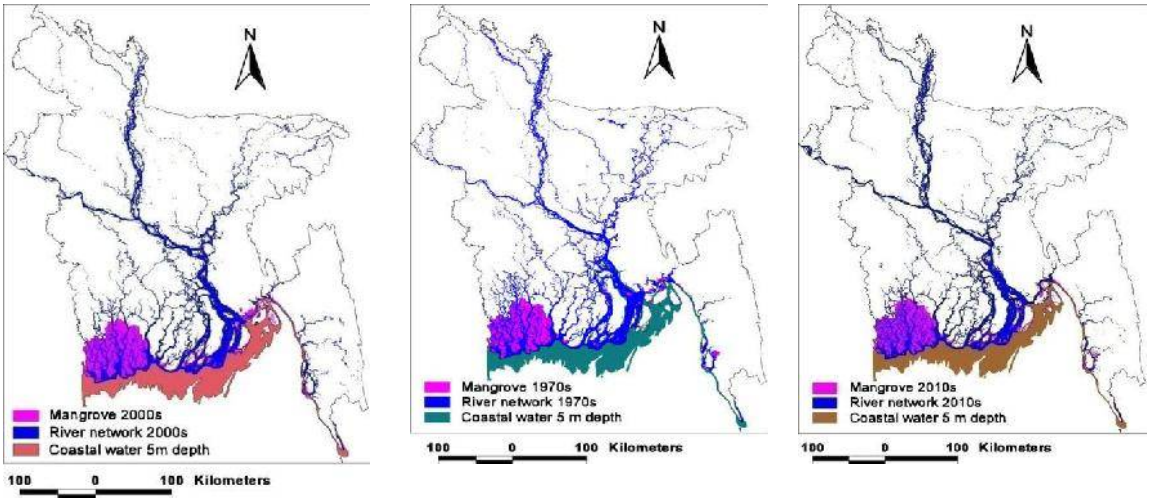

Figure 25 Mangrove forest and river network maps of Bangladesh

Source Hasan .et. al (2013)

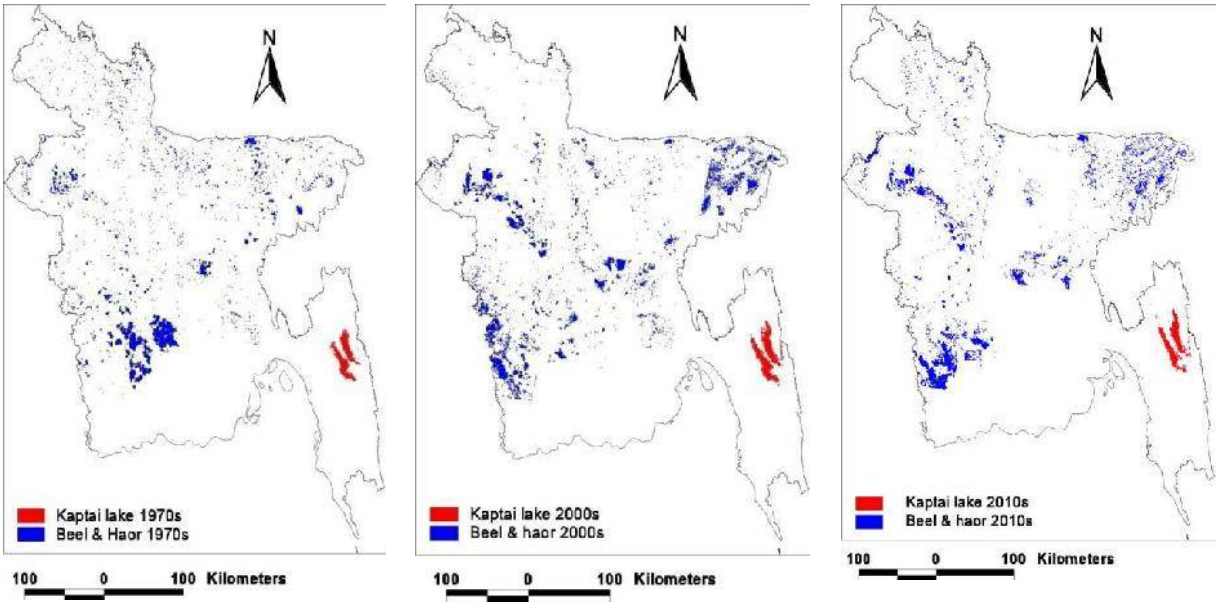

Figure 26 Maps showing Kaptai lake, Beel and Haor area of Bangladesh

Source: Hasan .*et. al* (2013)

6.1.7 Beel and Haor

The area under beel and haor was estimated 2, 39,977 ha in 1976 which covered 1.66 percent of the total area of the country. With the addition of 11,797 ha, the area under beel and haor rose to 1.73 percent in 2000. Thereafter, there was a slight decrease (1,047 ha) in 2010. It was also estimated that the annual rate of increase was 0.003 percent from 1976 to 2000, and that of decrease was 0.001percent from 2000 to 2010 with an overall increase of 0.002 percent from 1976 to 2010 (Table 21 and 22 & Figure 31).

Increase of area under beel and haor during the period 1976 - 2000, may be because of some area like beel Dakatia got under permanent water logging due to faulty flood management. Decrease in area during 2000- 2010 may be because of certain initiatives taken by the government to reduce water logging in some areas and also because of time of satellite image used for estimation. Area under aquaculture was estimated only 582 ha in 1976 which noticeably increased to 143,506 ha in 2000 and that was 0.99 percent of the total area of the country. However, the areas under aquaculture are increasing even after 2000 and stood 1, 75,663 ha which was 1.20 percent of the total area of the country. The annual rate of increase in aquaculture area was 0.041% and 0.022% for the period 1976-2000 and 2000 - 2010, respectively. The overall annual rate of increasing aquaculture area was 0.035 percent in respect of total area of Bangladesh (Table 21 and 22 & Figure 31).

6.1.8 Tea Estate

Land cover including tea estate area was 119,847 ha in 1976 and increased to 138,533ha in 2000 with the annual rate of increase by 0.005%. Thereafter, area under tea estate declined annually at the rate of 0.029 percent and reduced 96152 ha in 2010. However, the overall decrease in tea estate has been estimated at 0.005 percent, annually (Table 21 and 22 & Figure 31).

6.1.9 Salt Pan

The area of salt production has been consistently increasing in the coastal region in the country. It was only 11,789 ha, which was estimated 0.08 percent of the total area of Bangladesh, in 1976. However, this area has increased to 0.17% and 0.25% of the total in 2000 and 2010, respectively (Table 21). The rate of increase in salt pan area was 0.004

percent during the years 1976 to 2000, and that of 0.008 percent during the years 2000 to 2010. The average rate of increasing salt pan area was 0.005% of the total area during the study period. Annual land gained in salt pan was 522, 1172 and 713 ha during 1976-2000, 2000-2010 and 1976-2010, respectively (Table 22 & Figure 31).

6.2 Non-Agricultural Land

Non-agricultural land includes rural settlement, urban and industrial area and accreted land. The area under non-agricultural land as estimated in this study, was 11, 83,605 ha, which was 8.17% in 1976, and increased to 12.31% in 2000. It further increased to 16.47% in 2010(Table 21). Considering percentage of total land mass, land gained under non-agricultural land at an annual rate of 0.172, 0.416 and 0.244 percent during 1976-2000, 2000-2010 and 1976-2010, respectively. Considering area (ha) under non-agricultural land in 1976 and 2000 as the base, land gained during 1976-2000, 2000-2010 and 1976-2010 at annual rate of 2.129%, 3.425%, and 3.025% respectively (Table 22).

6.2.1 Trend of Urbanization and Industrial Area

Bangladesh is a densely populated country in the world. Urban and rural settlements have grown over time due to high population growth. The urban area has extended more rapidly due to internal rural to urban migration. Over time, the urban and rural settlement growth has been expelling other land uses such as agriculture, forest and nature. Rural settlement land use remains the main diversion of land out of agriculture. Between 2000 and 2010, agriculture land converted to urban area and settlements at a rate of 0.45%, annually. With that, cropland becomes scarcer, whilst simultaneously, the demand for agricultural products and higher yields rose due to population growth. The Bangladesh Centre for Urban studies classifies the urban centres in Bangladesh in different categories;

- Mega city (more than 5 million inhabitants)
- Metropolis (500.000- 5 million inhabitants
- City's (100.000 - 500.000 inhabitants)
- Medium towns (25.000 - 100.000 inhabitants)
- Small towns (less than 25.000 inhabitants)

Dhaka is the only mega city in the country. There are 3 metropolises: Chittagong, Khulna and Rasjhahi. Together with Dhaka, the three held about 56% of the country's total urban population in 2001.

Historic development of urban centres (CUS, 2014) is presented in Table 20.

Table 20 Historic development of urban centres

Size class	1901	1911	1921	1931	1941	1951	1961	1974	1981	1991	2001
Small town (below 25.000 inhabitants)	46	46	43	49	42	45	53	65	411	402	385
Medium town (25,000 – 99.999)	0	0	5	7	15	16	21	37	68	102	116
City (100.000 – 499.999)	2	2	2	2	2	2	3	4	10	14	17
Metropolis (500.000 – 5.000.000)	0	0	0	0	0	0	1	2	3	4	3
Megacity (more than 5.000.000)	0	0	0	0	0	0	0	0	0	0	1
All urban centres	**48**	**48**	**50**	**58**	**59**	**63**	**78**	**108**	**492**	**522**	**522**

Source: CUS, 2014

From this table, it is observed that the urban centres are developing over time. The urban area has extended more rapidly due to internal rural to urban migration.

Main drivers of upwards trends of urbanization are population growth, economic growth , climate change, impact of major interventions etc are the main /long term causes of urbanization. Population growth of Bangladesh as

described in Section 6.4 Bangladesh already experiences a high pressure on land for urbanization. The ongoing process of urbanisation will further aggravate the pressure on land. The number of people living in disaster prone areas will increase both from population growth perspective as well as from a climate change perspective, and this increases disaster prone areas within the country. Economic growth will impact the spatial development. If the spread of economic growth and profit increases more over the country, for example by strengthening the Dhaka- Chittagong corridor or by decentralization, the urban population growth would probably spread towards urban areas. Interventions such as improved urban amenities, new road connections, bridges or the development of new harbour, and economic centres will probably influence urban development as will major flood risk interventions, such as barriers or interventions providing land for urbanization.

There is significant increase in urban and industrial areas of the country during the period from 1976 to 2010. The total urban and industrial area was 26,799 ha in 1976 that expanded to 47,495 ha in 2000 and dramatically increased to 87,616 ha in 2010. The annual rate of increase was also higher (0.027%) during 2000- 2010, although the increase was only 0.006 percent during 1976 to 2000. The overall annual rate of urban and industrial area increase was 0.012% of the total area of Bangladesh (Table 21& 22). During the years from 2000 to 2010, 4012 ha of land went to urbanization and industrialization, annually (Figure 25 & 27).

6.2.2 Trends in Rural Settlement

Area under rural settlement was estimated 8, 85,637 ha in 1976 occupying 6.11% of the total area of the country. Rural settlement area consistently increased over time at a greater rate and become 10.03% in 2000 and 12.12% in 2010. The annual rates of increasing rural settlement area were 0.163% and 0.208 % during 1976-2000 and 2000-2010, respectively. The overall annual rate of increase in rural settlement was 0.177% during 1976-2010. It is revealed that rapid growth of rural settlement is the main driver of the declining agricultural land, especially crop land. It is estimated that annually, 23,850 ha and 30,809 ha of land went to rural settlement during 1976 to 2000 and 2000 to 2010, respectively (Table 22 & Figure27 & 31). About 76% of the country is under rural areas. Low-lying alluvial floodplains comprise the major part of the land, which is a large river basin or delta with annual flooding of the numerous rivers and water bodies that define the landscape. There are three main types of rural settlement: linear, clustered (or nucleated) and scattered. These patterns are originally related to the different physiographic characteristics. In the Hill tract area near Chittagong, it is a scarcely build linear pattern. This is because the unique topography of the hills and green vegetation. Since agriculture is difficult on the flat surfaces and gentle slopes along the streams, terraces are made to make the land suitable for agriculture.

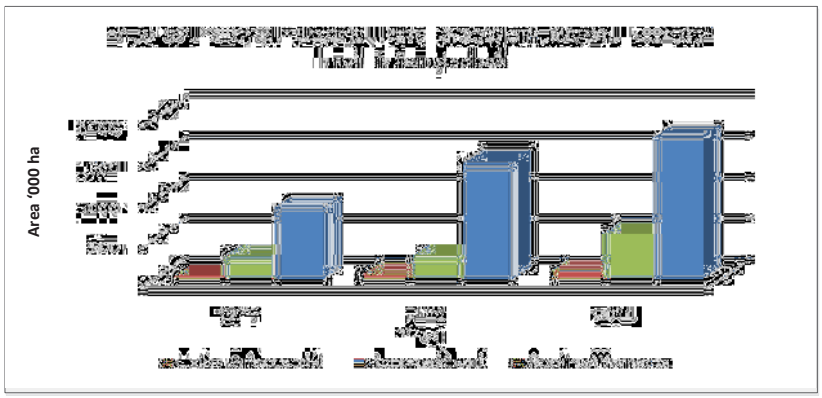

Figure 27 Trends of Land Cover for Urban and Industrial, Rural and Settlements and Accreted Lands during 1976 -2010(Area '000'ha)

Source Hasan .et. al (2013)

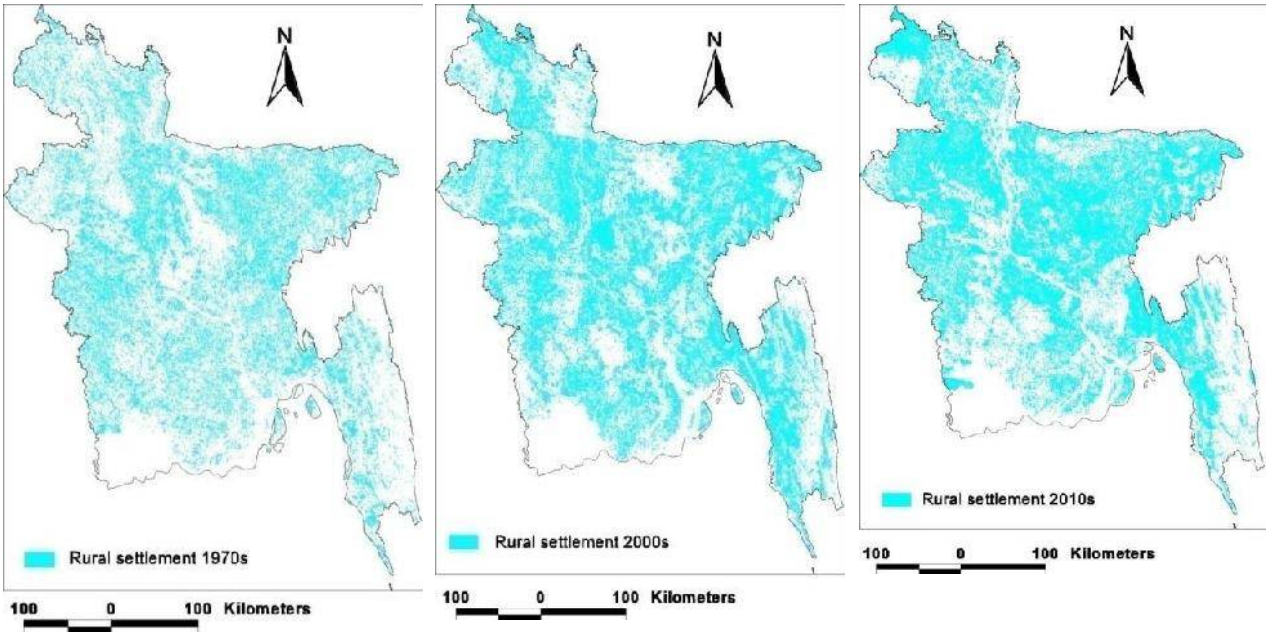

Figure 28 Maps showing rural settlement of Bangladesh

Source: Hasan .et. al (2013)

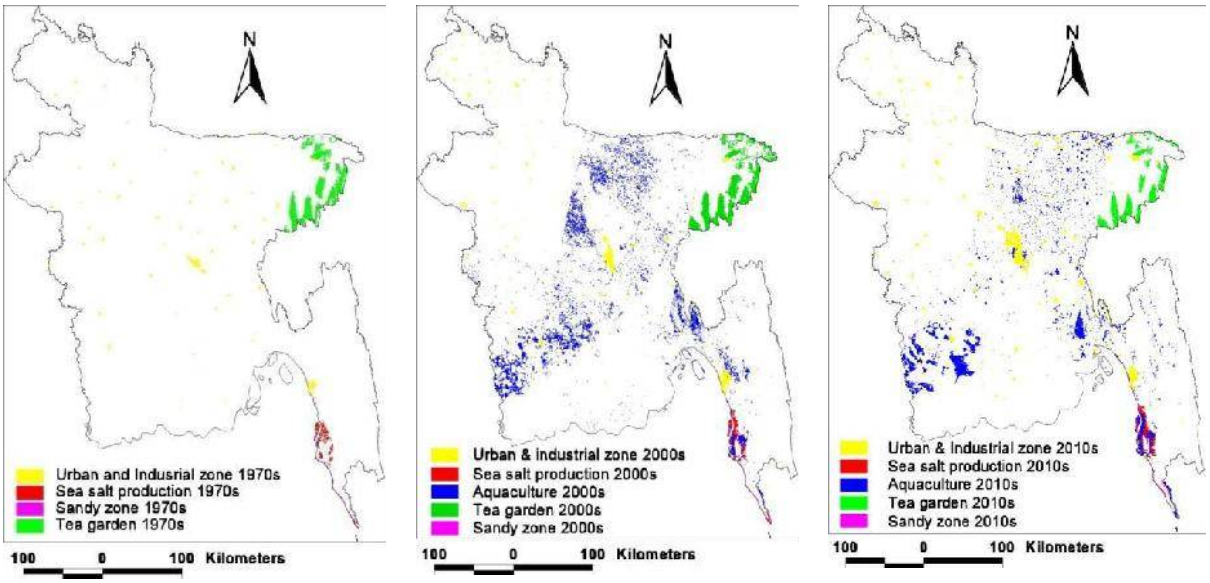

Figure 29 Maps showing urban and industrial zone, salt pan (sea salt production), sandy zone and tea garden of Bangladesh

Source: Hasan .et. al (2013)

6.2.3 Accretion

Accretion of land area in the river system of Bangladesh was much faster during the period from 2000 to 2010 compared to the period from 1976 to 2000. The accreted land area was estimated at 271,169 ha in 1976 and only 11,612 ha land was added by the year 2000, while it was 264,347 ha during 2000-2010. The rate of land accretion was

1.8, 1.95 and 3.75 percent in 1976, 2000 and 2010, respectively. From this, it was estimated that the annual rate of accretion was 0.003 percent during 1976-2000 and 0.180 percent during 2000-2010 with an average of 0.055 percent during 1976-2010. Subarna char, Nijhum Dwip under Noakhali District are the best example of accretion (Table 21 & 22 and Figure 27).

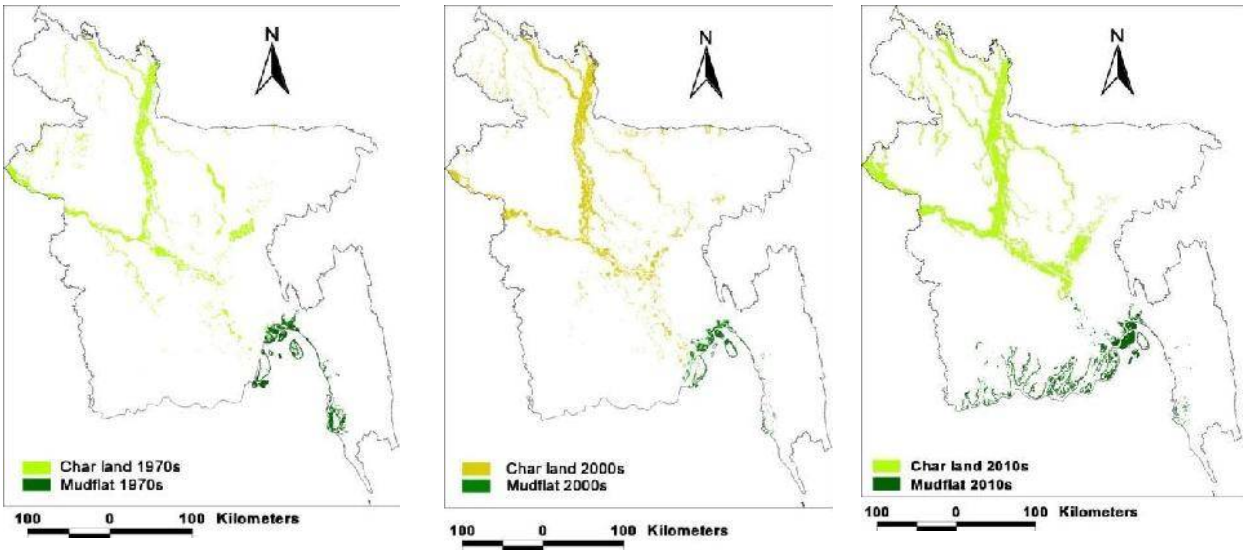

Figure 30 Maps showing char land and mudflat of Banglades

Source: Hasan .et. al (2013)

6.2.4 Population projections up to 2100

The average annual percent change in the population, is resulting from a surplus (or deficit) of births over deaths and the balance of migrants entering and leaving a country. The rate may be positive or negative. The population of Bangladesh would be 160.4 million at 2015, 185.1 million in 2030 and 202 million in 2050 (Worldometers, 2014 Population of Bangladesh). On the other hand, a paper presented at GED on "Population Dynamics and Development Challenges in Bangladesh"(Neaz,2013), showed that population was about 150 million during 2011 which would be about 185 million in 2031, 193 million in 2061, 178 million in 2081 and 156 in 2101. From this information, it is assumed that the growth rate would decline from the middle of 2100 century. The increase in population and decrease of land for agriculture and settlements would create problem for the country.

The United Nations (UN) had been publishing country level population estimates and projections since 1950s. In 2013, the "2012 Revision" of the World Population Prospects 29 was published, considering three fertility variants scenarios namely medium, high and low from 2010 up to 2100, each sharing the assumptions made with respect to mortality and international migration (GED, 015). The total population fertility rate of Bangladesh projection indicates to be declining significantly just after 2015, and would reach 1.8 and it is expected to continue at the end of the 21st century (GED, 2015). On the basis of those three variants of GED(2015), the total population of Bangladesh is expected to be as follows:

In the *medium variant,* total population in Bangladesh is projected to grow (from 151.1 million in 2010) to 201.9 million in 2050, reaching its maximum level of 203.7 million in 2060. In the next period, 2060 -2100, total population is decreasing very slowly to 182.2 million in 2100.

In the *high variant* comparable figures for total population are 235.6 million in 2050, 251.7 million in 2060 and increasing to even above the 300 million levels (306.8 million) in 2100.

In the *low variant* total population is increasing slowly to 175.0 million in 2035 (reaching its maximum level), and thereafter, slightly declining to 171.9 million in 2050. In the period, 2050-2100 total population is further decreasing significantly to about 100.3 million in 2100 (GED, 2015. & UN, 2012).

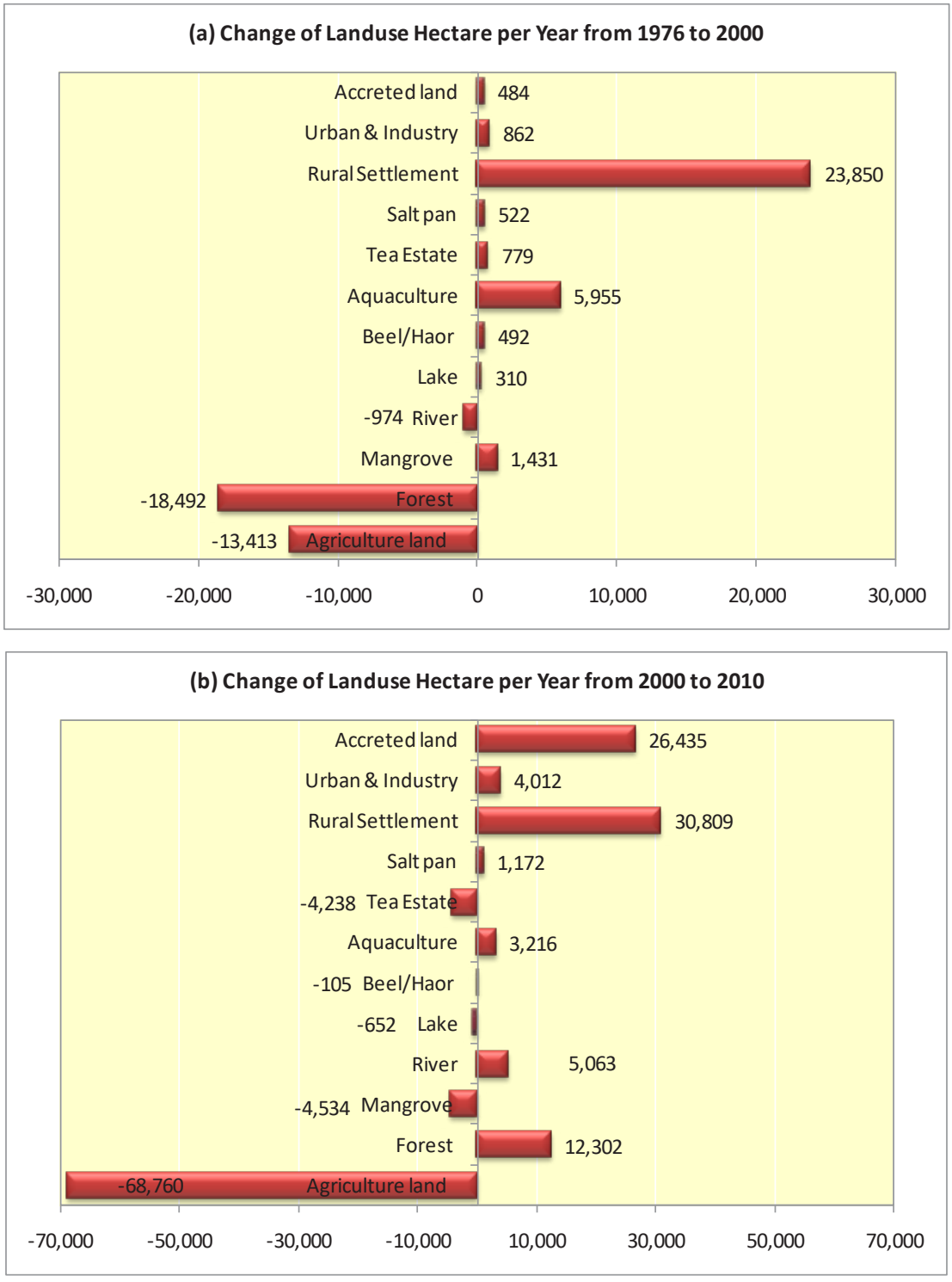

Figure 31 Annual net land loss and land gain in Bangladesh (a) during 1976-2000 and (b) during 2000-2010 under different land use categories. Source: Hasan et. al.,(2013)

Table 21 Area and average annual change of the percentage of the total area of different land cover

Land cover type	Year 1976		Year 2000		Year 2010		Average annual changes Of the % of total (%)		
	Area(ha)	% of total	Area(ha)	% of total	Area(ha)	% of total	1976-2000	2000-2010	1976-2010
Agricultural land:	**1,33,03,654**	**91.83**	**1,27,42,274**	**87.69**	**121,76,904**	**83.53**	**-0.172**	**-0.416**	**-0.244**
Crop land	97,61,450	67.38	94,39,541	64.96	87,51,937	60.04	-0.101	-0.493	-0.216
Forest	17,54,917	12.11	13,11,121	9.02	14,34,136	9.84	-0.129	0.081	-0.067
Mangrove forest	4,52,444	3.12	4,86,791	3.35	4,41,455	3.03	0.009	-0.032	-0.003
River	9,11,819	6.29	8,88,441	6.11	9,39,073	6.44	-0.007	0.033	0.004
Lake	50,829	0.35	58,261	0.40	51,739	0.35	0.002	-0.005	0.000
Beel and Haor	2,39,977	1.66	2,51,774	1.73	2,50,727	1.72	0.003	-0.001	0.002
Aquaculture	582	0.01	1,43,506	0.99	1,75,663	1.20	0.041	0.022	0.035
Tea estate	1,19,847	0.83	1,38,533	0.95	96,152	0.66	0.005	-0.029	-0.005
Salt pan	11,789	0.08	24,306	0.17	36,022	0.25	0.004	0.008	0.005
Non-agricultural land:	**11,83,605**	**8.17**	**17,88,307**	**12.31**	**24,00,867**	**16.47**	**0.172**	**0.416**	**0.244**
Rural settlement	8,85,637	6.11	14,58,031	10.03	17,66,123	12.12	0.163	0.208	0.177
Urban & Industrial	26,799	0.19	47,495	0.33	87,616	0.60	0.006	0.027	0.012
Accreted land	2,71,169	1.87	2,82,781	1.95	5,47,128	3.75	0.003	0.181	0.055
Total	**1,44,87,259**		**1,45,30,581**		**145,77,771**				

Source: Hasan et. al.,(2013)

Table 22 Area and average annual change in land acreage (%) under different land cover

Land cover type	Year 1976	Year 2000	Year 2010	Annual change by area(ha)			Average annual changes of ha(%)		
	Area(ha)	Area(ha)	Area(ha)	1976-2000	2000-2010	1976-2010	1976-2000	2000-2010	1976-2010
Agricultural land:	**1,33,03,654**	**1,27,42,274**	**1,21,76,904**	**-23391**	**-56537**	**-33140**	**-0.176**	**-0.444**	**-0.249**
Crop land	9,76,145	94,39,541	87,51,937	-13413	-68760	-29692	-0.137	-0.728	-0.304
Forest	17,54,917	13,11,121	14,34,136	-18492	12302	-9435	-1.054	0.938	-0.538
Mangrove forest	4,52,444	4,86,791	4,41,455	1431	-4534	-323	0.316	-0.931	-0.071
River	9,11,819	8,88,441	9,39,073	-974	5063	802	-0.107	.570	0.088
Lake	50,829	58,261	51,739	310	-652	27	0.609	-1.119	0.053
Beel and Haor	2,39,977	2,51,774	25,727	492	-105	316	0.205	-0.042	0.132
Aquaculture	582	1,43,506	1,75,663	5955	3216	5149	1023.2	2.241	884.78
Tea estate	1,19,847	1,38,533	96,152	779	-4238	-697	0.652	-3.059	-0.582
Salt pan	11,789	24,306	36,022	522	1172	713	4.424	4.820	6.046
Non-agricultural land:	**11,83,605**	**17,88,307**	**24,00,867**	**25196**	**61256**	**35802**	**2.129**	**3.425**	**3.025**
Rural settlement	8,85,637	14,58,031	17,66,123	23850	30809	25897	2.693	2.113	2.924
Urban & Industrial	26,799	47,495	87,616	862	4012	1789	3.218	8.447	6.675
Accreted land	2,71,169	2,82,781	5,47,128	484	26435	8116	0.178	9.348	2.993
Total	**1,44,87,259**	**1,45,30,581**	**1,45,77,771**	-	-	-	-	-	-

Source: Hasan et. al.,(2013)

6.3 Trend of Land Cover of Chittagang Hill Tracts (CHT)

The land use has been delineated by processing the satellite image of 2003 (LANDSAT ETM) and 2008 (TERRA ASTER). The study area of CHT is about 13, 23,978 ha (13, 23,535 ha in 2003 and 13, 24,420 ha in 2008). Detailed distribution of land cover has been estimated using processed satellite images (2003 and 2008) and presented in Table 23 and Figure 28 for the year 2003 and 2008. The percentages of land coverage for dense forest, medium dense forest, low dense forest, herbs / shrubs grass, Fallow/agriculture land, river and water bodies, settlements and hill shades are 15.2, 44.9, 21.3, 3.6, 3.3, 4.8, 4.8, and 2.0; and 5.9, 17.4, 31.2. 29.5, 5.9, 4.9, 4.2, and 0.9 in the year 2003 and 2008 respectively (Table 23 and Figure 32).

Table 23 Detailed land covers distribution in the CHT Area for 2003 and 2008

Land coverage	**2003**		**2008**		**Area (ha) Changes (2008-2003)**	**% Changes (-/+)in 2008 over 2003**
	Area(ha)	% of total Area	Area(ha)	% of total Area		
Dense Forest	2,01,793	15.2	78,596	5.9	-1,23,197	-61.1
M. Dense forest	5,94,479	44.9	2,30,753	17.4	-3,63,726	-61.2
L. Dense Forest	2,82,530	21.3	4,13,869	31.2	1,31,338	46.5
Herb Shrub Grass	47,742	3.6	3,90,910	29.5	3,43,168	718.8
Fallow/Agri. Land	43,149	3.3	78,099	5.9	34,950	81
River & Water	63,028	4.8	64,474	4.9	1,446	2.3
Settlement	63,939	4.8	55,162	4.2	-8,777	-13.7
Hill Shades	26,875	2.0	12,181	0.9	-14,694	-54.7
Others	-		376	0.0	376	0
Total	**13,23,535**	**100.0**	**13,24,420**	**100.0**	**885**	**0.1**

Source: CEGIS Estimation 2012 using 2-different years (2003 & 2008) satellite images

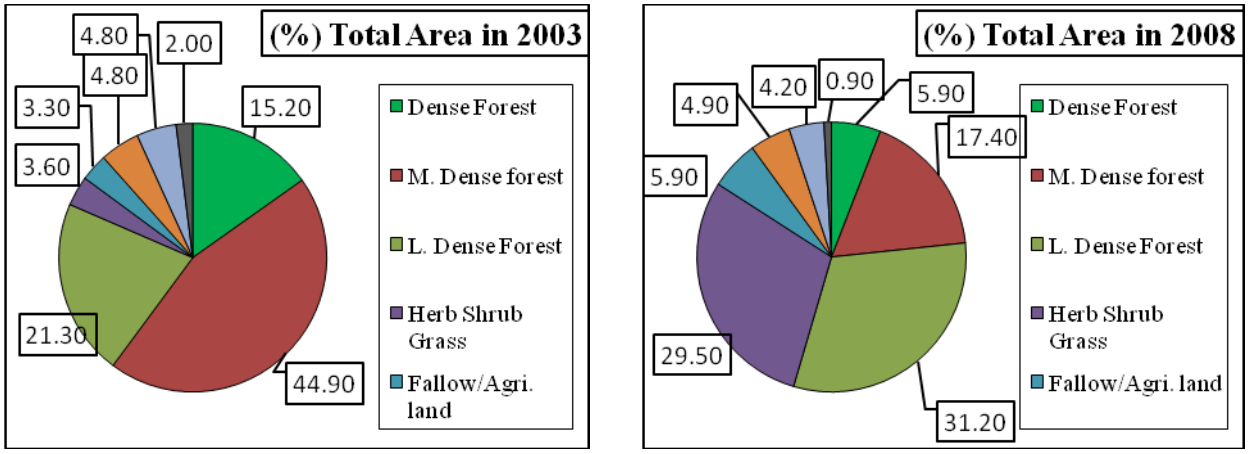

Figure 32 Percentage (%) of Land cover during 2003 and 2008 of the Study Area

Source: CEGIS Estimation 2012

It is observed that the maximum area (44.9%) was covered with medium dense forest in 2003 which was reduced to 17.4% in 2008. Similarly, the area of dense forest was about 15.2% in 2003 which declined to 5.9% in 2008. On the

other hand, low dense forest, herbs/shrubs grass and fallow/agriculture land increased in 2008 than that of 2003. The area of water bodies including river, chhara etc. more or less remained unchanged.

6.3.1 District wise Land Use/Land Coverage of CHT

The distribution of land coverage for Bandarban, Khagrachhari and Rangamati districts of the study area is presented in Table 24 and in Figures in 33, 34 and 35.

Table 24 Distribution of Land coverage in different Districts of the Study Area

Coverage	District wise Area (ha) during 2003			District wise Area (ha) during 2008		
	Bandar ban	Khagrachhari	Rangamati	Bandarban	Khagrachhari	Rangamati
Dense Forest	91,701 (20)	1,725 (0.6)	1,08,367 (18.8)	26,156 (5.7)	8,207 (2.8)	44,233 (7.7)
M. Dense forest	241,816 (52.7)	80,312 (27.8)	2,72,351 (47.3)	74,768 (16.3)	42,730 (14.8)	1,13,256 (19.7)
L. Dense Forest	72,433 (15.8)	1,27,885 (44.3)	82,212 (14.3)	1,52,594 (33.2)	87,535 (30.3)	1,73,740 (30.2)
Herb Shrub Grass	4,060 (0.9)	23,952 (8.3)	19,730 (3.4)	1,49,632 (32.6)	93,296 (32.3)	1,47,982 (25.7)
Fallow/Agri. Land	13,345 (2.9)	21,091 (7.3)	8,713 (1.5)	30,151 (6.6)	29,630 (10.3)	18,317 (3.2)
River & Water	3,299 (0.7)	3,638 (1.3)	56,091 (9.7)	5,324 (1.2)	2,476 (0.9)	56,674 (9.8)
Settlement	11,431 (2.5)	30,206 (10.5)	22,302 (3.9)	11,483 (2.5)	24,688 (8.5)	18,990 (3.3)
Hill Shades	21,075 (4.6)	57 (0)	5,743 (1.0)	9,247 (2.0)	356 (0.1)	2,578 (0.4)
Others	-	-	-	185 (0)	69 (0)	122 (0)
Total	**4,59,160 (100)**	**2,88,866 (100)**	**5,75,509 (100)**	**4,59,541 (100)**	**2,88,987 (100)**	**5,75,892 (100)**

Source: CEGIS Estimation 2012 using 2-different years (2003 & 2008) satellite images

Note: Figures within parentheses represent percentages

6.3.2 Land use of Bandarban District

In 2003, maximum area (52.7%) was covered with medium dense forest, which was followed by dense forest (20%). Low dense forest area coverage was about 15.8%. The coverage of fallow/agriculture land was only 2.9%. The area of dense and medium dense forest reduced to 5.7% and 16.3% during 2003-2008. In 2008, about 33.2%, 32.6% and 6.6% of area were covered with low dense forest, herbs/shrubs and fallow/agriculture land—which shows increase in coverage since year 2003 (Table 24 and Figure 33).

6.3.3 Land use of Khagrachhari District

In 2003, the coverage area of dense forest, medium dense forest, low dense forest, herb/ shurb grass, fallow/agriculture land, river and water, and settlements were about 0.6%, 27.8%, 44.3%, 8.3%, 7.3%, 1.3% and 10.5%, respectively. In 2008, the dense forest area increased slightly (to 2.8%) but the area of medium dense forest and low dense forest area decreased to about 14.8% and 30.3% respectively over total area. On the contrary, the area of fallow /agriculture land increased (7.3% to 10.3%) during the period 2003-2008 (Table 24 & Figure34).

6.3.4 Land use of Rangamati District

In 2003, the percentages of land coverage for dense forest, medium dense forest, low dense forest, herbs / shrubs grass, Fallow/agriculture land, river and water bodies, settlements and hill shades were 18.8, 47.3, 14.3, 3.4, 1.5, 9.7, 3.9

and 1.0, respectively over the total area. But the area of dense forest, medium dense forest, low dense forest, herbs / shrubs, grass, fallow/ agriculture land, river and water bodies, settlements and hill shades were 18.8, 47.3, 14.3, 3.4, 1.5, 9.7, 3.9 and 1.0, respectively over total area. But the area of dense forest, medium dense forest, low dense forest, herbs / shrubs grass, fallow/ agriculture land, river and water bodies, settlements and hill shades changed to 7.7%, 19.7%, 30.2%, 25.7%, 3.2%, 9.8% , 3.3% and 0.4%, respectively over total area till 2008. It indicates that the area of dense forest and medium dense forest decreased considerably, whereas there are increases in area of low dense forest, herbs/shrubs and fallow/ agriculture land (Table 24 & Figure35).

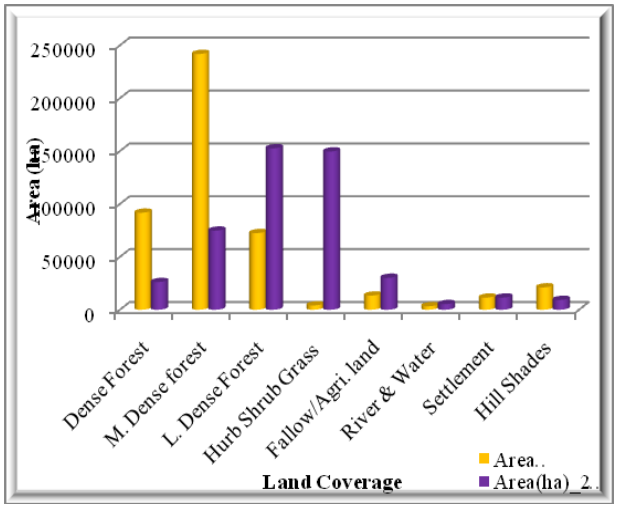

Figure 33 Land Coverage of Bandarban district during 2003 and 2008

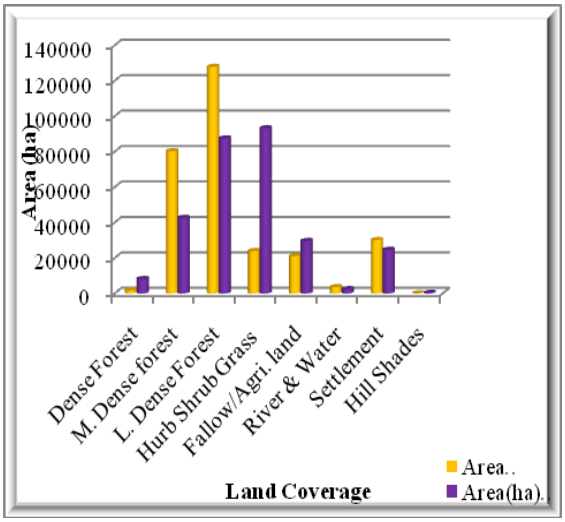

Figure 34 Land Coverage of Khagra- chhari district during 2003 and 2008

Source: CEGIS Estimation 2012 using 2-different years (2003 & 2008) satellite images

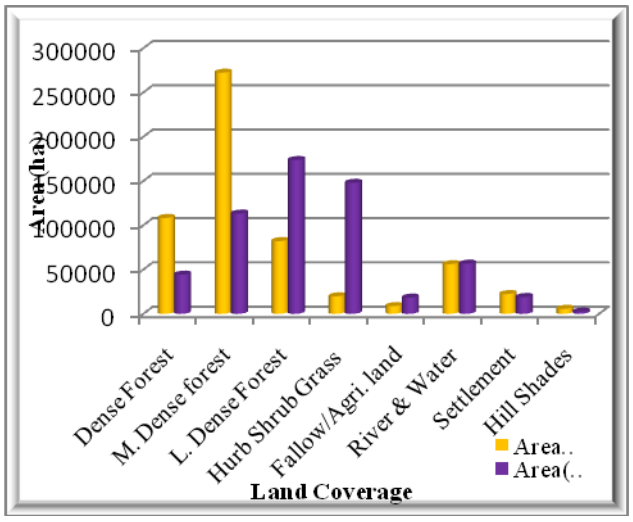

Figure 35 Land Coverage of Rangamati district during 2003 and 2008

Source: CEGIS Estimation 2012 using 2-different years (2003 & 2008) satellite images

7 Review of Institutional Framework and Legal Aspects

Bangladesh is one of the most densely populated countries experiencing high pressure on land. Many of the rural poor are landless or have only small plots of land, and thus, are depending on tenancy or shared cropping. The tenure insecurity is high due to outdated and unfair laws and policies. In addition, conflicts over land rights and wide spread land grabbing have increased. This has caused eonomic inequalities and instability in the rural areas. As a result, affected people are increasingly migrating to the towns, and increasing urban poverty. The concepts of land management are comprehensive and accommodate wider scope of the linkage of organizations. Land governance issue also includes floods and water management. The control of water bodies impact the lives and livelihoods of the poor fishermen communities. In Chittagong Hill Tracts (CHT) region, a legal regime -blending customary and formal laws, exists which differs from the rest of the country. The land governance should be good enough to ensure an effective parliamentary system, sound law and order, efficient public service delivery, independent, free, transparent, and accountable legal and judicial system. The local governance should be strengthened, and a corruption-free inclusive society with justice in all fairness should be established.

7.1 Institutional Arrangement of Land Resource Management / Land Governance Framework

The current administrative structure of land management in Bangladesh is built around three core functions: (i) record keeping, (ii) registration, and (iii) settlement. The core functions of land administration are maintained by various departments of two Ministries, The Ministry of Land (MoL) and the Ministry of Law, Justice and Parliamentary Affairs (MLJP). While the MoL discharges most of the land-related activities, including survey, collection of land development tax, arbitration process, the MLJP mainly records land mutation and transfers. Land administration at national level is presented in Figure 36. The following four departments conduct the core functions of land administration in Bangladesh:

7.1.1 Directorate of Land Records and Surveys (DLRS):

The Directorate is located in the MOL. It conducts cadastral surveys, from which it produces *mouza* (revenue village) maps showing individual plots of land and their corresponding *khatian* (individual land record certificates);

7.1.2 Land Reform Board (LRB):

The LRB under MOLdischarges its functions through Upazila Land Offices and Union *Tehsil* offices. It administers *khas* (public) land, and manages abandoned and vested property. It updates maps and land records between surveys and sets and collects the Land Development Tax (LDT). It is also formally responsible for the implementation of land reform legislation and the implementation of a tenant's rights;

7.1.3 Land Appeal Board (LAB):

The LAB, under MOL is the highest revenue court to serve as the final arbiter in matters of *khas* land, changes in records, plot demarcation and taxation. As such, it represents the final link in a chain running upwards from the Assistant Commissioner (Land) and the Nirbahi Officer at the Upazila, through the Additional Deputy Collector (Revenue) and the Deputy Revenue Collector at the District.

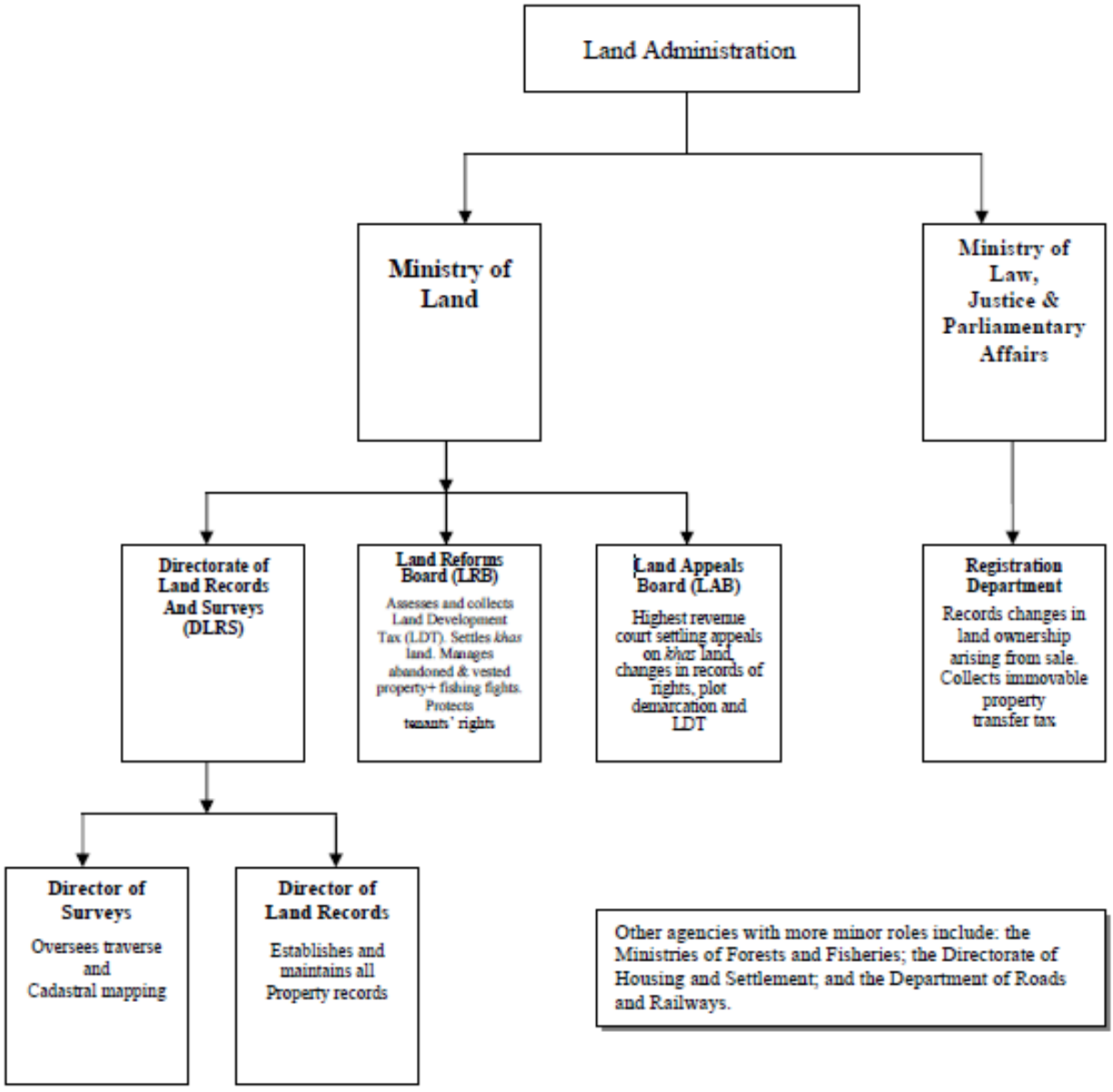

Figure 36: Land Administration at National Level

7.1.4 Department of Land Registration (DLR):

It is under the Ministry of Law, Justice and Parliamentary Affairs. It has three main functions - records land mutations arising through sale, inheritance or other forms of transfer, reports changes to the Ministry of Land, and collects the immovable property transfer tax (IPTT).

At the lowest tier, the function of record keeping is done by *Tehsil* office, while registration is done by Sub-registrar's office. There is an altogether different office which handles the function of land settlement. The current land administrative system is not integrated in the sense that ownership rights are recorded in three different offices, each of which is run through a completely different executive process. While the *Tehsil* office is linked to the Ministry of Land, the sub-registrar's office lies within the jurisdiction of the Ministry of Law and Parliamentary Affairs. In addition, the land settlement is done by a completely separate office. This disintegrated system creates hassles for the stakeholders.

7.2 Ministries and Agencies

The three ministries involved in planning:

(i) the Ministry of Planning,
(ii) the Ministry of Local Government, Rural Development and Co-operatives,
(iii) Ministry of Housing and Public works.

7.2.1 Ministry of Planning (MoP)

This Ministry prepares economic plans for the country. The Five Year Plan (FYP) provides budgets for sectorial allocation rather the spatial allocation.

7.2.2 Ministry of Local Government, Rural Development and Co-operatives

The existing structure of the local government of Bangladesh is presented in Figure 37.

Responsible for local government in a strict separation between urban and rural area:

- Rural Local Government (division council, district council, Upazilla council, Union council)
- Urban Local Government: City Corporation (6 + 5 upcoming) and Municipalities (Pourashava; 322)

Although Upazillas fall under rural local government, it can hold multiple villages, which can be turned into Pourashavas (municipalities) when a village reaches 15.000 inhabitants. This does not mean that the complete village turns into a Pourashava, only a part of it will, typically the most dense part. Later, the Pourashava area can be extended. A Pourashava receives additional funds from the central government, and it has more services (depending on their tier or size; A, B, C), therefore its inhabitants have to pay extra taxes. A Pourashava is always confined to a single Upazilla. Both the Upazilla and Pourashava have elected councils. A common issue of debate is the Upazilla budgeting, and how much of the budget should go to the Pourashava, which receives additional funds.

Local Government Engineering Department (LGED) located in the MOLGRD, is entrusted with the planning of local level rural urban plans, and planning and implementation for small scale water resources infrastructure development programs.

The LGED is mandated to produce (master) plans for local government bodies or Pourashava, which was the sole domain of the UDD earlier. As the Bangladesh's urban centres grow, the demand for planning services grows along with it. To cope with this strongly increasing demand for Pourashava Master Plans, the LGED was strengthened to increase the total planning capacity. The LGED has many local officers stationed in Pourashavas and some large Upazilla villages.

7.2.3 Ministry of Housing and Public works

Under Ministry of Housing and Public works falls:

- City Development Authorities of Dhaka (RAJUK), Cittagong (CDA), Kuhlna (KDA) and Rajshahi (RTDA) have jurisdiction in their metropolitan area. Other divisional towns such as Sylhet and Barisal do not have development authorities, although it was mentioned that these are about to be set up
- UDD (Urban Development Doctorate) the jurisdiction of UDD is the whole urban area except those under jurisdiction of City Development Authorities such as RAJUK, CDA, KDA, RTDA.

Activities for physical development are carried out per Annual Development Plan (ADP), implemented by different national and local authorities of different sectors.

It is observed from Figure 35 that within the administrative structure, there are exceptions with regard to the Hill Tracts: 3 districts fall under the Ministry of Chittagong Hill Tracts Affairs and the local government special areas.

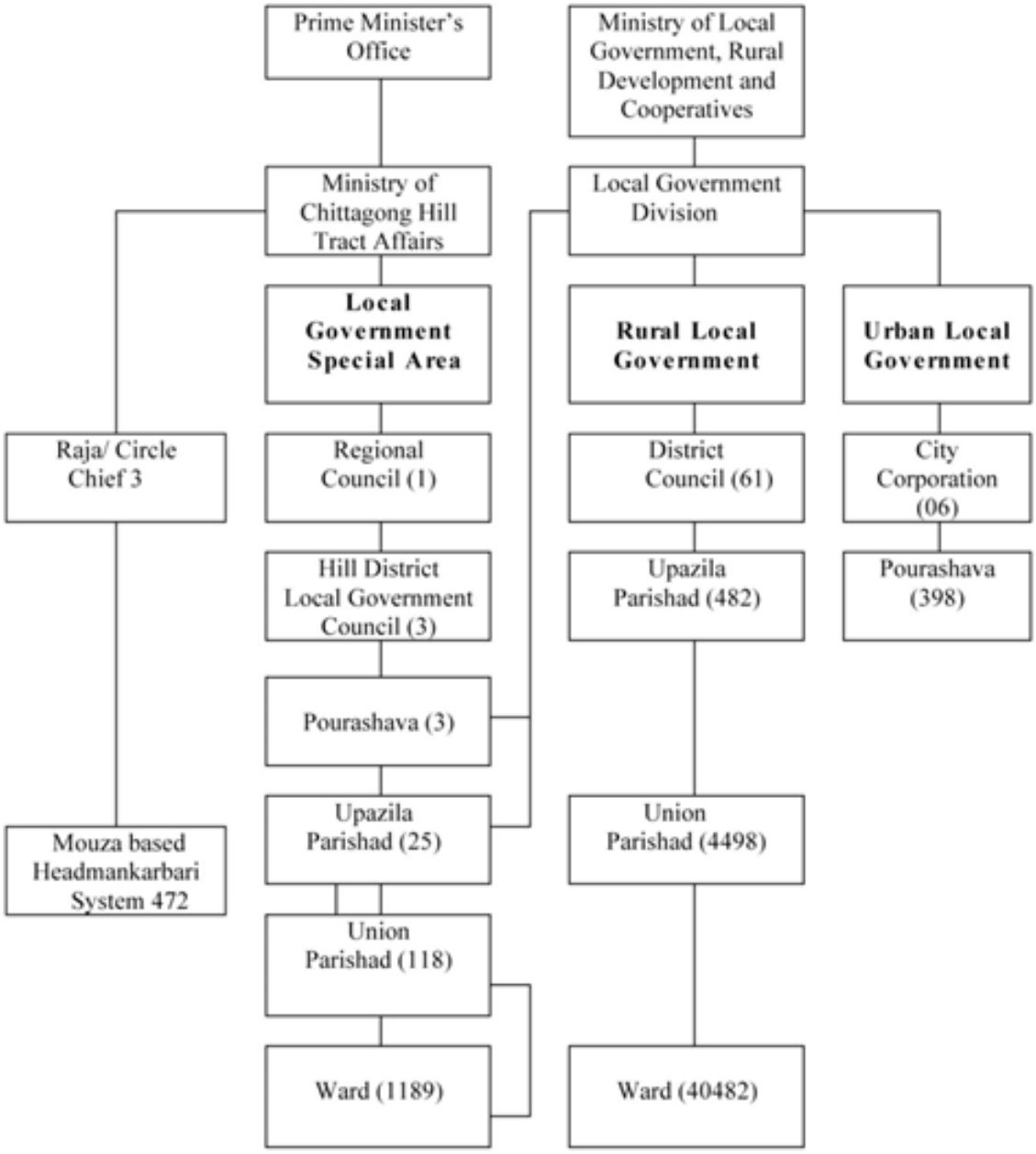

Figure 37 Existing structure of local government in Bangladesh (Panday 2011)

7.3 Strength and Weakness of the Current Land Administration System

Currently, the responsible ministries and agencies involved for land management and administration work independently with little coordination among them. The whole process is done manually which is laborious and time intensive. Traditional methods of land survey, preparation and upgradation of land records, maintenance of all related data for each parcel of land makes land administration and management inefficient and inadequate. On the other hand, land records at various stages i.e. plot-to-plot survey, preparation of records and drawing of maps through conventional methods, objections, checking works, printing, etc. hinder land development control and property tax collection. The current system of land administration and management appears to be inadequate and inefficient for a number of reasons:

7.3.1 Record of Rights (ROR)

Khatians are not conclusive evidence of ownership, and these merely provide basis for possession at the recording time. Under the prevailing legal system, *khatians* along with deeds and mutation documents are relevant for ownership decision by a Civil court (Mia, 1996). The lengthy and complex process of ownership determination enhances conflicts. The present system of registered transfer deed of land does not prove ownership or transferable rights of the seller; it rather invites the risk of false transfer (Aziz, 2003). Isolated maintenance of registration deeds and delay for sending land transfer (LT) notices to the AC (Land) office by the Registration office makes mutation and eventually the upgrading of ROR, a lengthy procedure. As a result, it requires revision settlement for updating land record that is more complex and time consuming. All the current stages of conventional preparation of ROR are vulnerable to tampering and distortion.

The current system produces multiple *Khatians*. The *khatian* is administered separately by DLRS, the DC Record Room, the AC (Land) office and the *Tahsil o*ffice. Also, the *khatian* managed by DLRS may differ from the mutated *khatian* managed by the AC (Land) office. If there is an ownership dispute, it is difficult to verify land ownership. The *khatian*, prepared by DLRS, can be printed for management. But the mutated *khatian* that is prepared by the AC (Land) is being prepared manually. If the book is recorded manually, some information, other than zone information, e.g. repeated information, may be omitted. To overcome the problems related to land record system a digitized system has been introduced. The current digital system is used for inputting the *khatian* records in the e23 Service Center and DLRS, and printing the information. The current system is available at the e- Service Center located in DC or Upazila office, and mainly used for the issuance of the *khatian*. However, the system only allows taking a print out of it, but cannot manage changes. For preserving land records digitally, the current system may be effective, however, for maintaining up-to-date record keeping in an integrated manner, a broader land information system (LIS) needs to be developed. Without having an integrated digital record system with a central server, it is expected that lack of coordination and inefficiencies in managing and maintaining land record keeping will prevail.

7.3.2 Registration

In Bangladesh, inadequate and improper land registrations create problems in securing land tenure and land transfer. A deed system does not provide the final proof of the proprietary right. There is no provision of compensation if any loses occur to some person due to errors in the deed. It causes a large-scale fraud and forgery related to land sale registration. Moreover, as many argued, there has been notable corruption in Registration offices during deed registration (Hossain, 1995), which increases the sufferings of the common people and acts to deprive the government of receiving its due fees. There is a wider tendency of reporting lower than actual price of land during the time of registration mainly for avoiding IPTT. There are also evidences of overpricing of land to get higher amount of bank loan for land development. Corruption and bribery are common place in *Tehshil* offices at the time of mutation. The mutation records can be distorted either during survey and settlement operations or due to false report of the *Tehsildars*.

7.4 Land Ownership

In Bangladesh, land ownership is managed in two ways. First, cadastres and ownership are investigated through surveys, and then mouza map and khatian are prepared. Second, the AC (Land) Office of the Upazila prepares the mutated khatian based on land transfers or inheritance. Different stages of Land record and registration process is shown in Figure 38. Women in Bangladesh rarely have equal property rights, regardless of the constitutional ban on the discrimination on gender. Social and customary practices effectively exclude women from direct access to land.

In Bangladesh, ownership of land is vested in either private individuals or entities of the state. Ownership rights to land for individual can be acquired through purchase, inheritance, gift or settlement by government. The antiquated Transfer of Property Act 1882 and Registration Act of 1908 set out the procedures for titling and registration land

ownership, which are complex, long, costly and suffer from corruption. Most families in the rural areas are poor. Land–tenancy agreements are conducted verbally, although the Registration Act 1908 sets out a process for registered leaseholds.

Table 25 Different stages of Land record and registration process

Sl	Procedure	Time to complete(days)	Cost to complete
1	*Verify the record of rights Party check that land tax payment are upto date. *Agency: Land office or Land Revenue Office under Ministry of Land*	15-60 days (simultaneous with procedure 2 and 3)	BDT:2,000
2	*Conduct RS Mutation on property (conversion into the current survey of property titles created before the last cadastral survey) *Agency: Assistant Commissioner of Lands (Tashil) under the Ministry of Land*	60 days (simultaneous with procedure 1 and 3)	BDT:6000
3	*Obtain inspection for RS Mutation/obtain inspection for this conversion *Agency: Assistant Commissioner of Lands (Tashil) under the Ministry of Land*	60 days (simultaneous with procedure 1 and 2)	Included in procedure 2
4	Obtain the non-encumbrance certificate from the relevant Sub-registry office. *Agency: Sub-registry under the Ministry of Law*	2-3 days	BDT:500-700
5	Prepare deed of transfer and pay stamp duty	1 day	3% of the property value(stamp duty)
6	Pay capital gains tax, registration fee, VAT and other taxes at a designated bank	1day	Local government tax(1%)+registration fee(2%) of property value
7	*Apply for registration at the relevant Sub-registry *Agency: Municipal Deed Registry Office*	180 days (simultaneous with procedure 8)	Already paid in procedure 6
8	*Register the change in ownership at the Land Revenue Office *Agency: Land Revenue Office*	45-60 days (simultaneous with procedure 7)	BDT 5,000

*Source: Rahman(2013). * Take place simultaneously with another procedure*

The process of land transfer is shown diagrametrically in Figure 38

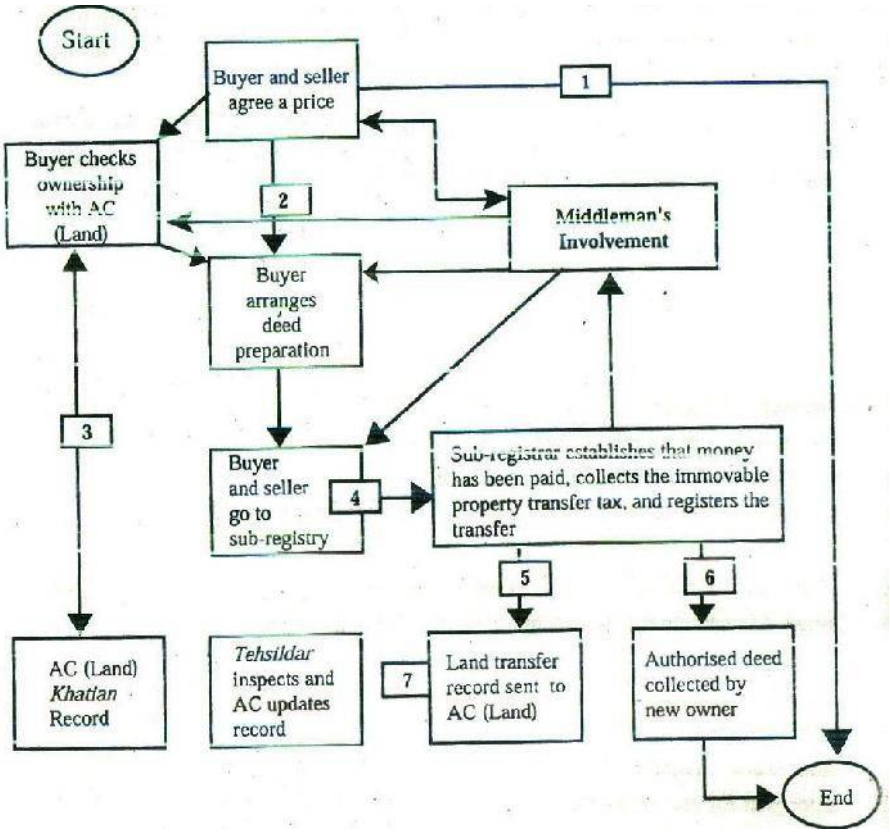

Figure 38 Process of Land Transfer in Bangladesh

Source: Rahman (2013)

7.5 Control Tools of Land Use Management

Legal framework

In Bangladesh, land inequality is a problem. A number of Government policies and legislative efforts have sought to address the extreme inequality in land holding, but very limited impact has been observed due to implementation process. The National Land Use Policy (2001) has setting out guidance for improved land use and zoning regulations. The policy was issued by the Land Ministry; it was found difficulties for implementation due to the involvement of many different ministries. To increase effectiveness, the Government needs to focus on decentralized and de-concentrated services.

About 70% of the population lives on only 20% of the residential land in the city, while 30% of the population lives on only on 80% of the land (Shafi and Payne, 2007; USAID, 2011, Rahman ,2013).

Most of the laws related to land management are very old in Bangladesh. Land reform initiated in 1989 and yet to be implemented on a full scale. Most of the land –related legislations prevailing in Bangladesh include the following (Shafi and Payne, 2007; USAID, 2010, Rahman (2013) :

- Transfer of property Act of 1882;
- Registration Act 1908;
- Non Agricultural Tenancy of 1947;
- State Acquisition and Tenancy Act of 1950;
- Acquisition of Waste Act of 1950;

- Bangladesh Land Holding Limitation Order of 1972;
- Acquisition and Requisition of Immovable Property Ordinance ,1982;
- Land Reform Ordinance of 1984;
- Land Reform Board Act of 1989; and the
- Chittagong Hill Tract Regulation Act of 1990, the Management and Allocation of Non-Agricultural Land Act, 1995.

For Dhaka Megacity, some laws have empowered RAJUK to control land use and development, including zoning. These are:

- 1953: Town Improvement Act(TIA)
- 200: Natural Water Body Protection and Preservation of Open Space and Playground
- 2004: Private Housing Project Land Development Rule
- 2010: Real Estate Development & Management Act
- 2010: Detailed Area {Plan (DAP) Gazette Notification.

Policies and regulations related to land management and urbanization have evolved in response to the problems faced rather than based on a vision and long term road map. Acquisition and Tenancy Act of 1950 enforced 33-acre land ceiling private land ownerships, which was revised in the Land Reforms Ordinance of 1984 and established a 21-acre ceiling. None of these land ceiling laws have been fully implemented (Uddin and Haque, 2009 quoted in USAID, 2010). The land laws for urban areas, somehow exclude the poor, and thus, chaos prevails in the overall management. The exclusion of the growing number of the urban poor and low income people , together with migrants and the landless from shelter opportunities, has given way to the complex tenure conditions(Shafi and Payne, 2007, Rahman ,2013).

The authority of CHT region is shared by the central government and traditional institutions. The government operates through its district and Upazila offices; but traditional jurisdiction over natural resource management and land and revenue administration lies with traditional village heads or chiefs (karbaris), the headmen responsible for several villages (mauza). It has been found rarely exercise concurrent jurisdiction by the government institutions. The content of some policies are outline below:

Law	**Content**
National land use policy-2001	• Stopping the high conversion rate of agricultural land to non-agricultural purpose; • Ensure maximum land utilization as per suggestion of aro-ecological zones; • Discourage the conversion of agricultural land to urban or development activities; • Improving environmentally friend sustainability of land use practices.
The 1972 Constitution(amended In2011)	• All citizens shall have the right to hold, acquire, transfer and dispose of property.
The 1984 Land Reforms Ordinance	• Placed a 20 acre ceiling on acquisition or holding a agricultural land and invalidated benami transactions, in which a person purchases land in the name of another so as to evade the land ceiling. • Agricultural households already occupying farmlands obtained rights to their homestead land through an anti-eviction provision (Uddin and Haque, 2009; Sharif and Payne, 2007)
Transfer of property ACT 1882 and Registration Act of 1908	• Procedures foe titling and registration of land ownership; • Procedure of updating land records.

7.6 Taxation

One of the major sources of public revenue to meet a country's revenue and development expenditures with a view to accomplishing economic and social objectives, such as redistribution of income, price stabilization and discouraging harmful consumption. It supplements other sources of public finance such as issuance of currency notes and coins, charging for public goods and services and borrowings. Tax is 'a contribution exacted by the state'. It is a no-penal but compulsory and unrequited transfer of resources from the private to the public sector, levied on the basis of predetermined criteria.

7.6.1 Land Taxation

(1) This Ordinance may be called the Land Development Tax Ordinance, 1976. (2) It extends to the whole of Bangladesh, except the Chittagong Hill Tracts. (3) It shall be deemed to have come into force on the fourteenth day of April, 1976. . In this Ordinance, unless there is anything repugnant in the subject or context, - (a) "body" means body of individuals, whether incorporated or not, and includes any company, firm, society, association, organization or authority by whatever name called; "Deputy Commissioner" includes an Additional Deputy Commissioner; (b) "land" includes land covered with water at any time of the year, benefits arising out of land and things attached to the earth or permanently fastened to anything attached to the earth;(c) "land taxes" means-(i) the development and relief tax payable under the Finance (Third) Ordinance, 1958 (E.P. Ord. LXXXII of 1958),(ii) the additional development and relief tax payable under the Finance Act, 1967 (E.P. Act XVII of 1967), (iii) the local rate payable under the Basic Democracies Order, 1959 (P.O. No. 18 of 1959), and (iv) the primary education payable under the Finance Act, 1974 (XLIV of 1974); (d) "non-agricultural land" has the same meaning as assigned to it in section 2(4) of the Non-Agricultural Tenancy Act, 1949 (E. B. Act XXIII of 1949); e) "prescribed" means prescribed by rules made under this Ordinance; (f) "Revenue Officer" includes any officer whom the Government may appoint to discharge all or any of the functions of a Revenue Officer under this Ordinance or any rules made there under; (g) "year" means a Bengali year commencing on the first day of Baishakh.

Exemption

The Government or any Officer authorized by it in this behalf may, by order in writing and subject to such conditions as it or he may specify therein, exempt from payment of land development tax, any public graveyard, public cremation grounds or place of public prayer or religious worship.

Explanation. "Place of public prayer or religious worship" shall have the same meaning as in section 151A of the State Acquisition and Tenancy Act, 1950 (E.B. Act XXVIII of 1951).]

Special provision relating to assessment of land development tax in respect of certain lands

3AA. Notwithstanding anything contained in section 3, in assessing the land development tax in respect of the lands mentioned in the Third Schedule to this Ordinance, the amount which was payable as rent or land revenue in respect of such lands under the State Acquisition and Tenancy Act, 1950 (E.B. Act XXVIII of 1950), shall be excluded from the total amount payable as land development tax for such lands.]

Power of Government to amend schedule

The Government may, by notification in the official Gazette, add any other police-station to the schedule or exclude there from any police-station or any area of any police-station.

Bar of proceedings in Civil Courts

No suit or other legal proceeding shall lie in any Civil Court to set aside or modify any classification of land or assessment of land development tax made by a Revenue Officer or any order made by any authority in any appeal under this Ordinance.]

Power to make rules

The Government may, by notification in the official Gazette, make rules for carrying out the purposes of this Ordinance.

7.7 Legal Strength to Ensure Execution of Plan and Policies

7.7.1 Land tenure forms

Government Land / Khasland

Khas land/ government lands are owned by the Ministry of Land as representative of Collectors is custodian. According to Specialists (Barket et al., 2001), Bangladesh has 3.3 million acres of khasland and 6-7 million landless households. These extreme poor households suffer because of the inefficiency in khasland distribution. Research shows that if these extreme poor households are provided with 0.50 acres of khasland, they can climb out of poverty and manage sustainable livelihoods. Khasland is the land which the government is entitled to both lease and give away to citizens of the country who do not own land. Khasland is considered an important livelihood source for the extreme poor and can generate and protect the gains made toward achieving sustainable livelihoods, particularly for those with low quality, under-sized and flood prone land. The strength and functionality of the relationships and networks that households build up are key to ensuring improved land productivity. If all of the khasland in Bangladesh is distributed among the extreme poor and if they are supported to use the land productively, Bangladesh can make significant progress toward eradicating extreme poverty and meeting the goals of MDG1.

Current land policies are fairly adequate and may not require extensive reform; however the process of applying and attaining the land needs systematic improvement.

Khas Land Management policies

There are two *khas* land management policies: Agricultural *Khas* Land Management Policy and Non-agricultural *Khas* Land management Policy. The basic tenets of these policies are to provide institutional structure and procedures for locating *khas* land and distributing it particularly to the landless. In addition, the policies set forth detail provisions on the composition and responsibilities of the committees that it establishes in relation to management of *Khas* land. Compared to non-agricultural *khas* land management policy, agricultural *khas* land management policy appears to be adequate in terms of its coverage of issues pertaining to *khas* land management (Gebremedhin, 2014). The non-agricultural *khas* land management policy was framed in order to address the issue of land grab by powerful elites and lease procedure of non-agricultural *khas* land. Considering the serious consequences of grabbing non-agricultural *khas* land, the related policies are not adequate in terms of their coverage and plan of action. The Policy does not provide any guidelines on how to recover illegally occupied land as well as how to distribute non-agricultural *khas* land to urban poor or landless.

Waqf: Waqf or Trustee land are under control of another Ministry or Dept. managed by the Waqf committee.

Debottar: A Hindu individual may dedicate property for religious or charitable purposes, usually formed by will or gift. No writing is necessary for creation of debottar. An endowment created by will, the will document must be attested by two witnesses.

Leases: Cast/temporary leasing agreements range from one to ten years of public or private properties.

Sharecropping: Sharecropper contact agreements must be for 5 years and are heritable. The sharecropper and the land owner each receive one-third of the crop; the remaining third is allocated based on each party's share for the costs of production.

7.8 Land Grabbing

In Bangladesh, wealthy and influential people encroach on public lands with false documents and obtain court decrees to confirm their ownership, often with the help of officials in law, administration and management departments (Uddin and Haque, 2009; Feldman and Geisler, 2011). Land–grabbing of both urban and rural land by domestic actors is a very serious problem in the country.

7.9 Integrated Water Management

7.9.1 Policy and legislation

Bangladesh is a vast deltic country. It has the GBM (the Ganges, the Brahmaputra and the Meghna) river system which originated from the Himalayas and reach the sea. About 80 % landform is floodplain and recurrent floods often destroy crops, infrastructure and settlements, and erode fertile agricultural land. A number of infrastructures have been initiated by the Government, but these do not fulfil the expectation.

Bangladesh developed National Water Policy (1999), Integrated Water Management plan (IWMP) for 2000-2025 and Water Act, 2013.

The Water Policy assigns for development and management of surface and groundwater in an efficient manner ensuring access to the poor, women and children to water; accelerating development of sustainable public and private water delivery system;, development of a legal and regulatory framework for private sector investment in water development, and capacity building for designing future water resource management plans.

The WARPO will delineate the hydrological regions of the country, based on appropriate natural features, for planning the development of their water resources and water-allocation decisions to local administrative authorities.

The IWMP addresses on (i) efficient use of water in the face of increasing scarcity; (ii) providing all people with access to sufficient, good-quality water; and (iii) ecologically sustainable use of the resource (Gupta et al. 2005). Land and water related policies have been presented in Chapter 3.

7.9.2 Institutional framework

The development and management of water sector is controlled by the Ministry of Water Resources (MoWR).Water Resources Planning Organization (WRPO) is responsible for coordinating planning for all water resources programmes and administration. Bangladesh Water Development Board (BWDB) under MoWR is responsible for flood control, irrigation, erosion control, and other water sector projects. The Forest Department owns all government forests and is responsible for managing all these forests under Ministry of Environment and Forests. Forest Master Plan (1992) is a macro forest plan designed to address policy issues, institutional reforms, and environmental concerns. The activities on forest policy, essential for watersheds, are consistently underfunded. The performance of some government departments have been found poor.

7.9.3 Realities on the ground

In the rural areas, 89% of the landowners own <1 ha and 39% has <0.2 ha. The number of landless is increasing (USAID, 2010). Land governance is caught up with social, economic, and political powerplay in Bangladesh. Land rights are insecure in large measures due to inefficient, expensive, and corruption –prone system for land titling and registration (Uddin and Haque 2009; USAID 2010; ADB 2004c; IMF 2005).

The conflicts of land are being caused due to distribution of khas land to ineligible households, possession of government-allocated land by ineligible persons, elite and corporate land grabs of public lands inhabited by landless people, unaccountable land administration, and record management. Public confidence and support has reduced for overall land grabs and illegal logging by authorities and officials (ADB, 2004b; World Bank, 2006).

The establishment of ownership rights over scarce land is highly competitive and violence is common. (ADB 2004c). Land titling disputes fall within the jurisdiction of the Ministry of Land but some disputes are resolved before an informal dispute resolution body called a 'Shalish' over which influential local leaders preside. It is necessary to strengthen local and traditional conflicts resolution bodies for alternative dispute resolution as well as to reform the law and accountability mechanisms. The increase in conflicts of Chittagong Hill Tracts (CHT) region is related to the migration of settlers onto lands which under customary law, are owned by the indigenous people (Roy *et. al.,* 2004; World Bank 2010; CARE 2003; Uddin and Haque 2009).

7.9.4 Recommendations

The conflicts over control of water-bodies is impacting negatively on life and livelihood of the poor fishermen communities for which the reform of water policy is required so that the fishermen can increase their fish production.

Land governance should be in such a way that there would be no conflicts in social and will be free from administrative corruption, political interference and muscele power and will be maintained as per law of Bangladesh. Land rights are insecure in large measures due to inefficient, expensive, and corruption –prone system of land titling and registration. The adverse system should be eliminated. Land governance should addresses among other things:

- The formulation and adoption of sustainable legislation, policies and institutions;
- The way legislation, institutions and policies are being established, enforced and implemented

The strategies should be focused on strengthening institutional capacity, reforming key institutions, controlling corruption, enhancing efficiency of planning and budgeting, financial sector monitoring, promoting e-governance, and ensuring access to information, and reviving value and ethics in the society. The roles and responsibilities of all involved stakeholders-local and national government, private sector, civil society-regarding ownership, administration, ownership and management of land resources need to be clarified.

7.9.5 Conclusion on land administration

The existing process of land administration has been found problematic in land management including lack of coordination and efficiency in the system. It has been estimated that about 80 % of court cases in the rural areas are related to land-conflicts. The current system is often viewed by stakeholders as time-consuming and costly, as well as a cause for potential land disputes. Digitization of land record is one of the solutions to minimize disaggregation/disintegration problem of the current system. Digitization of land records is now being implemented with support from various donors, but the progress is not satisfactory. Digitization of such records will reduce hassles of stakeholders and it will help create an integrated system of land records. The information regarding land ownership would be made available by this system. To reap the benefit of the digitized record system, one must needs to be careful about the flawless inputs of records. It is also important that the donors or agencies that are implementing the relevant projects should have some sorts of coordination among them for better management of works. Therefore, the ultimate objective should be to develop an integrated Land Information System (LIS) through land survey and land record keeping system.

7.10 Gender in Land Resources Management

The land resources provide food, fibre, shelter and medicines to the human kind. The livelihoods of many of the country's poor rural women are sustained through proper land resources management. However, growing numbers of rural communities are living in vulnerable environments where the quality and availability of this vital resource is declining. Land resource degradation occurs due to both external factors, such as climactic changes, encroachment by outsiders or conflict, as well as from internal issues, namely poor land resource management.

BDP2100 has a specific objective to help increase participation of women in land resource management. In order to address the said issues, a Gender Action Plan may be prepared on the basis of practical and strategic needs, mainly of the following objectives like;

a) Preparation of organic fertilizers, compost, farm-yard manure etc;
b) Afforestation in the newly accreted or char lands;
c) Embankment Management Groups (EMGs) may be formed for the protection of embankment from rain-cut, rate hole, erosion prevention, etc. for better land use management within the embankment;
d) Creation of enabling environment for women for sustainable land resources management;
e) Building gender–awareness among all stakeholders.

7.10.1 Benefits from gender –responsive actions

Overall improvement is seen in land resources management, use, and conservation and increased agricultural productivity. Rural women and men maximize their contributions to household food security through efficient land management. Understanding and addressing the gender dimensions of environment and energy programs ensure effective use of development resources. Gender relations improve and the social acceptance of women in decision-making positions increases. By identifying gender-differentiated opportunities and constraints, project implementers make better-informed decisions and develop more effective environmental and biodiversity conservation interventions.

7.10.2 Climate change

Households that are better equipped to cope with the impacts of climate change or extreme weather events can better use, manage, and conserve land resources. Efficient, cost-effective, and relevant interventions take place. Gender analysis helps clarify the specific and often different needs, vulnerabilities, and coping strategies of women and men, so that they can be more adequately addressed in response to the impacts of climate change and variability related to land resources.

7.10.3 Gender Equity on Land Resources Management

Land ownership and entitlement to land signify economic as well as social identity and reflect empowerment and dignity. Control over income and assets like land, etc. are an indicator of women and men's empowerment.

7.10.4 Gender based realities/information

(i) Study conducted by Human Development Research Centre in 2002 shows that women's involvement in agriculture is nearly 88%; however, they won only 4% of total land. Another statistics shows that women's contribution in food production is 80%, but till now women are not recognized as farmers which again drop them in disadvantaged position.

(ii) Situation of women with respect to land ownership/entitlement in Bangladesh is constrained by patriarchal attitude, lack of recognition of her productive work and social barriers. Muslim Personal Law provides daughter, mother and wife some share in inheritance but does not treat equally with their male counterparts and it lacks enforcement. ALRD research of 2013, states that in Bangladesh, 48% women are deprived of access to land though they are engaged in agricultural activities; and 98% of private land in Bangladesh is owned by male. (Source: Women and Land Rights in Bangladesh, ALRD, 24 October 2013). Since women do not own title deed, they are denied of the resources like institutional credit, extension services and technologies that are accessible only by the title holders.

(iii) Low social status, poverty, lack of relevant education and judicial discrimination are obstacles for women to claim their ownership of land. Separated and divorced women have no right to claim any portion of their husband's land. Bangladesh does not have the legal concept of co-ownership of marital property unless a woman's name is actually written on the legal document.

(iv) Climate change and women's land: Climate change is not gender-neutral. River erosion, flood, cyclone, sea level rising all has direct impact on natural resources including land. Women are especially vulnerable to these climatic conditions. In case of resettlement, it is difficult for a woman to get access to khas land allocation as she does not have a title deed in her name. Woman whose husband migrate to cities for better income opportunities leaving family behind, become subject of violence by in-laws and elite land grabbers.

7.10.5 Government initiatives towards pro-women policies and laws

In National Women Development Policy 2011, it has been states in Article 25(5) that 'women should have full right to control her property which she achieves through earnings, inheritance, credit or land and market management'.

Clause 6 (Page 184) of the Land Management and Distribution Policy 1997 states that land will be allotted in the name of both husband and wife while Clause 11 states that widow and separated women will be entitled to land allocation in the name of their matured son. Clause 16 of the same policy says that once the land is allocated in the name of both husband and wife, in case of divorce or separation, the court will decide. In some development projects, e.g., Sustainable Crop Diversification Project, ADB, relating to agriculture, women can get access to agricultural credit showing a letter of agreement from her husband that she can use his piece of land for getting access to credit. But question remains here whether these women can keep control over the loan money and also on the income that is earned through utilization of that financial support. The Char Development and Settlement Project (1987) granted and now the CDSP IV grants land titles in the joint names of both husband and wife, with the wife's name coming first.

7.11 Recommendations on Gender for Land Use Management

- Local level khas land management and distribution committees should have representatives from landless people – women and men. They can be executive committee members of local level development projects.
- Involvement of poor people (women and men) of the locality in the identification, selection and utilization of khas land should be strengthened.
- Ministry of Land should arrange awareness rising of women and men about their rights and procedures to get khas land, including land settlement procedures. Coaching on filling out application forms to get khas land is a real necessity. Gender Focal Point and Climate Change Focal Point of the concerned Ministries could implement specific programmes towards this.
- Displaced population (male and female) due to river bank erosion should be rehabilitated on the newly accreted chars and khas lands. Legal procedures should be gender-friendly for this.
- Women should be recognized as farmers considering their huge involved in farm land. Property inheritance right should be established considering equality of women and men; and for establishing women's human rights.

8 Land Resources Management and Strategy Development

Planning and management of land resources are integral parts of any development programmes with both rural and urban components. Land use does not consider agricultural uses only. It encompasses natural areas, forests, watercourses and urban areas among others. Land users should focus how to use their land based on scientific assessment of its capability or suitability. Land-use planning is the systematic assessment of land potential, alternatives for land use and economic and social conditions in order to select and adopt the best land-use options. Its purpose is to select and put into practice those land uses that will best meet the needs of the people. Thus, it will be safeguarding resources for the future. The driving force of land use pattern is in need for change, the need for improved management, the need for a quite different pattern of land use by changing circumstances. The following points have to be considered for land use management.

8.1 Identification of Land for Conservation Areas, Productive Areas and Areas Under Urban Development

It is necessary to protect a place which has significant cultural and historical importance. It is important for land conservation organizations to protect the places of profound natural, agricultural, or open space value. These places – often defined as cultural landscapes – are more than the sum of their parts. Loss of one dimension diminishes the experience of the whole place. Yet these complex sites can present challenges for organizations and resources structured to address solely historic preservation or land protection. The National Trust for Historic Preservation and the Land Trust Alliance are working to provide information, inspiration, and assistance to promote comprehensive protection of all the elements that make places special.

Types of conservation measures:

- Agronomic: such as plant / soil cover, conservation farming methods, contour farming
- Vegetative: such as planting barriers (vegetative strips), live fences, windbreaks
- Structural: such as Fanya Juus, terraces, banks , bunds, cut off drains, barriers
- Overall management: such as area closures, selective clearing

8.1.1 Productive land

In Bangladesh, the gross area of Bangladesh is about 14. 84 million ha of which is about 12. 18 million ha is agricultural land (83.5%) and the rest 16.5% is non-agricultural land. Rural settlement and urban including industrial land is about 12.1% and 0.6% respectively of the total area of Bangladesh. Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. These lands need to be conserved for food security (FAO, 1993. FAO, 2013)

8.1.2 Wetland

The term 'Wetland' means a very low-lying Eco-System where the ground water level is always at or very near to the surface. It includes – marshes, *Jheels, Beels*, Bog areas, floodplains and shallow coastal areas. Wetland is basically divided into Estuarine and Freshwater zones which are again subdivided according to their soil types and plant life. The *Ramsar Convention* which has been adopted and used in Bangladesh (1971), defined wetlands as – "*Areas of marsh, fen, peat land, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.*" So, wetlands lumps together a wide range of contrasting habitats like – the fluvial, estuarine, coastal and marine habitats. Based on their biological, physiological and ecological identities 39 categories of wetlands hves been globally recognized, of which 30 are natural and the rest artificial

The wetlands of Bangladesh can be categorized based on their land types as well as hydrological and ecological functions and is presented in Table 26.

Table 26 Different categorized of wetlands and its characteristics

Wetlands	Types	Characteristics
Saltwater	Marine	Shallow waters at low tide, e.g., Bay coral reefs like – St. Martin's island.
	Estuarine	Intertidal sand, mud or salt basins with specific vegetation, like – newly accreted intertidal land, marshes, forests and mangroves, e.g., Sundarbans.
	Lagoonal	Brackish to saline lagoons with narrow connection with the sea.
Freshwater (FW)	Riverine	Rivers and streams with their tributeries including the *Chars*.
	Lacustrine	Lakes, *Beels* or *Jheels* of different sizes and shapes distributed all over the districts of – *Noakhali, Comilla, Brahmanbaria, Sylhet, Faridpur, Pabna, Rajshahi, Jessore and Khulna*.
	Palustrine	Marshes and Swamps with emergent vegetation or swamp forest, or peat-forming swamps. e.g., *Hijal* forests in the lowlands.
Man-made		Aquaculture ponds (brackish and FW), irrigated lands and irrigation channels, salt pans or Hydro-dam. e.g., *Kaptai* Lake.

Source: Bhuiyan, (2013)

The total area of Wetlands in Bangladesh is about seven to eight million hectares, which constitutes about 50% of the land surface of the country. The soil scientists have adopted a different approach to define the wetlands here from the agricultural point of view. They have divided the country into six broad land types based upon the depth and duration of inundation or flooding in normal monsoon season (described in land type section 4.3, SRDI, 1988). The majority of land here was formed by the river alluvium of the rivers Ganges and Brahmaputra and their tributaries from where wetlands emerged.The major wetlands in Bangladesh constitutes the fluvial or floodplains, some of which are known as – *Ramsagar, Aila Beel, Arial Beel, Chalan Beel, Erali Beel, Kuri Beel, Meda Beel, Gopalganj-Khulna Beel, Beel Bhatia, Tanguar Haor, Dubriar Haor, Dekhar Haor, Hail Haor, Hakaluki Haor, Kawadighi Haor, Ata Danga Haor, Kaptai Lake, Bogakine Lake, Sundarban West, Sundarbar South, Sundarban East, Chakaria Sundarbans, Naf estuary, Atrai Basin, lower Punarbhaba floodplains, Surma-Kushiara floodplains, St. Martin's Island and Reef* etc. The man made wetlands include the – ditches, ponds, tanks, lakes. The areal extent of wetlands is given in Table27.

Table 27 Man made wetlands including ditches, ponds, tanks, lakes of Bangladesh

Name of Wetlands / Water bodies	Area in Sq. km.
Rivers	7,497
Estuarine & Mangrove Swamps	6,102
Beels, Jheels & Haors	1,142
Inundable Floodplains	54,866
Kaptai Lake	688
Ponds & Tanks	1,469
Baors (Oxbow Lakes)	55
Brackish-water Farms	1,080
Total =	**72,899**

These wetlands are very important from ecologically point of view. For the preservation, protection and management of wetlands and natural water resources, one must know their importance.

The Ecologically Critical Area (ECAs) of Bangladesh is presented in Table 28 and Figure 39. These lands may be protected for wildlife sanctuary, national park and game reserve etc.

Table 28 Protected Areas and Ecologically Critical Area (ECAs) of Bangladesh

Name of protected areas	Habitat Types	Area (ha.)	Hydrological Region
Wildlife Sanctuary			
1. Sundarban East WS, Bagerhat*	Mangrove Forest	31,227	South-West
2. Sundarban South WS, Khulna*	Mangrove Forest	36,970	South-West
3. Sundarban West WS, Satkhira*	Mangrove Forest	71,502	South-West
4. Rema-Kalenga WS, Hobigonj	Mixed Evergreen forest	1,796	North-East
5. Char Kukri-Mukri WS, Bhola	Char Land & Mangrove Forest	40	River & Estuary
6. Pablakhali WS, Chittagong Hill Tracts	High Hill Mixed Forest	42,047	South-East
7. Chunati WS, Chittagong	Mixed Evergreen forest	7,761	Eastern Hills
8. Hazarikhil WS	Mixed Evergreen forest	1,427	South-East
9. Hail Haor WS	Forest Water Wetland	2,903	North-East
10. Rampahar-Sitapahar WS	High Hill Mixed Forest	3,026	Eastern Hills
11. Sango Mouza Elephant Sanctuary	Hill Mixed forest	-	Eastern Hills
National Park			
1. Himchari NP, Cox's Bazar	Mixed Evergreen	1,729	Eastern Hills
2. Bhawal NP, Gazipur	Deciduous Forest	5,022	North-Central
3. Modhupur NP, Tangail-Mymenshing	Deciduous Forest	8,436	North-Central
4. Lawachara NP, Moulovibazar	Mixed Evergreen	1,250	North-East
5. Kaptai NP, Chittagong Hill Tracts	Wetland	5,464	Eastern-Hills
6. Ramsagar NP, Dinajpur	Wetland	52	North-West
7. Nizhum Dwip NP, Nowakhali	Mangrove Forest	16,325	River & Estuary
8. Medha Kochapia N P, Cox's Bazar	High Hill Mixed forest	396	Eastern Hills
9.Shatchari National Park, Hobiganj	Evergreen	243	Eastern Hills
Game Reserve			
1. Teknaf Game Reserve	High Hill Mixed forest	11,615	Eastern Hills
Eco-parks and Safari Park			
1. Madhabkunda EP, Moulavibazar	High Hill mixed forest	266	North-East
2. Sitakunda Botanical Garden & EP	High Hill Mixed forest	808	Eastern Hills
3. Dulahazara Safari Parks, Cox's Bazar	High Hill mixed forest	600	Eastern Hills
Ecologically Critical Areas (ECAs)			
1.Sundarbans East, West & South*	Mangrove Forest	7,62,034	South-West
2. Cox's Bazar-Tek-naf Sea Beach	Sandy Beach	10,465	Eastern Hills
3. St. Martin's Island	Coral Island	590	River & Estuary
4. Sonadia Island	Offshore Island	4,916	Eastern Hills

Name of protected areas	Habitat Types	Area (ha.)	Hydrological Region
5. Hakaluki Haor, Sylhet	Wetland	18,383	North-East
6. Tanguar Haor, Sylhet*	Wetland	9,727	North-East
7. Marjhat Haor, Jhinadh	Wetland	200	South-West
8. Gulshan-Baridhara Lake, Dhaka	Urban Wetland	-	North-Central

Source: *Sources: Forest Department & Dept of Environment*

Note: WS=Wildlife Sanctuary, NP= national Park, EP = Eco-park, * =also Designated as RAMSAR Site and World Heritage Site

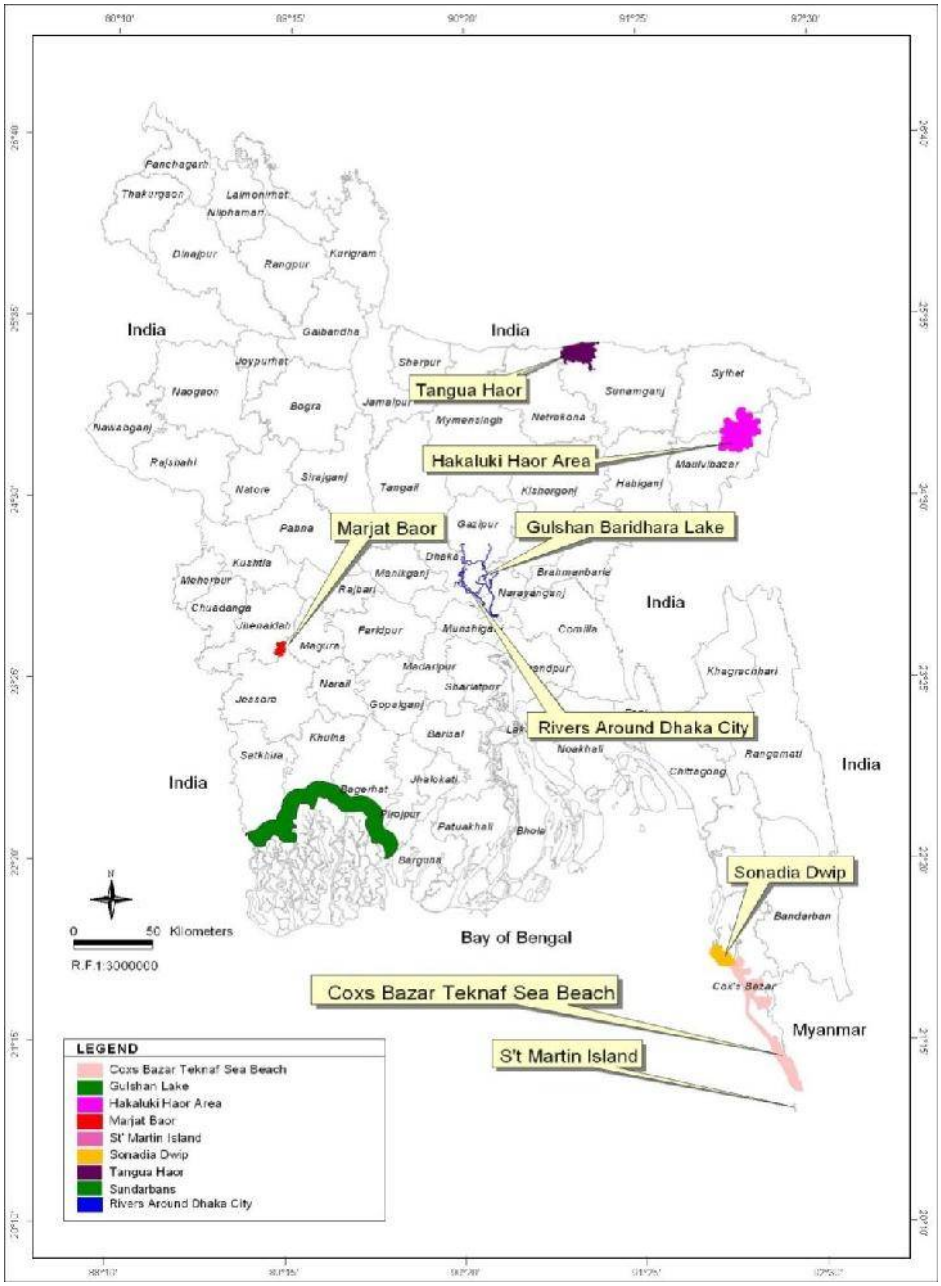

Figure 39 the Ecologically Critical Area (ECAs) of Bangladesh

8.1.3 Urban area

The area under urban and industrial, and rural is about 0.6% and 12.1%, respectively of the gross area of the country respectively. Identity is an important quality for people to be connected with the place they live. With identity different aspects play a role such as the preservation of cultural heritage, recognizable landmarks or urban fabric, the recognizable view when approaching a city from the distance, and natural features, In general, identification has to be done with an identifiable uniqueness of the city or settlement. This is often threatened by developers who would like to create the same buildings, shops and restaurants in every location. The most important tools for preservation of natural and urban or settlement characteristics are developing buildings, streets and open spaces fitting and enforcing the identity of the city.

8.2 Spatial and Physical Characteristics of Land Use for Urbanization

Land use management should act as a tool to keep reservations for future development and keep enough open space for water storage and flood plain management. The water areas can, provided the water quality will come to an acceptable level, serve as ecological and recreational areas within the city. Also, it can cool down air and mitigate the urban heat effect. The general principles of spatial planning are covered such as the density of cities, the mix of functions, open spaces, accessibility, identity and diversity.

Physical characteristics of spatial urbanization are green cities with open spaces, accessibility, concept of walkable cities, clustering destination, state programs and conservation casements. Open and green spaces are essential for bringing quality livability, sustainability and resilience into high density urban areas. The open spaces can contribute to urban drainage, urban heat mitigation, urban ecology and can function as recreational space. Good accessibility is essential both on the national scale as within cities. Plans for city form and mobility often go hand in hand. It is important that there are possibilities to work and use facilities in walking distance. Small building blocks and street grids are essential to be able to reach destination through an efficient route without going out of direction. All streets should have safe travelling possibilities for different modes of transport, including safe sidewalks for pedestrians. By clustering work destinations (as instance a campus, medical district, business district) the clusters can create enough support for public transport facilities for short daily commuting trips. Several states operate open-space preservation programmers, funded through real estate transfer taxes A conservation easement is an interest in real estate less than the complete bundle of land rights, the fee simple. It is a legally binding contract in which a landowner voluntarily restricts the rights to use and develop land. For example, a conservation easement may limit activities allowed on the land to open-space uses such as wildlife habitat and watershed protection.

Open space and diversity is important for recreational spaces, there should be different degrees of recreational space available at different distances. Play grounds should be available at a short walking distance. A city park at a moderate walking distance and it should be possible to reach a regional park within reasonable time by transit or car. Diversity is always an important feature for high appreciation quality of city. It is essential if there is a diversity of different neighborhoods with different identities. Those diversities can be in aspects such as densities, parcel sites, street profiles, views, building type and height, architectural differentiation and mixed functions, but also less tangible differences such as a variety of housing prices. Conserving old buildings and heritages is not only important for the identity of neighborhoods but also for the diversity within streets.

In designing streets there is often a hierarchy between different streets, from car corridors to local traffic streets to living neighbourhood streets and even pedestrian boulevards. The positioning of functions should correlate with the type of accessibility; for example, along a school there should be the capacity for cars to wait and children to exit the school by foot safely.

A common practice for land trusts is to purchase open space and sell it to local and state governments for parkland. Donors may use these gifts as charitable deductions for income tax purposes. Some land trusts actively acquire land rights to open space. A land trust may manage the open space on owns as a nature preserve with some public access for limited recreational and educational uses.

8.3 Conserving and Protecting Agricultural Land

Conservation agriculture (CA) can be defined by a statement given by the FAO (Food and Agricultural Organization) of the United Nations as "a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment" (FAO 2007). Agriculture is one of the most important sectors in the economies of the country. At the same time conservation is the use of resources in a manner that safely maintains and can be used by humans. Conservation has become critical on the fact that the population of Bangladesh has increased over the years and more food needs to be produced every year. Conservation land use management may be funded through conservation programs promulgated through agricultural legislation of farm budget. In Bangladesh, Agriculture annual budget may fulfill the requirement.

8.3.1 Key principles of conserving and protecting agricultural land

The FAO has determined conservation agriculture into three key principles that producers can proceed through in the process of conservation agriculture. The three principles are discussed below

Minimum mechanical soil disturbance

The first key principle in conservation agriculture is practicing minimum mechanical soil disturbance which is essential to maintaining nutrients in the soil, stopping erosion, and preventing water loss from occurring within the soil. In the past, agriculture has looked at soil tillage as a main process in the introduction of new crops to an area. People of Bangladesh would use traditional country plough. It was believed that tilling the soil would increase fertility within the soil through mineralization. Recently, it is known that the tilling of soil can cause severe erosion and crusting which will lead to a decrease in soil fertility. Today tillage is seen as a way as destroying organic matter that can be provided within the soil cover. Zero tillage farming can save soils organic levels for a longer period and still allow the soil to be productive for longer periods (FAO 2007). The process of tilling causes the time and labor for producing that crop. When zero-tillage practices are followed, the producer sees a reduction in production cost of crop. Tillage of the ground required more money due got fuel for tractors or feed for the animals pulling the plough. The producer sees a reduction in labor because labor does not have to be in the fields as long as a conventional farmer.

In Bangladesh, zero tillage practices being done especially in the fields of pulses, *tishi*, mustard, wheat (Ganga-Kobadak project), garlic, etc. In the low lying areas, like haor, baor, beels local Boro crops are being practiced under zero tillage. In many parts of the country, HYV Boro crops are also grown under zero tillage using residual/ residual stagnant water on the agricultural land.

Protecting Soil

The second key principle is dealing with protecting the soil. The principle of managing the top soil to create a permanent organic soil cover can allow for growth of organisms within the soil structure. This growth will break down the mulch that is left on the soil surface. The breaking down of the mulch would produce a high organic matter level which would act as a fertilizer for the soil surface. If the practices of conservation agriculture are being done for many years, a lot of organic matter is being built up at the surface, and then a layer of mulch would start to form. This layer prevents soil erosion from taking place and ruining the soils profile.

In the article "The role of conservation agriculture and sustainable agriculture" the layer of mulch that is built up over time will start to become like a buffer zone between soil and mulch. This situation will help to reduce wind and water erosion, and will protect surface soils when rain is falling to the ground. When soils are covered under a layer of mulch, the ground is protected so that the ground is not directly impacted by rainfall. This type of ground cover also helps to keep the temperature and moisture levels of the soil at a higher level rather than if it was tilled every year (FAO 2007). Cover crops are beneficial as to agricultural productivity through:

- Stabilize soil moisture and temperature
- Protect the soil during fallow periods
- Mobilize and recycle nutrients
- Improve the soil structure and break compacted layers and hard pans
- Permit a rotation in a monoculture
- Can be used to control weeds and pests
- Produce additional soil organic matter and improve soil structure

The practices of protecting soil are very limited in the Bangladesh Delta. Its impact should be known to the farmers through establishment of demonstration plots by the DAE officials.

Crop rotation

The third principle is the practice of crop rotation with more than two species. According to Hobbs et al.(2007) crop rotation can be used best as a disease control against other preferred crops. Rotational crops will act as a natural insecticide and herbicide against specific crops. Not allowing insects or weeds to establish a pattern will help to eliminate problems with yield reduction and infestations within fields (FAO 2007). Crop rotation can also help build up a soils infrastructure. Establishing crops in a rotation allows for an extensive buildup of rooting zones which will allow for better water infiltration, nutrients availability, improvement of soil physical parameters etc. (Hobbs et al. 2007).

The breakdown of organic molecules into available forms for plant such as phosphates, nitrates, etc. which can be absorbed by plants easily from soil extract. Ploughing influences the amount of oxygen in the soil to increase. Tilling operation helps the aerobic processes, hastening the breakdown of organic material. Thus, more nutrients are available for the next crop but, at the same time, the soil is depleted more quickly of its nutrient reserves.

8.3.2 Wild Nature conservation

The zero-tillage helps minimal mechanical soil disturbance. Zero-tillage also brings other benefits to the producer. According to the FAO, tillage is one of the most "energy consuming" processes that can be done: It takes a lot of labor, time, and fuel to till. Farmers can save 30% to 40% of time and labor by practicing the zero-till process. According to Green, et al. (2005), Farming and the Fate of Wild Nature are two more kinds of conservation agriculture. The practice of wildlife-friendly farming and land sparing are ideas for producers who are looking to be more conservative towards biodiversity.

Wildlife-friendly farming is a practice of setting aside land that will not be developed by the farmer. This land will be set so that biodiversity has a chance to establish itself in areas with agricultural fields. At the same time, the producer is attempting to lower the amount of fertilizer and pesticides application on the fields so that organisms and microbial activity have a chance to establish themselves in the soil and habitat (Green, et al. 2005). To create a habitat suitable for biodiversity, something has to be reduced, and as in this case for agriculture farmers, yields can be reduced. This is where the second idea of land sparing can be looked on as an alternative.

Land sparing emphasizes that the land is being used for agricultural purposes continue to produce food and products through increase in yield but other land can be set aside for conservation and production for biodiversity. Land in agriculture stays in production but would have to increase its yield potential to keep up with demand. Land that is not being put into agriculture would be used for conserving biodiversity (Green, et al. 2005).

Large farm size households of Bangladesh can practice land sparing separately to see the impact of both of the practices.

8.3.3 Benefits of conservation agriculture

In the field of conservation agriculture there are many benefits for the producer and conservationist. The conservationist, conservation agriculture can be seen as beneficial because there is an effort to conserve what people use every day. Since agriculture is one of the most destructive forces against biodiversity, conservation agriculture can change the way humans produce food and energy. These benefits include less erosion possibilities, better water conservation, improvement in air quality due to less emission being produced, and a change for larger biodiversity in a given area.

For the farmer, conservation agriculture can eventually do all that is done in conventional agriculture. It can conserve better than conventional agriculture. Farmers like it because it gives them a means of conserving, improving and making more efficient use of their natural resources (FAO 2006). The benefits of conservation agriculture will come later rather than sooner. Since conservation agriculture takes time to build up, enough organic matter and have soils become their own fertilizer, the process does not start to work over night. It will take time for satisfactory production. The conservation agriculture is shown to have even higher yields and higher outputs than conventional agriculture. The conservation agriculture has been established over long periods. The producer has the benefit of knowing that the soil in which crops are grown, is a renewable resource. According to New Standard Encyclopedia, soils are a renewable resource, which means that whatever is taken out of the soil can be put back over time (New Standard 1992). As long as good soil upkeep is done, the soil will continue to renew itself. This could be very beneficial to a producer who is practicing conservation agriculture and is looking to keep soils at a productive level for an extended time.

8.4 Conserving and Protecting Land in CHT

Soil erosion is one of the main constraints for agriculture development in the CHT. It causes rapid fertility depletion, damage crops by sedimentation, raise bed of stream/river/ channels by siltation. The siltation causes flash floods and restricts discharge capacity, irrigation and navigation. For these, soil conservation measures considered a major means for sustainable hill farming.

The common practices are to plant crops up and down the slopes which facilitate soil erosion in CHT due to onset of heavy rainfall. As a measure of conservation, plantation should be made along the counters. Topsoil removal may be reduced significantly if conservation measure like mulching could be adopted. The yield of maize, sesame, turmeric and ginger gave good yield of 3-4, 1-1.5, 20-30 ton/ha, respectively when cultivated under mulching condition. The experimental findings presented in Table 29 indicated that zero-tillage with surface mulch reduced soil erosion by about 3-6 times as compared to traditional method without mulch at 5-15% hill slope (Miah and Saheed, 1995).

Table 29 Effect of Tillage and Mulching on Soil Erosion in Hill Slope (5-15%)

Treatments	Dry weight eroded soil (t/ha)
Mulch	22.25b
No mulch	58.02a
Zero-tillage (dibble)	23.77c
Minimum tillage (furrow planting-conventional)	35.68b
Tillage(Spading)	61.13a
Zero-tillage+Mulch	13.12e
Zero-tillage+no Mulch	34.43c
Minimum tillage+ Mulch	20.12d
Minimum tillage + no Mulch	51.24b
Coventional tillage+Mulch	33.43c
Conventional tillage+no Mulch	**88.85a**

Souece: Miah and Saheed (1995)

Prospects for promoting soil conservation and watershed protection in CHT

The intensity of rainfall and varied topographical features cause different types of erosion and depletion of soil in the hilly region of CHT. The increase of population pushes landless farmers onto steeper, more fragile land, which is then cultivated more and more intensively. There are many cases in the hilly regions of Bangladesh where most part of the productive soils has been washed away from the slopes. For this, expensive reservoir like the Kaptai Lake and river beds has silted up rapidly through deposition of sediments. Recently, the impact of these processes on environmental degradation is being realized increasingly. Some research issues have been identified for the Chittagong Hill Tracts based on national conservation strategy in achieving management of natural resources in integrated way for sustainable development of agriculture (Rahman, 1991). The following issues need to be addressed:

- Semi-detailed land evaluation survey to identify areas suitable for field crops without terracing, field and tree crop on terraces and appropriate kind of terraces; forest plantation and watershed protection forest.
- Soil conservation through contour plantation, inter-cropping, use of cover crops and use of mulches to protect the soil surface and appropriate kinds of control structures.
- Identification of watershed area for reservation for the integrated development on agriculture and fisheries through land and water resources management.

Therefore, it is necessary to develop an integrated soil conservation and watershed management system for the Chittagong Hill Tracts to ensure a sustainable development in agriculture, forestry, horticulture, fisheries etc.

8.5 Future Development

The producers (farmers) and conservationist are always looking towards the future. In this case conservation agriculture is a very important process to be looked at for future generations to have a chance to produce. There are many organizations that have been created to help educate and inform producers and conservationist about conservation agriculture. These organizations can help to inform, conduct research and buy land in order to preserve animals and plants (New Standard 1992).

Secondly, conservation agriculture is looking to the future is through prevention. The farmers / producers are looking for ways to reduce leaching problems within their fields. These producers/farmers are using the same principles within conservation agriculture (CA).They are leaving cover over their fields in order to save fields from erosion and leaching of nutrients from land. This technique is not popular in Bangladesh. It needs further investigation.

Plant nutrients can be a vital part to conserving for the future for successful land resource management. The uses of animal manure, animal waste, food and urbanized waste are being looked towards as a way to use growth within CA (Kirchmann & Thorvaldsson 2000). Turning these products from waste to being used to grow crops and improve yields, is something that would be beneficial for conservationists and producers.

8.6 Sustainable Land Use System

The land use management efficiency in directly related with water resources. The improved land and water management practices should be aimed to increase crop yields through sustainable management of land resources. The productivity of degraded agricultural land can be restored and crop yields boosted if small holder farmers can be motivated to invest their labor and their limited financial resources in their land and water management practices. The following pathways may be considered to accelerate improved practices for sustainable land use management.

- Strengthen knowledge management systems and access to information.
- Increase communication and outreach in ways that amplify the voices of champions and leverage direct engagement with farmers.
- Support institutional and policy reforms, particularly for strengthening property rights through organization of CBOs.
- Support capacity building, particularly in community-based organizations (CBOs) management of natural resources through imparting training.
- Increase support for integrated landscape management especially irrigation and flood control and drainage projects.
- Reinforce economic incentives and private sector engagement.
- Mainstream investments in improved land and water management to catalyze adoption of these practices as a strategic component of food security and climate change adaptation programs.

8.7 Challenges of Conservation of Agriculture of Land Use Management

The conservation agriculture can benefit the country. But there are many problems for conservation of agriculture and for these reasons there cannot always be a win-win situation for conservation agriculture.

Firstly, there are not enough people who can financially turn from a conventional farmer to a conservationist. The process of conservation agriculture needs time; when a producer first starts to process as a conservationist, the results can be a financial loss to that certain producer. Since conservation agriculture is based upon establishing an organic layer and producing its own fertilizer, and to produce that layer, takes time. It may take time to see better yields than he/she has had previously experienced.

Secondly, financial undertaking is purchasing of new equipment. Conservation agriculture is a producer which may have to buy new planters or drills, combined harvester, thresher, dryer etc. in order to produce effectively, also comes with the responsibility of harvesting a crop. These financial tasks are ones that may impact whether or not a producer would want to conserve or not.

Thirdly, the conservation agriculture has not spread as widely as most conservationists would like. The reasons for this are because there is not enough pressure for producers in places to change their way of living to a more conservative outlook. In Bangladesh, there is pressure to change conservation areas because of the limited available resources. In Bangladesh, the ideas and principles of conservation agriculture give tittle attention as such still nothing much is being done to change practice, as there being not a minimal amount of motivation for people to change their ways of living (FAO 2006).

The conservation agriculture comes with the idea of producing enough food. With cutting back on fertilizer, not tilling of ground, and among other processes, come the responsibility of feeding the country. It is expected that the population would be round 220 million people by 2050. With this increase, the responsibility for producers comes to increase food supply with the same or even less amounts of land to do it. The conservation agriculture problems arise in the fact that if farms do not produce as much as produced through conventional ways, then this would leave Bangladesh with less food for more people.

8.8 Legislation for Sustainable Agricultural Productivity

The smallholder farmers are the key actors; many other entities and organizations have a role to play in implementing these strategies. Governments should create enabling agricultural development policies—as well as land tenure and forestry legislation that secure farmers' rights to their land and recognize their ownership of on-farm trees. Government should create enabling conditions for the private sector to invest in market-based approaches to strengthening agro-forestry value chains. The public and private sector of local communities, international partners and development assistance organizations can take these improved practices to scale up by investing in knowledge management, communication, and outreach, which will help restore agricultural productivity, enhance rural livelihoods, and contribute to a sustainable food future.

8.9 Improvement of Land Use Management Practices in Bangladesh

Thousands of farmers of Bangladesh are struggling to feed their families as they contend with land degradation, land use pressures, and climate change. Many smallholder farmers must deal with low and unpredictable crop yields and incomes, as well as chronic food insecurity. These challenges are particularly acute where land degradation, depleted soil fertility, water stress, and high costs for fertilizers contribute to low crop yields and associated poverty and hunger. Farmers and scientists have identified a wide range of land and water management practices that can address land degradation and increase long-term agricultural productivity. The benefits of these improved land and water management practices to farmers and rural economies, include higher crop yields, increased supplies of other valuable goods such as firewood and fodder, increased income and employment opportunities, and increased resilience to climate change. These benefits occur because these improved land and water management practices:

- Increase soil organic matter.
- Improve soil structure.
- Reduce soil erosion.
- Increase water filtration or permeability.
- Increase efficiency of water use
- Replenish soil nutrients
- Increase the efficiency of nutrient uptake.

There are four improved land and water management practices that can help smallholders boost crop yields and provide other benefits on individual farms. The sustaining agricultural productivity will require coordination between resource users situated in different parts of the larger landscape, including in non-farmed lands, wetlands, forests, and rangelands.

Integrated Landscape approaches bring sectors and stakeholders together to jointly plan, design, and manage their landscapes for improved agricultural production, ecosystem conservation, and sustainable livelihoods. In many cases, national policies and legislation do not provide sufficient incentives—such as secure land tenure and property rights-to stimulate farmers to invest in improved land and water management. Many smallholder farmers are not reached by extension agents at all. Agro-forestry, conservation agriculture, and other improved land and water management practices are insufficiently integrated in absence of extension activities. There is a vast potential to scale up the improved management of land and water resources as an integral component of agricultural development strategies in Bangladesh.

8.10 Coastal Land Management in Bangladesh

Bangladesh faces cyclones and storm surges regularly, which cause widespread damage to life and property. The shallow continental shelf and flat coastal land exacerbate the cyclonic storm surges. Surges usually exceed normal tide levels by three metres but in extreme cases, can be as high as six to nine metres. Recurring storm surges are of greater societal concern than an occasional tsunami (Mascarenhas, 2006). Land accretion and land erosion on the coast generate socio-economic anomalies and issues. Erosion leads to the displacement of people, land capture and

illegal settlement are prevalent in areas where the coast is accreting. Protection from recurring storm surges is an important issue in coastal land management.

A number of changes incorporated into the final Coastal Management Plan (updated on14/04/2014). These included:

- which government and non-government bodies can use it
- types of management activities
- land tenure it applies to.

Applied by:	Applied to:	Applied on:
Managers of local government-controlled coastal land; for example local government	Management planning	Government coastal land and other land tenures that include coastal resources.
Natural resource management bodies;	Decisions and works that are not regulated under the SPA; for example, development of a local government shoreline erosion management plan.	
Research organizations		
Businesses		
Individuals that own coastal land		
Community groups	Management activities	

- Rewording of the Foreword and Introduction sections to clarify that the Coastal Management Plan is non-regulatory, and that the policies contained in the plan provide best practice coastal management guidance only.
- Update to the Introduction section and Policy context notes to identify the other legislation and instruments related to dealing with coastal development and related matters.
- Addressing policy duplication by removing guidance for tenure decisions and environmental offset requirements for nature conservation policies and tenure decisions.

8.10.1 Reasons for coastal land management

Natural disasters have direct and indirect impacts on land resources and their use. Coastal land uses comprise agriculture, shrimp and fish farming, forestry, urban development and other settlement needs. There is demand for expansion of all current land use, while the need for new exploitation is also emerging. Moreover, land is being degraded or lost due to the effects of increased salinization, flooding and erosion. Since the 1960s, measures to address these problems have been polderization, land reclamation and coastal afforestation. New land is being generated through accretion. Newly emerging lands are being captured by local power-brokers and the government's land allocation programme has been implemented slowly. The coastal land management is needed for following reasons:

- The coast of Bangladesh is prone to natural hazards like cyclone, storm surge, and flood. The combination of natural and man-made hazards , such as erosion, high arsenic content in ground water, water logging, earthquake, water salinity etc.
- Local communities have been haphazardly utilizing these resources, resulting in complete destruction of some of them (e.g. Chakaria Sundarban mangrove forest), some being over-utilized (e.g. coastal shrimp farming, natural fish stock) while some other resources remain under-utilized (e.g. mollusces, seaweeds).
- Increasing population, competition for limited resources, natural and, man-made hazards, lack of economic opportunities, important ecological hot spots, etc. calls for distinctive coastal management.

To explore the coast site, the following issues may be considered:

Licenses and permits

- Environmentally relevant activities - Prescribed
- Mining resource activities
- Resource activities including petroleum, geothermal and greenhouse gas storage
- Development application process
- Coastal development
- Contaminated land
- Heritage places
- Plants and animals
- Waste management

Management regulation

Contaminated land

- Environmental impact assessment
- Environmentally relevant activities - Prescribed
- Air and Water quality and ecosystem health quality
- Compliance and enforcement
- Green tape Reduction
- Incidents and disaster recovery
- Mining resource activities
- Natural resource management
- Planning and guidelines
- Public performance reports
- Resource activities including petroleum, geothermal and greenhouse gas storage
- State of the environment
- Waste
- World Heritage Area management review.

Monitoring

- Coal dust management
- Storm tide
- Air quality monitoring
- Water quality
- Wave
- Wetlands

8.10.2 Stabilization and protection of new accreted or char lands

Bangladesh has used coastal afforestation and polderization to stabilize and protect newly accreted lands from tidal and storm surges.

Coastal green belt

Dense forests can attenuate wave velocity (Mascarenhas, 2006). In 1966, the Forest Department began a mangrove plantation programme outside the protective coastal embankments in order to better protect life in coastal areas from cyclones and tidal surges. The Coastal Afforestation Scheme operated from 1966 to 1974, during which time 4,745 hectares of plantations were established. Encouraged by its initial success, the project was extended to 1980. and another 29,700 hectares of plantations were raised. All these plantations were concentrated on the offshore islands and new accretions. The afforestation species raised were keora (Sonneretia apetala), baen (Avicennia officinalis), kankra (Bruguiera gymnorrhiza), golpata (Nypa fruticans) and gewa (Excoecaria agallocha).

Of late, the coastal green belt has been undergoing indiscriminate destruction and encroachment. Power-brokers with links to local politicians have taken the lead in clearing the forests. The administrative machinery is powerless to stop the clearing. A programme of participatory mangrove plantation involving nearby coastal communities, which has proved successful in other countries, could be a sustainable mechanism to protect mangrove forests. This mechanism is being actively considered within the Forest Department. Recently, lands are reclaimed through construction of embankment at Undarchar which was developed by plantation of green belt in Patuakhali district.

Polders

Polders are mainly designed to provide protection against tidal intrusion with the main objective of increasing agricultural production; however, they also provide protection against floods and storm surges. Polders are now part of the natural setting of coastal Bangladesh. A sudden increase in the construction of embankments took place after 1960. The initiative, called the Coastal Embankment Project (CEP), involved the construction of some 5,107 kilometres of embankments to form 123 polders and protect an area of 1.5 million hectares. It has been estimated that 957 kilometres are sea dykes. These dykes are being used for the protection from tidal surge. Sea dykes are perceived to provide protection against storm surges and anticipated sea-level rises due to climate change. Drainage in these polders is provided at low tide by means of flap gates mounted in sluice structures, usually located where natural drainage channels (khals) cross the embankment alignments. The objective to increase agricultural productivity was achieved with great success for the first ten upto 1980s, until drainage congestion became serious in some areas. As a result, the Coastal Embankment Rehabilitation Project started to incorporate elements of internal water management, land use inside the polder, and social use of the embankment and foreshore.

Despite criticisms over drainage problems, the polders have resulted in higher agricultural returns by excluding saline tidal flooding. Communications have also improved. Polderization has contributed considerably to altered and new land use in coastal Bangladesh. Provision should be made in future that the sea dyke/ polder should be high enough that the sea level rise would not be affected. Desiltation technique on river or khals needs to be developed by TRM and other suitable way.

Coastal land resources development strategy

The coast of Bangladesh and marine zone are especially rich in diverse natural resources. The challenge is that the resources of the coastal zone will have to be managed in a manner that will not only ensure their sustainability but will also secure access to the poor for meeting their livelihood requirements. The strategies to mitigate the challenge are estuary and coastal ecosystem management, coastal land zoning, integrated management of coastal water infrastructures, socially and environmental responsive shrimp farming, and marine and development of coastal environment. The following strategies should also be considered for coastal land development:

- Ensuring availability of fresh and safe water ;
- Safety from man-made and natural hazards;
- Improving livelihood conditions of people, especially women;
- Environmental conservation;
- Empowerment through knowledge management
- Optimizing use of coastal lands;
- Promoting economic growth emphasizing rural non-farm employment;
- Sustainable and equitable management of natural resources;
- Creating an enabling institutional environment.
- Disaster preparedness, among others, should include: Construction of cyclone shelters and effective warning mechanisms.

Optimizing use of coastal lands

Land use in the coast is diverse, competitive and often conflicting. Erosion of land is a common feature, especially in the Meghna estuary and on islands. Land is also degrading due to increased salinity and water logging. Moreover, new lands are accreting and gradually, being developed. Acceleration of land accretion process and optimum use of these coastal lands would significantly contribute to the regional economy and well-being of the local people. Land zoning is one instrument that optimizes the use of coastal lands. The coastal zone may be utilized through

identification of zones such as agriculture; shrimp (brackish water); shrimp (sweet water); salt – shrimp; forest; mangrove; tourism zones; industrialization, urban settlements, etc.

In Bangladesh, there are about 2.83 million ha of coastal area of which 1. 0 m ha lands are affected by different levels of soil salinity (Karim et al., 1982).These soils are mostly mono-cropped with rice with poor yield during rainy season. The cultivation of winter crops is very limited due to the accumulation of salts in the surface soil and lack of fresh water irrigation during dry season. Many workers studied in saline soils and brackish water with rice and non-rice dry land crops using different technologies. There are many research findings which indicated encouraging results. A number of crop production technologies have been developed in the Benerpoda Salinity Research Station, Bangladesh Water Development Board (BWDB). Satkhira. Salt tolerant limit of different rice cultivars have been evaluated in Boro season and found variation in salt tolerant limit among the cultivars tested (Aich et al., 2000). Use of soil amendments for improving rice yield in dry season under sub-surface drainage in saline soil irrigated with brackish water has been found very positive results in respect of crop yield and reclamation of soil salinity (Aich et. al., 1998). Dry land crops such as wheat, barley, millet and cheena can be practiced in saline soils having soil salinity (ECe) 10.8, 10.2, 9.4 and 9.4 dS/m, respectively, in dry Rabi season having expected yield reduction of 50% (Aich et. al., 1993). Most of the Rabi crops are sown from mid-November to mid-December. In coastal area, the soil salinity generally, remained much below than those levels of salinity during crop growing period. Accumulation of salt in the soil under brackish water shrimp-cum-paddy culture is likely to adversely affect the paddy cultivation to a considerable extent if proper precaution is not exercised for removal of salts due to onset of monsoon rainfall (Aich et. al., 1994). Aich et. al., (1996) reported that the application of NPK fertilizers in presence of FYM, increased the availability of plant nutrients and improved the soil's physical environment, resulting into higher yield of rice in salt affected soils.

Recently, Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) are working at Benerpota Regional Station, Satkhira to develop salt tolerant crop cultivars for the cultivation in the coastal region. Some crop cultivars such as BRRI dhan 28, BRRIdhan47, BRRIdhan55 and BINA dhan 7. have been claimed to be effective for the cultivation in saline soils. Besides, BRRI dhan 40, BBRIdhan 41, have been developed. Achievable yield at farmers' fields is 4.0 –5.5 t ha-1. Salt tolerant rice varieties for Boro season (November-March) are: BRRIdhan 47 can tolerate EC 12 dS /m at seedling stage and 8 – 10 at maturity stage with 6.5 t/ha yield potentiality. BINAdhan 8 can tolerate EC 8-10dS/m at maturity stage with 6.0 t/ha yield potentiality. The scientists of these research institutes are performing research programmes to develop salt tolerant, short duration cultivars of rice, and salt and heat tolerant cultivars of Rabi crops for management of coastal lands effectively.

8.10.3 Response of crops to fertilizers in Bangladesh

Response of fertilizers added to corps depends on soil-crop-climate variables and production practices. A positive response is only expected if nutrient supplying capacity of a soil falls short of the nutrient demand of a crop under a particular set of conditions. Fertilizer applied to the soils for crop production behaves differently in the soil-plant-system. Zinc and shulphur have considerable residual effect and only a fraction of the total applied amount is recovered by a single crop. In this case, application of fertilizer in full dose at each crop will not be economical (BARC, 2012, and BARI, 2012).

For judicious and effective fertilizer management, Rabi season crops should be considered as the first crop of the cropping pattern and will receive all type of necessary fertilizer nutrients. In the subsequent crops of the patterns, the fertilizer dose is to be reduced.. Nitrogen is unstable and leaves very little or no residues in soil. Nitrogen fertilizer dose may be reduced by 25-30 Kg /ha provided 12-15 tons green manure (dhanchia) can be incorporated and following grain legumes, dose of N may be reduced by 8-10 kg/ha. Phosphorus recovery is usually very low (15-25%) and has considerable residual effect. Generally, K supplying ability of light textured soil is low, but K requirement of crops, particularly rice and tubers crops are high. About 25% of K can be reduced with subsequent crops after potato,

tobacco, sugarcane, vegetables and spices where high doses K fertilizer are generally used. Potassium application should be considered as maintenance dose. Sulphur availability is high under upland culture and low under wetland rice culture and has substantial residual effect. Sulphur release from soil organic matter is higher in Kharif season due to high temperature. Zinc availability is low due to intensive cultivation of wet land rice. About 5-10% of the added Zn is recovered by a single crop. Zinc fertilizer recommended only once for every fourth crop. When rice is grown under irrigated condition in a cropping pattern following a properly fertilized Rabi crops, then the application of P and S can be reduced by 50-60%. If organic matter like compost cow dung, FYM, compost etc. (except GM), is used in the cultivation of field crops, appreciable quantity of fertilizer nutrients can be reduced from the recommended rates.

8.11 Urban, Rural Settlements and Industrializations

The expansion of rapid urbanization, rural settlements and industrializations leads to many issues in relation to land use management which create the liability of cities as well as reduction of crop land in the rural areas. Climate change and rapid urbanization are increasing pressures on the cities. Informal expansion of slums and further engraves the already dire living conditions, striking the marginalized population (landless households, the unemployed, and women) the hardest. The ill-equipped urban governance and planning system will face enormous challenges to sustainable guide in the growing cities towards 2100. This is very serious threat to proper land use management.

A spatial planning mechanism in relation to urban land use policies, land use zoning, land use management systems that relate to the development of urban and rural settlements themselves (regional/township planning) as well as the development of cities, rural, as well as industrial areas, among themselves, need to be addressed for the interest of proper land use management (described earlier in Chapter 6/ sections 6.3.1 & 6.3.2)

8.12 Strategy Development

Strategy would be developed with the collective vision of stakeholders based on insights from baseline studies, joint fact finding as well as on professional knowledge and experience on land resources management. Key strategic elements include land zoning, prevention of soil and land loss through improved agronomic practices and river training works, land reclamation in the coast, restoration of soil fertility, and checking salinity intrusion in the coastal region and desertification, especially in the northwest region. It might be started with a number of building blocks for the Bangladesh Delta vision. BDP 2100 comprises a long term (50 to 100 year), integrated and holistic vision and strategy, to improve safe living and sound economic development in the Bangladesh Delta, taking climate change into account for proper land resources management in various aspects. Being an indicative plan, the Bangladesh Delta Plan 2100 (BDP 2100) would interact with sectoral plans, absorbing input, as well as providing coordination and a long term perspective, strategy and plan. The Five Year planning cycle forms an important element in the planning context. BDP 2100 would deliver input to this cycle, starting with input for the 7th Five Year Plan. Therefore, a tentative vision, together with stakeholders, would be developed at an early stage of the BDP 2100 planning process as state earlier in this paragraph.

The challenges of natural disasters and climate change impact should be focused in the strategy. The strategies elements in this regard include rehabilitation and climate proofing of coastal polders with special focus on removal of water logging, disaster risk reduction, mainstreaming disaster risk reduction and climate change, coastal char land aforestation, development of climate stress tolerant crop varieties, and proper utilization of climate change funds in suitable places.

8.13 Development Possibilities

The tasks of development possibility require a lot of creative thinking. These have to be done through interactions between experts and stakeholders in brainstorm sessions through proper land resources management. Land-use planning is "the systematic assessment of land and water potential, alternative patterns of land use and other

physical, social and economic conditions, for the purpose of selecting and adopting land-use options which are most beneficial to land users without degrading the resources or the environment, together with the selection of measures most likely to encourage such land uses" (FAO, 1999).

A delta vision, scenarios and flexible strategies would be developed with multiple purposes for future development. The climate and socio-economic changes would be uncertain in future and prediction of such uncertainties with certain figures, is a great challenge. Future adaptive strategies and creating an informed science-policy interface would be developed on the basis of information of the baselinev study. It might be easier to anticipate for future developments and to take into account uncertainties, thus, allowing policy makers to take informed decisions about an uncertain future and linking it to ongoing sectoral policy processes and important investments.

Emphasis on adequate governance is important for implementation. The involvement of ministries/agencies/ NGOs as well various department in the relevant planning, institutional and stakeholder need to be ensured for BDP 2100. The development of common understanding, procedures, methods or approaches of institutional should be strengthened through capacity building by human development. The relationship between national, regional, as well as local planning, would require attention to gain commitment but also to align strategies and plans. Some ideas have been identified for starting the discussion with stakeholders and experienced professional, for formulation of development plans. . Detailed development plan will be formulated as per format presented in *Appendix B*.

8.14 Linkage and Common Issues with other Baseline Studies

Land resources management is closely related with (i) land development, (ii) land utilization, and (iii) land management. Linkage of land resources with other thematic studies are shown in Figure 40.

8.14.1 Land Development

For coastal land development, the main focus will be accreted land and coastal land development. Land development has to be linked with the themes of River systems management (Thematic 1). This thematic study would work for land development through river systems management with emphasis on geographical and geological setting of Bangladesh, history of the delta development process, historical hydro-morphological changes of the Delta, changing river morphology, sedimentation, subsidence, river and coastal erosion and accretion processes, river course shifting, and, importantly, transboundary cooperation opportunities. Forest and bio-diversity (Thematic 10) would take participation for land development through forest ecosystems, mangrove forest ecosystem, coastal green belt, biodiversity, forest management, choices of plants for afforestation by agro-ecological zones, etc. Both of these thematic studies would help in the development of the land resources.

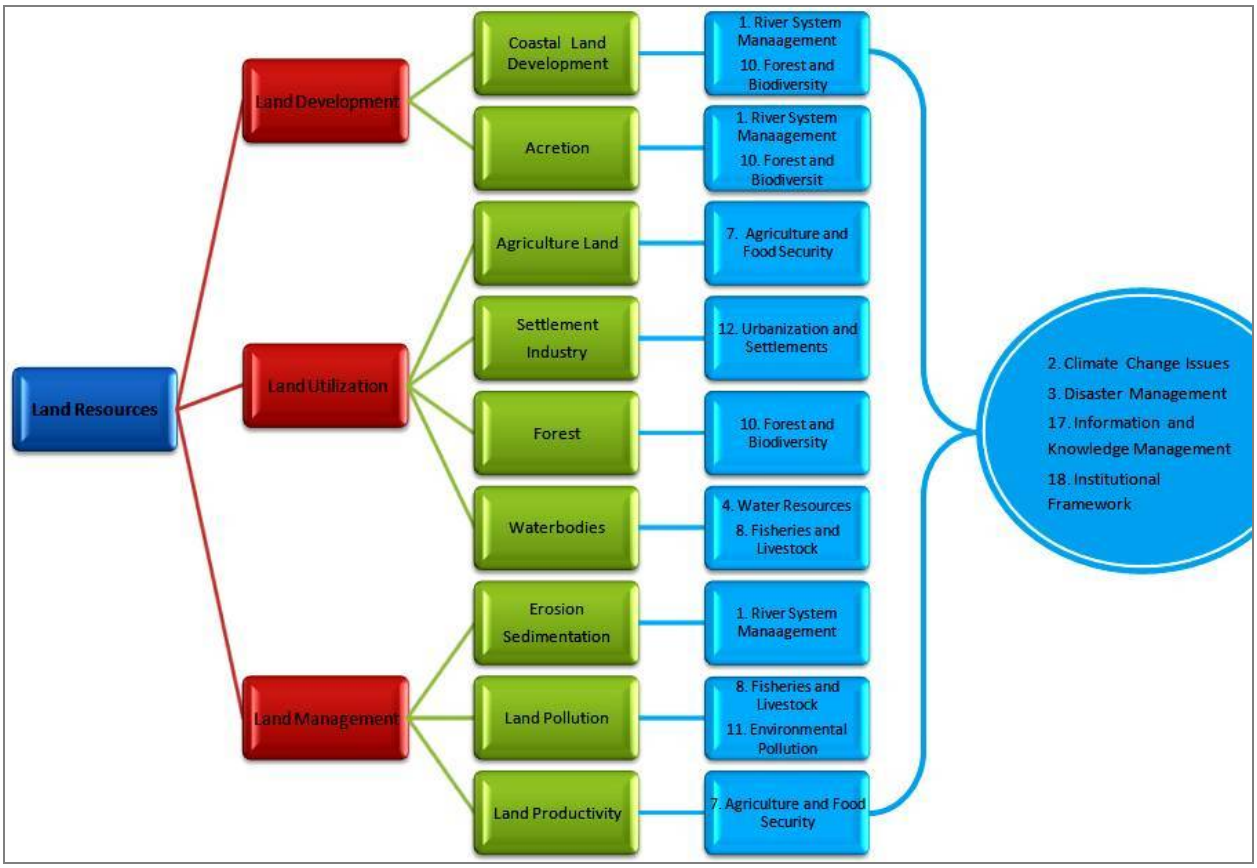

Figure 40 Linkage of land resources with other thematic studies of BDP2100

8.14.2 Land Utilization

The utilization of land includes agricultural and non-agricultural lands. The agricultural lands include crop land, forest, mangrove forest, water bodies (aquaculture, lake, beel/haor, river, etc.), tea estate, saltpan etc).. Non-agricultural land use includes settlements both urban and rural and industrialization. The land utilization is linked with themes of agriculture and food security (Thematic No 7). The proper agriculture practices and agricultural production depends on proper utilization of agriculture land use planning.

Urbanization and settlements (Thematic No 12) is connected with land utilization. This thematic study links with land resources through spatial planning mechanism utilizing land use policies, land use zoning, urban and rural settlements, land use management system, and growth of rural township.

The thematic study on Forest and biodiversity (Thematic No 10) is also linked to land utilization through forest ecosystems, mangrove forest ecosystem, coastal green belt, biodiversity, forest management, and choices of plants for afforestation by agro-ecological zone.

Land utilization is linked with the water bodies (aquaculture, lake, beel/haor, river, etc) which include water resources (thematic No 4) and fisheries and livestock (thematic No 8). These activities have direct relation with the thematic study of water resources (Thematic No 4) through aquaculture, lake, beel/haor, river, etc utilization of surface water and groundwater water, river and estuary management, char land development, use of trans-boundary rivers, water logging and dry season irrigation management both in monsoon and dry seasons.

The fisheries and livestock are linked with land utilization in respect of practices of fisheries and livestock production, land use planning for fish and livestock.

8.14.3 Land Management

Land resources management is directly linked with erosion of sedimentation, land pollution and land productivity. Land resources management is linked with erosion and sedimentation management through river system management (Thematic 1). This is linked with land resources management on river systems management with emphasis on geographical and geological setting of Bangladesh, history of the Delta development process, history of hydro-morphological changes of the Delta, changing river morphology, sedimentation, subsidence, river and coastal erosion and accretion processes, river course shifting.

Land resources management is also linked with land pollution which is connected with fisheries and livestock (Thematic No 8) and environmental pollution (Thematic No 11). The thematic study of fisheries and livestock have focus on practices of fisheries and livestock production, and land use planning for fish and livestock. Land may be polluted due to industrial effluents contaminated with heavy metals, and arsenic with irrigated water. It leads to loss of the forest cover on earth which might affect rain fall. Land pollution may be reduced by introducing organic farming; producing organic food; disposing garbage properly; separation of garbage materials by types before disposal; encourage recycling of recyclable products, and restricting use of herbicides and pesticides, and irrigation with pollutated free water. Agriculture and food security (Thematic No 7) is directly linked with the proper management of land resources. This thematic study has linkage with land resources management for agriculture practices, agricultural production, agriculture land use planning, and scope of agro-ecological planning. The knowledge of land or crop suitability may help in this regard.

The Themes of Climate Change Issues (Thematic 2), Disaster Management (Thematic No 3), Information and Knowledge Management (Thematic 17) and Institutional Framework (Thematic No 18) are also linked with the land resources in respect of land development, land utilization and land management.

8.15 Consequences and Tipping Points

The point at which the system can move away from one stable state toward another, is called a 'tipping point' (or threshold). On the other hand, the term tipping point refers to the point at which "the forces that create stability are overcome by the forces that create instability". A number of key concerns are needed for consideration in view of the changes due to the drivers described earlier for a long term perspective. However, a projection is needed which has to be done within a period of time with-multi-discipline team consisting of land use planner, urbanization developer, agriculture, socio-economic, morphologists and other relevant experts. These need to be validated through public consultations and national workshop.

8.15.1 Reduction of agricultural land

Land scarcity and ensuring wise use of land is the major challenge of Bangladesh. Agricultural land included cropland, forest, mangrove forest, river, lake (Kaptai), beel and haor, tea estate and salt pan. The area under agricultural land was 133, 03,654 ha which was about 91.83% of the country in 1976. This agricultural land has decreased to 127, 42,274 ha with the annual loss of 23,391 ha by 2000. The loss reached to 121, 76,904 ha in 2010 with annual loss of 56,537 ha. The annual loss of agricultural land during the study period (1976-2010) was 33,140 ha. This indicates that the availability of agricultural land was in decreasing trend being much faster during the period from 2000 to 2010. The percentages of the total land mass area lost annually from agricultural land are 0.172, 0.244 and 0.416 during 1976-2000, 1976-2010 and 2000-2010 respectively. The area of agricultural land which would be made available for food production is really a 'Tipping

It is apprehended that the availability of agricultural land would decrease significantly by 2050 and 2100. This would create serious problem in food security in future. The area of tipping point needs to be estimated for agricultural land. For this, projection is needed and have to be done in period of time with-multi-discipline team consisting of land use planner, urbanization developer, agriculture, socio-economic and morphologists. Based on the developing of the rationale and multi-discipline teams and appropriate model could be developed for 2100.

8.15.2 Water logging problem in future

Water logging is creating problem in the southwest region. In water logged area, dewatering is necessary for cultivation even in dry season. Some areas of Satkhira and Khulna which are water logged, water is being removed by using LLPs for cultivation of Boro crops. In future, the water logging areas might increase due to siltation, as well as, sea level rise. This is also a 'Tipping point'. The probable areas of tipping point need to be identified. Tidal River Management (TRM) may be adopted in the low lying areas where river is active and the tidal river water has to carry sufficient sediments. The sediments will deposit in the low lying areas/ beel areas and the land type would be improved. This situation would be very favourable for land resources management.

8.15.3 Sea level rise: land loss or land gain

Land loss due to sea level rise for induced climate change might compensate by building with nature. It is conceived that the Bangladesh Delta could still be growing toward sea. This might depend on the availability of enough sediment. Land loss may be supplemented by accretion of new land formation through land reclamation, cross dams, building with nature, construction of closure where feasible, and stabilization of newly accreted land through protection of mangrove/ vegetation and poldering.

8.15.4 Intrusion of salinity major problem in future

In the south-western region, water and soil salinity is very severe problem in respect of crop production and fresh water fisheries. Soil and water salinity generally increases with dryness and reaches maximum in the month of April and May and then tend to decrease due to onset of monsoon rainfall. It is expected that the sea level rise is likely to impact significant changes in coastal river water salinity in this one area of Bangladesh by 2050, which might significantly reduce availability of drinking water in the coastal urban areas, increase scarcity of water for irrigation for dry-season agriculture, and bring significant changes in the coastal aquatic ecosystems (IWM, 2014). In addition, increase in salinity is expected to change the mangrove pattern of Sundarbans. The reduction of upstream flow of fresh water from the Ganges has already created a 'Tipping point' for the areas of the southwestern region.

Salinity may thus become the biggest problem in the coastal zone for the next 50 to 100 years which might seriously affect land resources management. This indicates that a comprehensive approach needs to be planned to increase water supply through other ways along with river flow. This may be possible by i) water storage; ii) sustainable use of groundwater through active groundwater recharge in monsoon season; iii) practices of salt tolerant crop cultivars; iv) Construction of the Ganges Barrage, and, v) rain water harvesting...

8.15.5 Lack of sound O&M in FCD/FCDI

Operation and maintenance of flood control and drainage (FCD) and flood control, drainage and irrigation (FCDI) projects, especially the coastal embankments and other water infrastructure, is not functioning well [Ref?]. A sustainable cost recovery mechanism should be developed for monitoring, operation and maintenance of the embankments, FCD/FCDI projects. These might improve the land use situation.

8.15.6 Land reduction for rural settlement

Population growth threatens to reduce agricultural land. Area under rural settlement was estimated to be 8, 85,637 ha in 1976 occupying 6.11% of the total area of the country. Rural settlement area consistently increased over time at a greater rate and become 10.03% in 2000 and 12.12% in 2010. The annual rates of increasing rural settlement area were 0.163% and 0.208 % during 1976-2000 and 2000-2010, respectively. The overall annual rate of increase in rural settlement was 0.177% during 1976-2010. It is revealed that rapid growth of rural settlement is the main driver of the declining agricultural land, especially crop land. It is expected that in 2050 and 2100, a significant area of crop land might get reduced to accommodate increasing rural settlements. This space which would be available for rural settlements is a 'Tipping Point'.

8.15.7 Land reduction for urban and industrial area

The country is going to witness a rapid spread of urbanization over the next decade. There is significant increase in urban and industrial areas of the country during the period from 1976 to 2010. The total urban and industrial area was 26,799 ha in 1976 that expanded to 47,495 ha in 2000 and dramatically increased to 87,616 ha in 2010. The annual rate of increase was also higher (0.027%) during 2000- 2010, than that of 1976 to 2000 (0.006%). The overall annual rate of increasing urban and industrial area was 0.012% of the total area of Bangladesh. It is gleaned that a significant area would be used for urban and industrial area within 2050 and 2100. It would be very difficult to accommodate land for urban and industrial in future. The selection of additional land for urban and industrial area is 'a Tipping Point'. This situation might create problem for land resources management. Spatial mechanization should be developed so that the minimum land should be used for accommodating maximum population.

8.15.8 Soil fertility depletion

Soil fertility is very essential for good crop yield. Soil fertility has decreased due to intensive land use without appropriate soil management. The situation has worsend in those areas where HYV crop cultivars are being practiced using imbalanced inorganic fertilizers having no or insignificant application of organic matter. Recently, it is noticed that six nutrient elements (N, P, K, S, Zn and B) are commonly deficit in soils of Bangladesh. This would result in low crop yield. Restoration of soil fertility repleted with nutrients to meet the additional food requirement through proper application of organic or inorganic matter for reasonable good yield is the 'Tipping Point'. Therefore, optimum levels of fertilizer requirement need to be evaluated through research on various crops under different management practices to increase efficiency of land use management.

9 Future Vision (2100) for Land Resource Management in Bangladesh

9.1 Summary of Major Findings

In Bangladesh, about 83.5% of land is covered with agriculture related land use and the rest 14.5% is used under non-agricultural land of the Bangladesh Delta. [Repetitions of details taken out]

The main constraints of land resources management are flood (flash flood, river/monsoon flood, rain flood), drainage congestion/ water logging, drought, coastal/tidal surge, soil salinity, river bank erosion, land degradation, soil erosion, soil fertility depletion, decrease of land productivity, siltation on river bed and khals, rise of sea water due to climate change, increase of population, urban and rural settlements, decrease of crop land, and problem of farm mechanization. Socio-economic growth and political development is constrained by increased population growth, natural calamities and environmental problems, political instability, inequality, and corruption.

Major challenges of land resources management is land scarcity and ensuring wise use of land. Soil degradation due to over-exploitation is another major challenge to sustainable agricultural. The current population dynamics are affecting human development. The key challenges are (i) Food security and shelters; (ii) Optimize land use;(iii) Restore soil health;(iv) Increase land area of the country along the rivers and coast;(v) Meet the increase demand of food for increased population,(vi) Extreme challenge for infrastructures (e.g., schools, hospitals, urban and rural settlements, industries, roads), resources (e.g., food, water, soils, electricity), and jobs, as such crop land would reduce; (vii) Reducing conflicts in coastal land use; (viii) Integrated management of coastal and hilly land resources; (ix) Conversion of potential agricultural land to brackish water shrimp culture; (x) Recover organic matter content in agricultural land which is declining; (xi) Climate change would affect on land degradation and sea level rise which would enhance land loss, salinity intrusion and migration/adaption of settlements.

Lands are mainly used for agricultural and non-agricultural aspect. Agricultural land included cropland, forest, mangrove forest, river, lake Kaptai), beel and haor, tea estate and salt pan. Non-agricultural land included rural settlement, urban and industrial area and accreted land. The findings indicated that the land use pattern is

continuously changing, while the suitability of land is also changing. The use of agricultural land as estimated in this study was 91.8%, 87.7% and 83.5% of the total area of the country in 1976, 2000 and 2010 respectively while the use of non-agricultural land as estimated in same study was 8.2%, 12.3% and 16.5% of the total area in 1976, 2000 and 2010 respectively. These findings indicated that the area of agricultural lands are decreasing trend while the urban industrial and rural settlements are gradually increasing. This scenario might create adverse impact on food security and settlements in future.

Erosion of land is a common feature, especially in the Meghna estuary and on the islands. Land is also degrading due to increased salinity and water logging. Moreover, new lands are accreting and being gradually developed

In CHT areas, it is observed that the maximum area (44.9%) was covered with medium dense forest in 2003 which was reduced to 17.4% in 2008. Similarly, the area of dense forest was about 15.2% in 2003 which declined to 5.9% in 2008. On the other hand, low dense forest, herbs/shrubs grass and fallow/agriculture land increased in 2008 than that of 2003. The area of water bodies including river, chhara etc. more or less remained unchanged.

The existing policies/strategy documents/ plans relevant to land resources in Bangladesh have been reviewed. Some of the gaps of the land use policies are regional level plan and policies are mostly absent, National level policies and local level plans are prepared as a consequence there is lack of integration and coherence among different levels of plan in the country. In the land use policy, there is scope to ensure best utilization of land through "land zoning" for agriculture, marketing, settlements, etc. through modern technology, but practically these are not implemented. In land management, corruption is rampant in survey, settlement.. So, settlement lands are not properly distributed to the landless people. Policy regarding settlement of land is not properly exercised. There are many gaps in policies and plans which are described in relevant sections of Chapter 3.

Techniques and key principles of conservation and protecting agricultural land, wetland and productive land and its management have been evaluated. The coastal zone, haor areas, Barind Tract (drought prone areas), major rivers and adjoining areas, urban areas, and Chittagong Hill Tracts and its strategy have also been elaborately cited in the report. Benefit of conserving agricultural land uses management system and improvement of land use management has been described. Research findings and research need for land use management have been evaluated especially in hotspot areas (coastal zone, haor areas, drought prone area, and flash flood).

Institutional framework and legal aspects have been have been reviewed and its gaps have been identified for its improvement. The existing process of land administration has been found problematic in land management including lack of coordination and efficiency in the system. It has been estimated that about 80 % of court cases in the rural areas are related to land-conflicts. The current system is often viewed by stakeholders as time-consuming and costly, as well as a cause for potential land disputes. Digitization of land record is one of the solutions to minimize disaggregation/disintegration problem of the current system. Therefore, the ultimate objective should be to develop an integrated Land Information System (LIS) through land survey and land record keeping system. Property inheritance rights need to be established considering equality of women and men, and for establishing women's rights.

The proper strategic plan would identify to provide a direction to investigate for possible ways and means in the land resources sector- the backbone of the country's economy for the growing population without disturbing and degrading environmental and ecological security. Strategies have been developed on the crop sector, land management for forestry, land zoning, reducing soil and land loss, restoring soil fertility, land reclamation in the coast, prevention of salinity intrusion and desertification, integrated management of coastal water infrastructures, climate change on agriculture, climate change adaptation ,water management, gender, and anti-corruption strategy etc.

On the basis of Delta vision, strategy has been developed based on the possible interventions with the flexibilities (enabling to address different scenario) to achieve the formulated goals. Keeping the Delta vision in consideration and reviewing the Delta goals and targets, and considering challenges and constraints on different hotspot, a number

of development plans have been identified which are furnished in Appendix A which may be considered in the formulation of BDP2100.

9.2 National Vision of Bangladesh

The social and economic environment needs to be transformed from a low income economy to the first stages of a middle-income nation by the year 2021 through the Bangladesh Vision of 2021. Bangladesh is aiming to consolidate its growth to become a full-fledged developed country by 2041. Bangladesh, being strategically positioned between India and China - two economic giants of the century, can meaningfully become a developed country by 2100.

9.3 Future Vision and Primary Goals

The economic development of Bangladesh, as well as the deltaic challenges and problems are likely to be influenced by socio-technical uncertainties such as, environmental degradation, climate change induced sea level rise, frequent drought and floods, land subsidence, population growth, urbanization, industrialization etc in future. For this, an integrated approach to foster future land and water management, in relation to water safety and food security is needed. In order to optimize the interventions and investments and to prepare for climate change, as well as other uncertainties, it is necessary to develop a holistic plan having long term perspective on the Bangladesh delta, with adequate land governance framework and layered investment programme. Existing land use related policies and governance setup of Bangladesh needs to be strengthened and integration by emphasizing the future challenges to achieve proper land use, water safety, and increased agricultural production to enable positive arrangements in food security for long term sustainable growth.

9.3.1 Delta Vision

The socio-economic diversifications of Bangladesh through proper land use management and the expected impacts of climate change, there is need for an integrated and long term vision. The Delta vision is supported by a set of contemporary goals, tangible and intangible indicators and phase-wise targets to be achieved. The vision also provides an insight for preparation of implementation plan and hence, develops portfolio of probable 'no regret' projects that need to achieve targets up to 2021.

In Delta vision, it is necessary to realize a sustainable and commonly agreed upon strategy, with all relevant stakeholders, for an optimum level of land resources management, water safety and food security, as well as sustained economic growth of Bangladesh. A framework of implementation and investment plan should be chalked out as short, medium and long term interventions. In order to achieve the Delta vision, a total number of six contemporary goals along with decision support indicators have been identified. For each decision support indicator, a set of phase wise targets has been formulated up to different tipping points (discussed in Chapter 8).

9.3.2 Goal Selection Criteria

The goals to achieve BDP2100 vision have to be identified based on distinctive selection criterea such as, land resources availability, food security and economic development. Sustainable environment to fulfil these criterea is also a contributing factor to the goals. Comprehensive review of national level policies, plans or strategies has considered as the basis of the identified goals.

9.4 Toward a Vision for the Land Resources Management

A holistic, integrated and comprehensive development programmes in land resources from the perspective of BDP2100 of Bangladesh should be addressed considering important problems in a suitable way considering economic development. Land scarcity and ensuring wise use of land, is the major challenge for Bangladesh. Soil degradation due to over-exploitation is another major challenge to sustainable agricultural. The current population dynamics are affecting human development particularly in the light of the post Millennium Development Goals (MDGs) and the

Government of Bangladesh's Sixth Five Year Plan. It is expected to enable the participants to see the current situation critically, identify the gaps in the existing policies and the problems in the implementation of the program. The key challenges and constraints which have been identified need to be overcome through implementation of interventions in future are:

- food security and shelters;
- optimization of land use;
- restoration of soil health'
- increasing land area of the country along the rivers and coast;
- meeting the in increase demand of food for increasing population,

There will be extreme challenge for infrastructures (e.g., schools, hospitals, urban and rural settlements, industries, roads), resources (e.g., food, water, soils, electricity), and jobs, as such crop land would reduce. Intensive cultivation would be required to meet the additional food requirement, which would deplete nutrient status of the soil. Conversion of potential agricultural land to brackish water shrimp culture; recover organic matter content in agricultural land which is declining; climate change would affect on land degradation and sea level rise which would enhance land loss, salinity intrusion and migration/ adaption of settlements, etc. climate induced changes aggravating drought and desertification to the detriment of proper land use for crop production. A lot of economic developments have been achieved for the last few decades due to implementation of development projects but new dimension of problems /constraints are being threatened which have to be mitigated through lessons learned from past experiences. Therefore, attempts should be undertaken with new interventions on a more inclusive and integrated way. A set of targets would be used to evaluate the goals within different selected tipping points (from 2015 to 2021 short term, from 2021 to 2041 as medium term, and beyond 2041- long term).

A long term vision for the land resources have to be considered in the national goal of the GOB. The goal is formulated in the Land Use Policy. A vision for land resources could be described as follows:

- An idealized future state of the land resources;
- A significant number of principles and mechanisms needs to be developed through which the future state of land resources management would be made realized.

9.4.1 Input to 7th Five year plan

A 18 number of probable ideas have been identified based on the analyses and measures in the preceding sections which might be formulated in the input of 7th FY Plan. All these are considered in the line with the general strategy described in the earlier sections and may be considered for the inclusion in the next five year. However, this ideas/project may be discussed further with concerned stakeholders and experienced professionals and experts for formulation of development of possibilities planning. Some tentative development plan has been presented in Appendix A. Detailed development plan will be formulated as per format considering the tipping points of various issues and through discussion with stakeholders and public opinion.

9.5 Possible List of Strategies

In Bangladesh, land resources management will continue to remain important for overall economic development in the foreseeable future. The proper strategic plan would attempts to provide a direction to investigate for possible ways and means in the land resources sector- the backbone of the country's economy for the growing population without disturbing and degrading environmental and ecological security.

Strategies for the Crop sector

- ✓ For crop intensification, the coastal zone, the Sylhet region and the char areas and drought prone areas must receive priority in crop sector development plans.

- ✓ Appropriate land reforms such as:
    - Computerization of records of landownership and land transfer, must be attempted.
    - ceiling of rents for the fixed rent system,
    - distribution of Khas land among landless and non-viable marginal farmers where ever feasible,
    - imposition of restriction on conversion of prime agricultural land for nonagricultural uses,
    - hourly rental system for irrigation equipment instead of crop-share based or season-based fixed irrigation charge,
- ✓ Policy strategy on protecting agricultural land from inundation, river erosion and other productive purposes.
- ✓ In order to meet the growing demand of additional food for the increasing people of the country emphasis should be given in utilizing the unutilized hoar land of the north-east part of Bangladesh.
- ✓ Strategy, policy and action should be formulated to convert the single crop land into double crop land, double crop land to triple crop land.
- ✓ Land reclamation in coastal areas and reclamation of cultivable land in water logging areas and emphasizes on the intensive cultivation of saline tolerant varieties particularly in Rabi season and will take necessary steps in this context.
- ✓ In order to maintain soil fertility and use of organic fertilizer would be popularized.

Land management for Forestry

- ✓ The existing coastal aforestation and enrichment plantation need to be continued.
- ✓ To prevent the extent of damage by cyclones and tidal surges, Coastal Green Belt needs be created and seedling will be raised to distribute or sale in the coastal zone.
- ✓ The redlands of Sylhet has long been lying unutilized which needs to be brought under afforestation.
- ✓ The protected area of forest would be increased to 20 percent of the total forest land during next 7th Five Year Plan period.

Land zoning

Land zoning process including formulation of necessary laws and acts need to be accelarated. The following indicatives may be considered for land zoning, including coastal area strategies to help government in planning for rational land use:

- Shrimp (brackish water) Zone
- Shrimp (sweet water) Zone
- Salt – Shrimp Zone
- Forest Zone
- Mangrove Zone
- Urban and Commercial Zone (Industrial, Port, EPZs and Ship breaking Yards)
- Tourism Zone
- Agriculture Zone

Reducing soil and land loss

- Prevent soil erosion by promoting and adopting improved tillage and irrigation practices wherever feasible;
- Undulated hilly areas may be brought under afforestation programmes;
- Adaption of proper river training to reduce land loss to river bank erosion;

Restoring soil fertility

- Use recommended / balanced rates of chemical fertilizers, and organic fertilizer through proper motivation of the concerned farmers;
- Proper utilization of fertilizer guide and soil testing facilities to increase soil fertility;
- Restore soil fertility through introduction of crop rotation practices;

- Removal of top soils for non-agricultural purposes such as brick making, filling of ditches for construction of roads, boulder extraction, etc. need to be prevented to sustain soil fertility;
- Restoration of soil health through popularized crop rotation practices.

Land reclamation in the coast

- Ensure sustainable land reclamation as a priority action under the proposed Delta Plan 2100.
- Newly accreted lands need to be stabilized through plantation of mangrove.

Prevention of salinity intrusion and desertification

- Provision needs to be established to increase fresh water flow from upstream to prevent salinity intrusion;
- Vegetation in the Barind area needs to be increased;
- Reduce stress on water resources system

Integrated management of coastal water infrastructures

- The polders should be managed in an integrated manner in respect of embankment maintenance with foreshore afforestation and fisheries and agricultural development;
- Water logging problem in the south-west region need to be relieved permanently through appropriate management of polders.

Climate change and agriculture

- Short varieties of HYV rice varieties or early harvest (short duration) rice varieties so that new varieties can be harvested in 100 days instead of 140-150 days as required for traditional varieties of paddy.
- Encourage development of drought resistant rice and dry land crops, salt and submergence tolerant rice cultivars.
- Salt tolerant and heat tolerant wheat cultivars for coastal zone.
- Water Saving Technologies: Alternate Wetting and Drying (AWD);
- Mini pond for supplementary irrigation during drought spells.
- Floating vegetable cultivation on water hyacinth mass.

Climate change Adaptation

- Increase farmer's capability adaption to climate variability.
- Change crops or varieties, choose different harvest and sowing dates, alter land management, and employ water efficiency techniques.
- Long-term climate change farmers should be dependent on land resources, and so at the national and international levels, governments and development agencies play a fundamental role in building the capacity of farmers to cope with and adapt to a changing environment.

Water management

- Should be focused on strengthening institutional (water management organizations) capacity, reforming key institutions, controlling corruption;
- Enhancing efficiency of planning and budgeting,
- Financial sector monitoring, promoting e-governance, and ensuring access to information, and reviving value and ethics in the society.
- The roles and responsibilities of all involved stakeholders-local and national government, private sector, civil society-regarding ownership, administration, ownership and management of land resources need to be clarified.

Gender

- Land ownership and entitlement to land, signify economic, as well as social identity and reflect empowerment and dignity.
- Control over income and assets like land, etc. are an indicator of women and men's empowerment

Anti-corruption strategy

- Economic development,
- Democratic reform
- A strong civil society with access to information and mandate to oversee the state , and
- Presence of rule.

9.6 Policies to Attain the Goals

9.6.1 National Land Use Policy, 2001

The main objectives of formulating the 'National Land Use Policy, 2001' is to ensure criteria based uses of land and to provide guidelines for usage of land for the purpose of agriculture (crop production, fish cultivation and rearing of ducks and chickens), housing, aforestation, commercial and industrial establishments, rail and highway and for tea and rubber gardens. This policy mainly identifies limitation of land use and management of limited land resources of the country. The key objectives of the Policy are to:

- reform the present land administration system by introducing Certificate of Land Ownership (CLO) which records all lands of each household in a single document;
- zoning of land for commercial and other purposes;
- prevent wasteful use of acquired land;
- increase crop intensity through optimal use of available agricultural land;
- update different laws related to proposed land administration reform;
- prevent alarming loss of agricultural land, which is needed to increase production tommeet the food demand of the population;
- protect state-owned (*khas*) land which can be used to meet the needs of development projects;
- prevent soil degradation;
- Establish a data bank (Management Information System –MIS) for *khas* land, fallow land, acquired land, char land etc. for ensuring proper use.

A draft National Zoning Act and Village Improvement Act were prepared in 2010 in line with the Land Use Policy, they have not yet been adopted, officially. In absence of these, the above objectives appear to be non functional as a sustainable and planned utilization of land. However, the preparation of a nation-wide Land Zoning Map is ongoing under a project implemented by the Ministry of Land, but its progress is very slow. Mapping of about 100 Upazilas have been completed by this time and the rest is expected to be finished by 2015. Considering landlessness, historical inequities, and widespread land grabbing, it would have been more useful if the Land use Policy was to be conceived as a tool for striking a balance between efficient and equitable utilization of land resources (Hossain, 2014).

The existing policy falls short of providing guidance as to how cross-sectoral interests and plans relating to land should be coordinated (Gebremedhin, 2014).

To overcome the existing limitations of NLUP, a revision of the national Land Policy is desirable during the Seventh Five Year Plan period by outlaying guiding principles on appropriate and sustainable use of specific type of land, sectoral and cross-sectoral land use and environmental management.

The policy must take inputs from the ongoing land zoning maps, particularly the problems associated with multi-sectoral nature of land use, unabated frictions among different sectors due to competing uses and negative environmental effects on land. For a conclusive Certificate of Ownership, it is important to rationalize the existing

institutional framework for recording or registration of property rights and avoid mandates that are either overlapping or difficult to coordinate.

The cross-sectoral policies of the National Agricultural Policy, National Rural Development Policy, National Forest Policies and Coastal Zone Policy need to be aligned and harmonized in order to prepare a comprehensive land use policy.

9.6.2 Khas Land Management policies

The following instruments may be major historical elements which can be traced in the evolution of the laws on *khas* land:

Bengal Regulation XI 1825, Bengal Alluvion Act 1868, Government Estates Manual 1919, Bengal Crown Estates Manual 1932, East Bengal Acquisition and Tenancy Act 1950, The Bangladesh State Acquisition and Tenancy (Fourth Amendment) Order 1972 (PO 135), Bangladesh Landholding Limitation Order 1972 (PO 98), President's Order LXI 1975, Land Reform Action Program 1987, Agriculture *Khas* Land Management and Settlement Policy 1997.

Besides these, many circulars and memos were issued by competent authorities from time to time, many of which are contradictory by nature. So far, agricultural *khas* land is concerned, the East Bengal State Acquisition and Tenancy Act 1950 was the mainframe legal document which was promulgated to abolish the Zemindari System (Permanent Settlement of 1793). This law was the basis for all subsequent laws on *khas* land which declared that "So far as agricultural lands are concerned, they shall be held by one class of people to be known as maliks or raiyats which means that those shall be no intermediary between the State at the top and malik or raiyats to be regarded as the tillers of the soil at the bottom"(Hossain, 2014).

There are two *khas* land management policies: Agricultural *Khas* Land Management Policy and Non-agricultural *Khas* Land management Policy. The basic tenets of these policies are to provide institutional structure and procedures for locating *khas* land and distributing it particularly to landless. In addition, the policies set forth detail provisions on the composition and responsibilities of the committees that it establishes in relation to management of *Khas* land. Compared to non-agricultural *khas* land management policy, agricultural *khas* land management policy appears to be adequate in terms of its coverage of issues pertaining to *khas* land management (Gebremedhin, 2014).

Non-agricultural *khas* land management policy was framed in order to address the issue of land-grab by powerful elites and lease procedure of those lands. Considering the serious consequences of grabbing non-agricultural *khas* land, the related policies are inadequate in terms of their coverage and plan of action.

Gap: The Policy does not provide any guidelines on how to recover grabbed land from powerful elites as well as how to distribute non-agricultural *khas* land to urban poor or landless.

The following points may be considered during review and revision of *khas* land policy:

- Local level *khas* land management and distribution committees should have representatives from landless people – women and men. They can be executive committee members of local level development projects.
- Involvement of poor people (women and men) of the locality in the identification, selection and utilization of *khas* land should be strengthened.
- Ministry of Land should arrange awareness raising activities for women and men about their rights and procedures to get *khas* land including land settlement procedures. Coaching on filling out application forms to get khas land is a real necessity. Gender Focal Point and Climate Change Focal Point of the concerned Ministries could implement specific programmes towards this.
- Displaced population (male and female) due to river bank erosion should be rehabilitated on the newly accreted chars and khas lands. Legal procedures in these situations should be gender-friendly.
- Women should be recognized as 'farmers' considering their huge involvement in farm land.

- Property inheritance right should be established considering equality of women and men; and for establishing women's rights.
- Ensuring ownership of land in the name of women even though they do not have a mature son; and for enforcing this, necessary policy revision is important (Reference- Agricultural *Khas* Land Management and Settlement Policy 1997).

9.6.3 Land Acquisition Related Policies

The compulsory acquisition of land has historically been a difficult and delicate issue for Governments in Bangladesh. Therefore, land acquisition and the concomitant smooth resettlement process are always a challenge. In addition to micro-level conflicts relating to implementation of specific projects and the communities impacted by those, land acquisition processes generate disputes at a higher level when associated with possible differential uses of lands. Laws in Bangladesh does not distinguish between processes governing the acquisition of farmland and urban lands. While the Industrial Policy of Bangladesh addresses the potential conflicts emerging from uses of fertile farmland for industrial purposes, there are no effective mechanisms to ensure the application of the principles put forth in the policy. It creates a challenge when large footprint projects are to be implemented in green-field areas, industrial estates, special economic zones or export processing zones. The instrument of current legal aid for expropriating lands for public purposes is the Land Acquisition and Requisition of Immovable Property Ordinance, 1982. The 1982 Ordinance has roots in the British colonial Land Acquisition Act of 1894 that laid the basis for the practice of land acquisition in South Asia during the colonial and post-colonial periods. As it stands, the 1982 Ordinance presents significant challenges in its application, as it is based on compensation rationale only. As such it monetizes productive (for ex: land) or important assets (houses) that are not based on market valuations and it provides affected people with a promise of a payment later for an asset foregone today.

Bottlenecks

No process of consultation with affected communities is envisioned in the law. Because of this and other issues, the Ordinance fails to provide a solid ground and clear-cut policies on which implementing agencies of the Government of Bangladesh can implement public infrastructure projects to sustain growth and development. Bangladesh does not have a resettlement policy or law to address the array of problems faced by people due to implementation of development projects, particularly in moving residence from one area to another (Rahman 1996, Rahman and Zaman, 2010, Hossain, 2014).

The process of acquiring lands in Bangladesh involves as many steps and multiple government bodies and agencies for implementation. The payments to project affected people are seldom delivered on time. Sometimes, the affected person did not receive in full due to well-known rampant corruption (CARE 2003). Compensation rates and mode of payments in installments often create tension among the resettlers. Therefore, a comprehensive and modern technique of resettlement needs to be adopted in order to smooth acquiring of land.

9.6.4 Economic Zone Act, 2010

The Government has enacted Economic Zone Act in 2010 to ease land-related problems faced by potential investors. The Act provides legal basis for the establishment of economic zones in all potential areas including backward and underdeveloped regions with a view to encouraging rapid economic development through industrialization. The development of Economic Zones is expected to help investors through providing a place with various facilities that are conducive for industrial development. The Act promotes Economic Zones in the Private sector, Government led EZs or in a combination. In this connection, Bangladesh Economic Zone Authority (BEZA) has been established. The mandate of the BEZA is to identify local potential zones, acquire lands and build the zones with necessary facilities. BEZA may seek public-Private Partnership (PPP) to build and effective utilization of such zones (Hossain, 2014).

9.7 Analysis of Major Constraints to Attain the Goals

Land use is intensively used for agriculture, settlements, forests, shrimp ghers, natural fisheries, salt production, industrial and infra-structural developments and tourism. All these have resulted into the following features:

- Demand for expansion of all land uses (urban, settlements, shrimp etc.);
- Increasing demands for new uses (tourism, export processing zones and others);
- Conflicting land uses and demands (agriculture and fishermen communities); and
- Encroachment and conversion of land from one use to the other.

The population is increasing and the land is being converted directive from productive purposes such as crop production to other uses like housing and roads and urban development. It is reported that cultivated land is declining by almost 0.4% annually. It is expected that the cultivated land will decrease to 20% by 2050. The oversized population creates challenges for the future development of the country's economy exerting huge pressures on environment and a available resources, limiting agricultural growth found grain production through reduction of arable land for housing and non-agricultural purposes, thus slowing down the rate of poverty reduction. Effective measure need to be taken to arrest this alarming trend the land available for crop production that will continue to fall.

Natural calamities and environment problem plays a vital role against the economic and infrastructure development of Bangladesh. The disastrous effect of cyclone and tidal surge are imparting pressure on the national economy. Bangladesh is a land of different natural calamities such as floods, storms, droughts, erosion etc. In 1998, flood had devastative effect on the economy and the agriculture of Bangladesh, where 75% of the land was submerged, loss of crops in 700,000 hectares cultivated land and infrastructure damages were experienced (BBC, 1998).

Degradation means loss of land's potential of productivity which affects effective land use. Soil related problems may be a major constraint on agricultural growth. Soil fertility, soil erosion and salinization affect a significant land area. Soil erosion is generally regarded as the most serious problem of soil degradation. Accelerated soil erosion has been encountered in the hilly regions. Soil erosion such as sheet, rill, and gully erosion, landslide, riverbank erosion and coastal erosion, commonly occur in Bangladesh frequently.

The loss of navigability of rivers and sudden flow of water from upstream are main reasons for erosion. Development of salt and submergence tolerant rice cultivars would be useful. Scientific researchers suggested that Bangladesh has fallen into risk zone of earthquake, arsenic poisoning in the northern part of Bangladesh, deteriorating level of ground water and arsenic rich materials in the region's river system has caused worldwide alarm.

Soil fertility has been deflected due to unrestrained use of chemical fertilizers, intensive cultivation, and inadequate use of organic matter. Land degradation is caused for over-exploitation of biomass from the cultivated fields for fuel, fodder and thatching.

The exploitation of ground water for irrigation for Boro crop has gone beyond the capacity of annual recharge of aquifers, which affects irrigation, as well as safe drinking water, adversely. The arsenic contamination of drinking water in large area of the country is often blamed to exploitation of ground water for irrigation with DTWs/STWs. The north-west region of the country especially the Barind area, shows signs of desertification. This area experiences frequent droughts and water scarcity, which immensely hamper dry season irrigation initiatives.

The coastal zone often subjected to inundation by high tides, salinity intrusion, cyclonic storms and associated tidal surges. The haor regions dry up in dry season except some beels and low pockets, and remains completely inundated during the monsoon. The haor region experiences flash floods and shortage of water during the pre-monsoon, floods during the monsoon and drainage congestion during pre- and post-monsoon. Rice research scientists have been trying to develop a unique variety of rice which can stand the flood and saline water. These findings would help to improve the food security of the country in future.

The urban areas frequently experience floods, drainage congestion, water logging, water shortage, environmental degradation as well as high incidences of water, air, soil, noise and thermal pollution. The Chittagong Hill Tract region experiences cyclonic rainfall, flash flood and landslides during the monsoon and water shortage during the dry season both for domestic and agriculture purposes. The region has the potential for development of mini-hydropower. All these threats may accentuate under climate change scenario.

The geographical location of Bangladesh is the top most reason for its at-risk of disasters situation. Three major systems, the Ganges, the Brahmaputra and the Meghna flood, cyclones and tornadoes occur every year, lives and properties causing deterioration of the economic growth. A significant land area is lost every year by river bank erosion which creates land scarcity. Since 1973, land has been accreted in the Noakhali coast. It is assumed that there would be significant land increase by the year 2050 if proper interventions could be implemented in a sustainable manner.

Global warming is one of the reasons for continuous occurrence of natural disasters in Bangladesh. Industrialists and financial institutional while financing any projects, must agree jointly to prevent the effect of carbon emission and other industrials hazards to environment. Accordingly, policy needs to be developed.

There are Socio-economic growth and political development related problems in Bangladesh. Major barriers affecting socio-economic growth of Bangladesh are population, natural calamities and environmental problems, political instability, inequality, and corruption.

Corruption is one of the major barriers to economic development of the nation. Corruption is the result of weak state management and it exists where individual or organizations have monopoly power over a job or service , discretion over making decisions, limited or no accountability and low-level of income. Corruption is one of the greatest obstacles to economic development of the country.

9.8 Conclusion

A standardized land use classification system is a prerequisite for land resource management which is absent in Bangladesh. A land use may be classified under three broad headings.

a. Areas of conservation (natural resource of protection /areas with environmental concern like wetland, watershed, river, hills, disaster prone areas, heritage areas etc.
b. Agriculture and forestry production (includes agricultural land , forest areas, other production oriented resources and rural homesteads)
c. Under areas (developed areas, and areas needed for future development for residential, commercial, industrial and other urban areas).

Most of the land related problem and prospects are existed and taken into consideration in land use related polices though all are not implemented. It requires updated problems, issues, information to address regarding problem of land resources of the country to bring expected result. Following conclusion may be considered for further improvement:

- Local government institutions to be strengthened to implement land zoning.
- Land ceiling of rural areas to be minimized and policy required for ceiling determination of the urban areas considering land limitation;
- Khas, Char, Haor, and Wetlands need to be kept reserve for future distribution among the poor to ensure their maximum utilization;
- Land ceiling for homestead of both urban and rural areas need tot be determined as minimum as possible through compact township;

- Growth centre based development activities to be included in the land use policy of the rural areas for maximum utilization of land;
- Strategy of women empowerment and child rights required to include to the land use policy;
- Provision of data base (Management Information System) included to land use policy for proper planning and development of land management issue;
- Fertile land should not be settled for development activities;
- Precautions measurement need to be developed for the prevention of land degradation;
- Policy regarding awareness building should be included to land use policy to ensure optimum use of land;
- There should be a policy decision regarding waste management to keep the land inhabitable and pollution free;
- Community- based cultivation should be given priority to ensure maximum utilization of land avoiding the tendency of land division into pieces;
- Policy should include a provision to ensure environmental protection and protection from the adverse effects on climate change on global warming;
- Policy will focus on development and management of protected areas such as eco parks, botanical garden and safari park under a reformed legal framework;
- Land use policy will ensure proper management of saltmahal, jalmahal, balumahal and other mahals for poverty reduction. On the other hand it will ensure protection and conservation of wet lands, hilly areas, tea gardens, heritages, and rubber gardens including coastal land;
- Land use policy will ensure delivery of land related services to the people through modernized and efficient land administration.
- Acceleration of the land accretion process and optimum use of these coastal lands would significantly contribute to the regional economy and well-being of the local people. Land zoning is one instrument that can optimizes the use of coastal lands
- It is apprehended that the availability of agricultural land would decrease significantly by 2050 and 2100. This would create serious problem in food security in future. The area of agricultural land needs to be estimated for food security.
- A projection is needed and has to be done in period of time with-multi-discipline team consisting of land use planner, urbanization developer, agriculture, socio-economic and morphologists. Based on the developing of the rationale and multi-discipline teams and appropriate model could be developed for 2100. This should be done with other thematic study also such as urban and rural settlements, industrializations, insfrasture development. In this situation, tipping points need to be considered in different hotspot situation.
- Key constraints/ technological gas of the agro-ecological regions have been identified. Updating the Agro-ecological Zones Data Base for effective land resources management in Bangladesh need to be done immediately.
- Modernization of Land management through Digital Land Management System(DLMS) with the objectives:
    - Strengthening Access to Land and Property Rights to all Citizens of Bangladesh through development of Digital Information System (DIS) to Ensure Proper and Planned wise Land Use
    - To develop Digital technique for thepreparation of design and khatian using modern equipments(GPS, ETS, Data Recorder, Computer, Map Processor, Soft ware, Platter, Printer etc.)
    - Strengthening governance management for land resources;
    - Computerization of Existing Mouza maps and khatian;
    - Strengthening Access to Land and Property Rights to all Citizens of the country;
    - To ensure proper and planned wise Land Use
    - To create Authontheic land record, it may be established with joint venture of AC(Land), settlements and Sub-Registry;

- Increase land availability through Accretion/Land Reclamation in the Meghna Estuary, toward sea and coastal region. The land loss due to sea level rise and river bank erosion may be overcome by new land formation toward sea through land reclamation, construction of closure, cross dam which may be accelerated with nature techniques for stabilization through protection of pioneer (mangrove) vegetation
- Tidal River Management (TRM) for improvement of land use management which might develop land type in the low-lying beel of coastal area through sedimentation on low lying beel areas. This might bring under double/ triple cropping pattern and might increase the availability of land for settlements also.
- Prevention of intrusion of saline water in the southern region may be achieved through increase of supply of upstream fresh water by water storage by construction of Ganges barrage.
- Prospects for promoting soil conservation and watershed protection in CHT through identification of watershed areas for reservation through integrated development on agriculture and fisheries in CHT.
- Integrated agricultural development project (on farm water, soil water management, salinity, drought, submergence tolerant, problem soils etc) through proper land resources management in Bangladesh.
- Re-excavation of river and khals and maintenance of structure in the coastal area to create smooth functioning of the regulators to improve the hydrological situation in the agricultural land for growing HYVs rice in the polder areas.

A lot of sediment and fresh water are flowing through the Bangladesh Delta from the Himalaya to the Bay of Bangal. If these sediments can be managed to form new accreted land toward the sea, then the scarcity of land might be diminished to some extent. Similarly, if the fresh water which is flowing toward sea can be stored through construction of Dam like Ganges Barrage, then the upstream flow might be made high enough to prevent the intrusion of salinity in dry season. The problems/ constraints, challenges, development strategies and prevailed opportunities which have been identified in the baseline study, might be very helpful for the preparation of development plans of BDP2100.

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BASELINE STUDY: 13

Urbanization and Settlement

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Executive Summary : Study 13

With regard to urbanisation and settlement we see a rapid growth driven by amongst others population growth and with regard to the growing rural to urban migration is an important contributor. Bangladesh knows many urban centres of which the Mega city Dhaka and the metropolises of Chittagong, Khulna and Rajshahi. In Bangladesh the rapid urban growth at this moment takes place in an unsustainable way.

On the national scale we see an unbalanced development of urban centres with Dhaka as a primate city. The centralised government makes Dhaka the focus point for services, government and economic developments and investments. This attracts many migrants from rural area's that settle in the city. This big increase of inhabitants in Dhaka, but also in other cities puts pressure on the density, open space of flood plains and agriculture land, availability of sufficient services and affordable houses, infrastructure and in general to the liveability of the city, especially for the poor.

This pressure with regard to the lack of the availability of land is present in the whole country. From 1976-2010 we saw an increase of the percentage of surface for urbanization, industries and settlement of 6.4 %, mainly at the coast of cropland, forest and mangroves (Hasan et al 2013). In addition to this the expected climate change and population growth are expected to put even more pressure on the amount of available and productive agriculture land.

Bangladesh is one of the highest populated countries (According to 2011 census data, the total population density is about 1,015 people per square kilometre). In the national road network however we see that some rural regions are still poorly connected to markets and services.

With regard to the water management aspect of the Bangladesh delta plan the main urbanization and settlement issues are the uncontrolled and unplanned growth within area's that either have a have a function or reservation for water management (such as water storage, drainage or flood plains) or are prawn to a high risk of disasters such as hurricanes, erosion or floods.

Though there are plans, policies and acts in place for managing housing and urban development in relation to the preservation of open space, they are not integral and are in general poorly implemented. There is no structure for urban or spatial planning that is applied on a national and hierarchic level, resulting in a lack of coordinated holistic spatial planning and with that a lack of connections with national budgets.

There are two main challenges for Urbanisation and settlements with regard to the Delta plan:

- A well functioning planning and implementation structure.
- A national holistic long term plan combining (amongst others) water management and sustainable spatial and urban development.

Bangladesh's national government is organized along a traditional centralized management structure, which cannot keep pace with the growing demand. It controls local government through setting strict rules of engagement and strict budgeting, retaining much decision power at the national government level. Illustrative for this is that local spatial and urban planning is performed by agencies under the national government (LGED and UDD).

Another major issue is the lack of planning enforcement. Urban plans drafted by LGED, UDD or City Development Authorities have to be enforced by the local Mayor and its council and/or the city corporation. Physical planning can be conducted by a range of agencies and service providers, without any coordination.

Additionally, a large part of Bangladesh's population is not serviced by the formal institutions. Urban authorities and planners in Bangladesh typically ignore the informal economy and its people. Most informal layers of the city are negatively associated, and not accommodated in the local urban governance systems or participation processes. In absence of the formal institutions, lower and middle income groups perform informal governance activities (building roads, self-initiated access to services and amenities) to bridge the gap between their needs and that what is offered.

Private sector real estate developers take advantage of weak urban governance by anticipating on poor implementation and compliance to acts and laws that should protect the environment and limit unwanted land use. Furthermore, the private sector exacerbates inequality in the large cities by investing only in luxury housing projects, neglecting the urban poor and the lower and middle income classes.

Coordination of the combined deployment of resources in time is key in a complex urban governance system. Generally speaking, the multiplicity of institutions and service providers is regarded as the principal culprit in the current urban governance system. The multitude of agencies and companies with unclear and often overlapping mandates combined with poor coordination capacities is at the origin of most current problems and the negative perception of government services.

Since the current national and local planning institutions and multiplicity of service provides are crippled by unclear mandates, a lack of accountability, weak finances, and other factors, the need arises to rethink the structure and configuration of the planning and implementation apparatus. Several potential measures are identified to bring back hierarchy and coordination in national and local spatial planning.

In this baseline report a variety of possible measures is brought forward to enhance the national and local planning and implementation systems along five notions; (1) bringing coordination and hierarchy in physical planning and policy, (2) effective urban governance, (3) decentralization and participatory planning, (4) aligning budgeting with the modern urban context, (5) accepting the informal sector in the formal urban governance system.

The national scale strategy should relate water management interventions to the location of growth centres and urban and rural development. Within this national strategy the choice for development locations, can be related to the way the country will be protected from floods or provided with water.

Of course water management is not the only relevant factor in a holistic plan: amongst others the economic development, the route and energy network, large infrastructure and industrial developments and land use planning with regard to for instance ecology forest and agriculture also play an essential role on the national scale. Providing liveable cities is indicated to not only influence the physical living condition: but also be an essential requirement for attracting international high skilled workers, which is essential in respect to reaching a higher value adding economy and middle income status.

A holistic plan food flood risk protection, water and flood management and spatial design, should connect sustainable and robust measures and strategies on different scale levels such as the regional scale (country / regional strategy), settlement scale (urban centres or rural settlements), local scale of a place (neighbourhood / street) and the building scale. Within this plan individual master plans for urban and rural centres are essential to guard sustainable environmental friendly and water related development.

Essential aspect with regard to a long term plan for water management and spatial development are: to consider both flood prevention as well as consequence reduction measures, to be aware of the interrelation between water management interventions and spatial development, to be aware of changing values in time and changing needs with regard to function and liveability in a growing economy and to provide strategies that are robust under different scenario's.

The discipline of Urban planning should be extended with that of urban design and research by design to come to possible holistic strategies. In the book 'Designing Dhaka, a manifesto for a better city' by Kazi Khaleed Ashraf, the need and importance of urban design in the Bangladesh context. He prefers to use urban design over urban planning since the latter is burdened with an association of bureaucratic and policy-laden slowness. He feels that design can offer alternative realisms and claims it is important that design studies and proposals infiltrate the collective imagination, so they may become fodders for public pressure and activism and perhaps even policy making.

In order to come to such a holistic plan or designs for sustainable urban and rural development one has to understand the complexity the urban and rural centres and include all aspects of urban and rural life, including the informal settlements and urbanization. Achieving this conceptual understanding of the complex nature of urbanization and settlements would be a requirement to be able to come to successful plans.

In the possible measures section a first selection of available tools and concepts for sustainable planning are described including measures for flood proofing, urban drainage and water capturing and storing, methods for balanced urban form and infrastructure development (such as for example compact townships), and general measures and concepts for developing liveable neighbourhoods, such as providing open and green spaces, walk able cities, mixes neighbourhoods, identity diversity and sufficient amenities.

This baseline is part of a series of in total 6 baselines drafted for the BDP2100. Since some aspects that are relevant for urbanisation and settlements (such as for instance infrastructure, economics, demographics, land use, environment, water supply and flood risk protection) are discussed in this baseline reports, in this baseline they are described in a more condense way.

Since this is a baseline study meant as an inventory of the existing available information with regard to urbanisation and settlements, a lot of information is based on information and data described in existing literature. For some chapters the story line is strongly based on existing literature, in the source section (chapter 15) the sources for those chapters are described.

1 Urbanization and Settlement in Bangladesh

1.1 Urban Centres

Bangladesh is known worldwide for its dense urban areas. The Bangladesh Centre for Urban studies classifies the urban centres in Bangladesh in different categories;

- Mega city (more than 5 million inhabitants)
- Metropolis (500.000- 5 million inhabitants
- City's (100.000 - 500.000 inhabitants)
- Medium towns (25.000 - 100.000 inhabitants)
- Small towns (less than 25.000 inhabitants)

Dhaka is the only Mega city in the country, there are 3 metropolises; Chittagong, Khulna and Rajshahi. Together with Dhaka the three held >50% of the country's total urban population in 2001.

Table 1 Number of urban centres per Census year

	Size Classes	**Number of Urban Centers**					
		Census Year					
		1951	**1961**	**1974**	**1981**	**1991**	**2001**
Mega city &Metropolis	5,00,000 and over	-	1	2	3	4	7
City	1,00,000-4,99,999	2	3	4	10	14	26
Medium towns	50,000-99,999	2	5	14	23	26	50
	25,000-49,999	14	16	23	45	76	116
Small towns	Under 25,000	45	53	65	411	402	332
	Total	63	78	108	492	522	531
	Level of Urbanization	4.33	5.19	8.78	15.54	20.15	23.1

Source: Bangladesh Bureau of statistics, 6th Five Year plan GED

1.2 Urban Growth

Urban areas are growing at a fast pace, the main contributors to urban growth are the natural increase of existing urban population, rural to urban migration and the areal expansion of cities in which existing settlements are incorporated.

1.2.1 Growth of Urban centres over time

At beginning of the 20th century, only 2, 43 percent of the population in the Bangladesh areas of British-India lived in urban centres. The urbanization process in Bangladesh got underway since the independence of the Indian sub-continent for the British Empire in 1947. For four decades the rate of urbanization remained almost static and in 1941 still less than 4% of the population (corresponding to 1, 45 million people) lived in urban centres. With the end of British India came the new geographic and political status of Bangladesh, or East-Pakistan at the time. This is when urbanization picked up its pace, and in the next century the urban population spiked, induced by the many Muslim immigrants that entered from India. These immigrants mainly settled in urban areas, resulting in a relatively big increase of the urban population, growing to 5.19% in 1961 (Islam 2012).

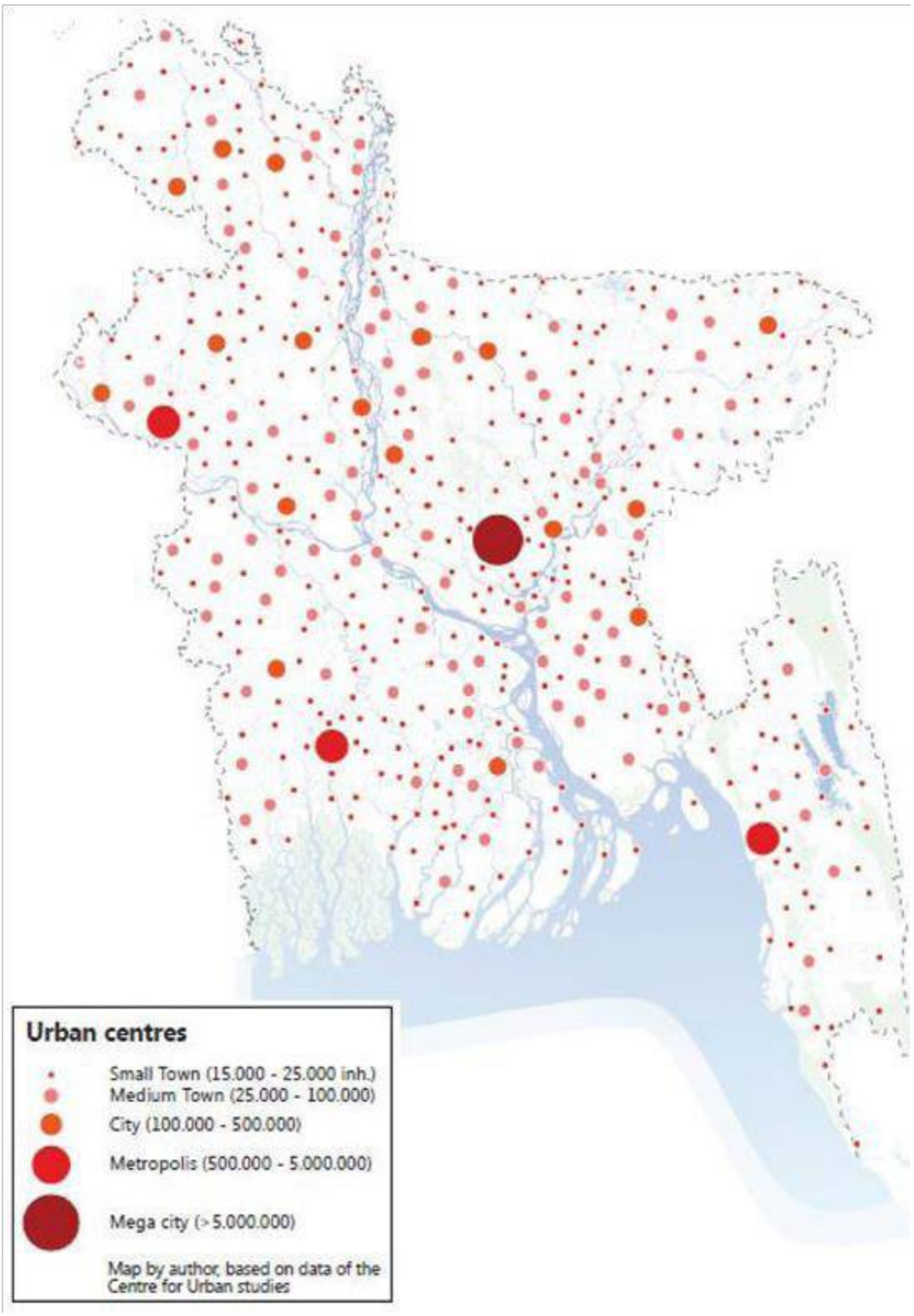


Figure 1 Bangladesh urban centre classification, based on data of the Bangladesh Bureau of Statistics

Source: Defacto Urbanism

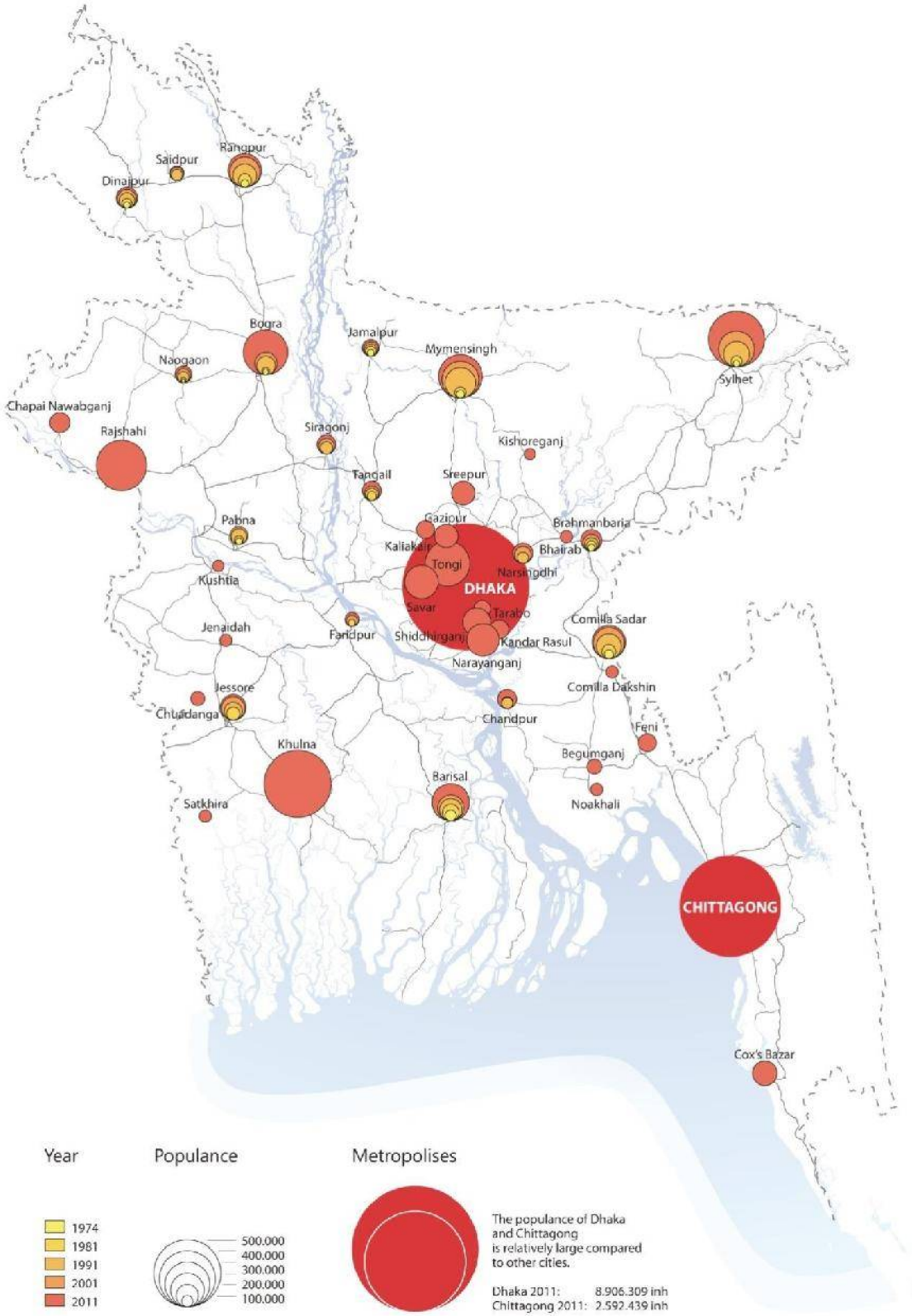


Figure 2 Urban centres with a population of over 100.000 and if available their growth in time

Source: Defacto urbanism

In the following decades, a combination of socio economic, political and demographic factors drove the influx of people into cities. A main contributor is the rural to urban migration, mainly caused by urban industrialisation and rural push factors such as the economic impoverishment of the countryside and the adverse impact of natural disasters. In table 2 the urban population growth over time is shown. The most important factor for the dramatic increase in urban population between 1974 and 1981 was the redefinition of urban centres in the census. "The extended definition of the urban area with the inclusion of all 460 Upazila Head Quarters as urban accounted for 30 percent of the total increase in urban population during this period" (Islam 2012 p. 2). Currently the UN estimates that 25% of the Bangladesh population lives in urban areas. With this rapid urbanisation come many challenges, those will be described in chapter 3.

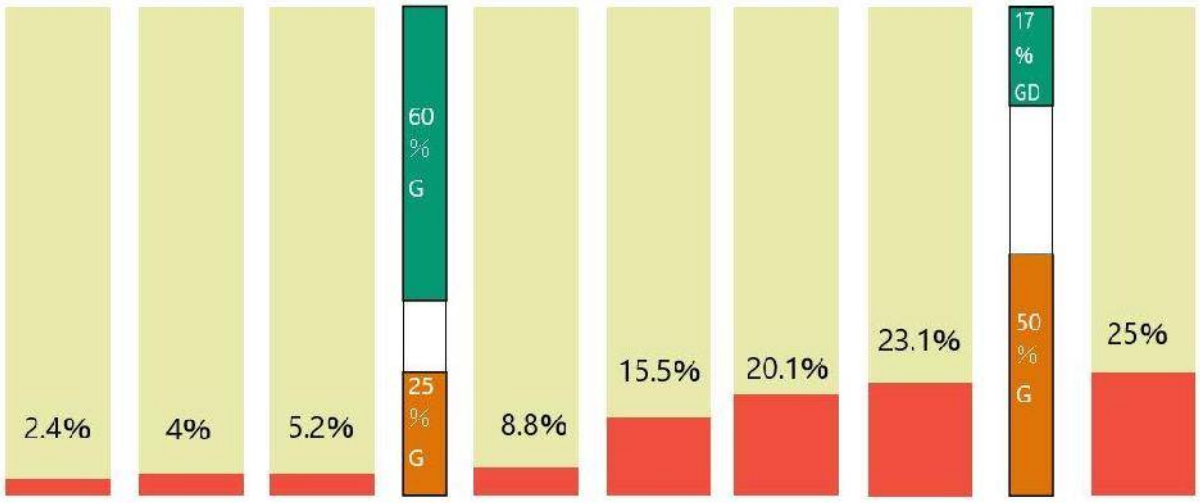


Table 2: (red Colour) Share of urban population in Bangladesh, according to Islam 2012, Population Census and UN estimation. Also the GDP share of urban and (orange colour) agriculture (green Colour) economy.

The population is not spread evenly over the different cities. The areas which grew most rapidly in the 2000-2010 decade are those inside the country's core (Dhaka and Chittagong) resulting in the growth of outskirts of those major cities. We see that the Dhaka Metropolitan area population in 2001 of 10.7 million people (census report) and an estimated 15.5 million people in 2015 (UN) can almost not be compared to other cities. Chittagong Metropolitan area is the second city of the country with 3.4 million inhabitants in 2001 (census report).

Below in table 3 the population growth of the 4 large cities; in the 'old' way of doing things; by including a very large area around the cities to form a Statistical Metropolitan Area (SMA). The census indicated that the population of Khulna dropped here because of several industries moved away from the area in that decade.

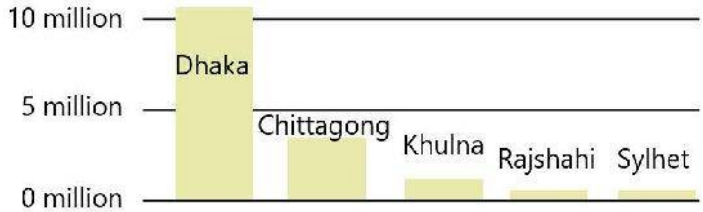


Table 3 Urban population of the metropolitan areas and Sylhet, according to the Population Census 2011

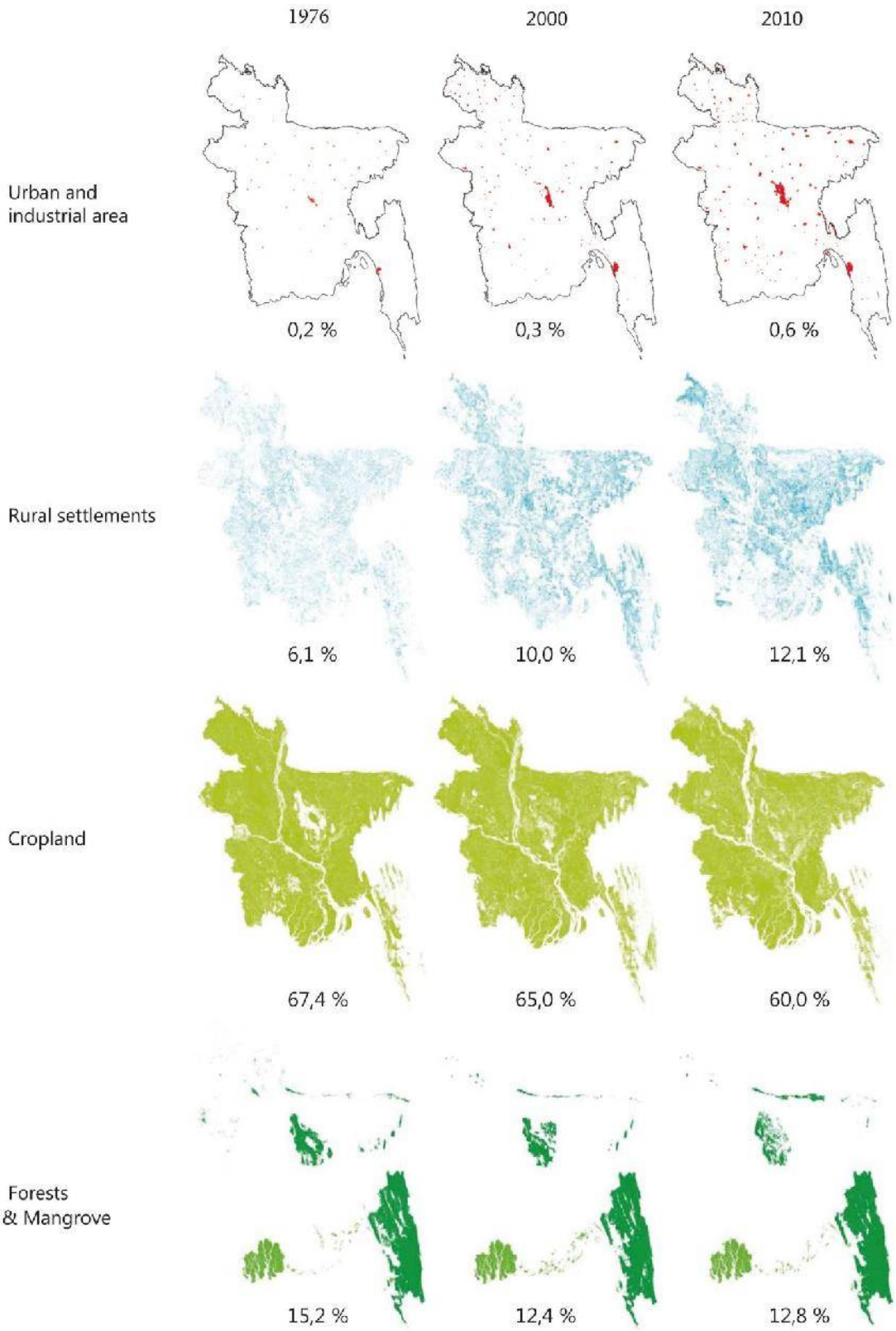


Figure 3 Selected land use types over time

Source: Hasan et al. 2013

Table 4 Population growth of the 4 large cities; in the 'old' way of doing things; by including a very large area around the cities to form a Statistical Metropolitan Area (SMA) Data from the population censuses 2001 and 2011.

	Dhaka	Chittagong	Khulna	Rajshahi
1991	6.844.131	2.348.428	1.001.825	544.649
2001	9.672.763	2.991.723	1.172.831	651.062
2011	14.171.562	3.724.433	1.046.341*	679.889

1.2.2 Urban and rural growth in relation to national land use and spatial variation

Over time the urban and rural settlement growth is expelling other land uses such as agriculture, forest and nature. Figure 3 holds an overview of some of the country's land uses over time and indicates the historic trends. Rural settlement land use remains the main diversion of land out of agriculture. Between 2000 and 2010 agriculture was converted to urban area and settlements 0.45% annually (SIRDI, MOF 2014). With that cropland becomes more scarce, whilst simultaneously the demand for agricultural products and higher yields rises due to population growth.

What stands out in the table 5: Main land cover types in Bangladesh during 1976-2010, is that the amount of land in total increased over time. This is due to natural sediment accretion and specific land reclamation projects. For more information on land use, we kindly refer you to the "Land use management" thematic baseline study.

Table 5 Main land cover types in Bangladesh during 1976-2010, derived from Landsat imagery

Land cover	Area(1976)		Area(2000)		Area(2010)	
	ha	%	ha	%	ha	%
Cropland	9,761,450	67.4	9,439,541	65.0	8,751,937	60.0
Forest	1,754,917	12.1	1,311,121	9.0	1,434,136	9.8
Mangrove	452,444	3.1	486,791	3.4	441,455	3.0
Tea	119,847	0.8	138,533	1.0	96,152	0.7
Salt pan	11,789	0.1	24,306	0.2	36,022	0.3
Agriculture	**13,303,654**	**92**	**12,742,274**	**87.7**	**12,176,904**	**83.6**
Rural settlement	885,637	6.1	1,458,031	10.0	1,766,123	12.1
Urban &Industrial	26,799	0.2	47,495	0.3	87,616	0.6
Accreted Land	271,169	1.9	282,781	2.0	547,128	3.8
Non-agriculture	**1,183,605**	**8.17**	**1,788,307**	**12.31**	**2,400,867**	**16.47**

Source: Hasan et al. 2013

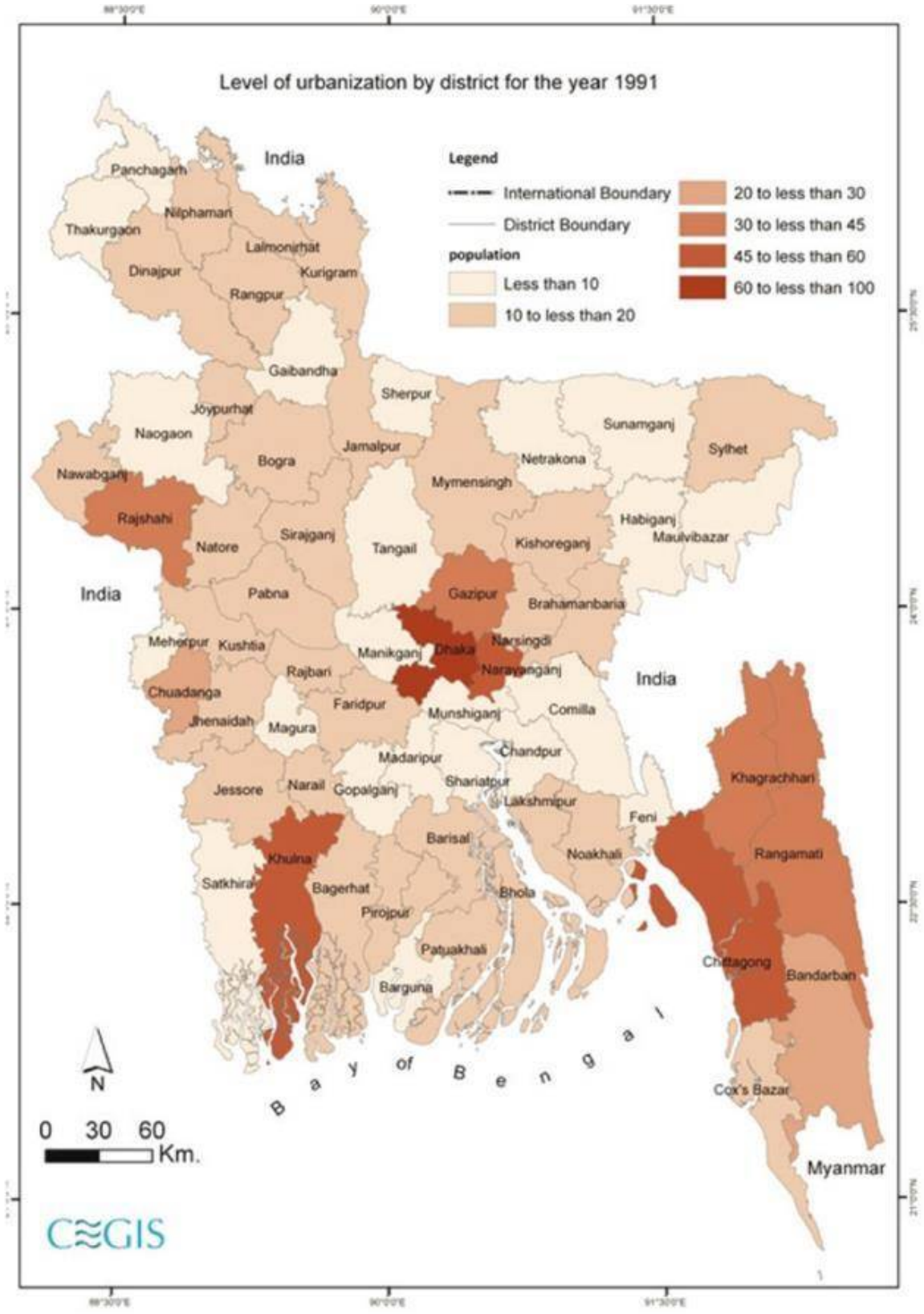


Figure 4 Level of Urbanization by Districts in 1991

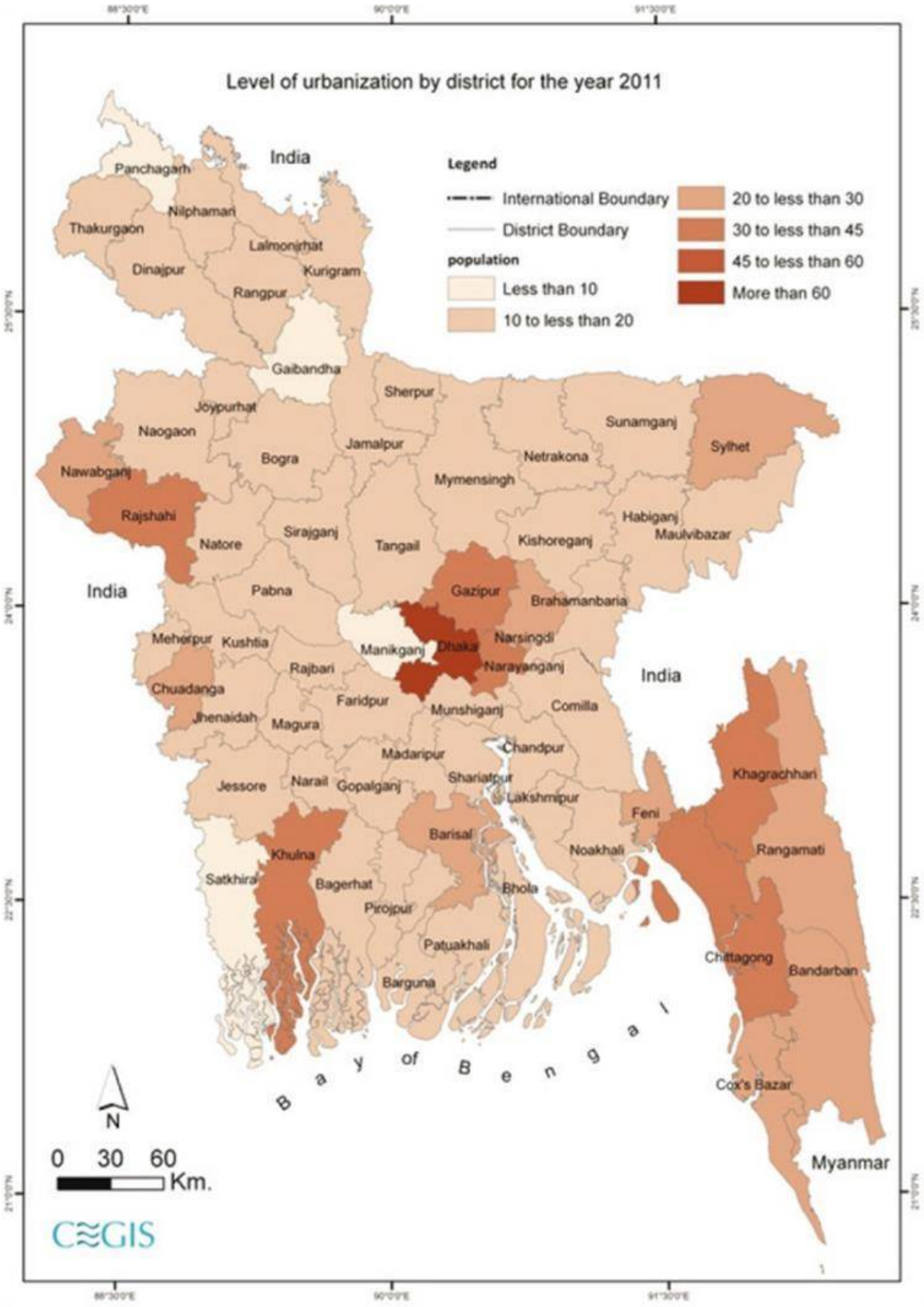


Figure 5 Level of Urbanization by Districts in 2011

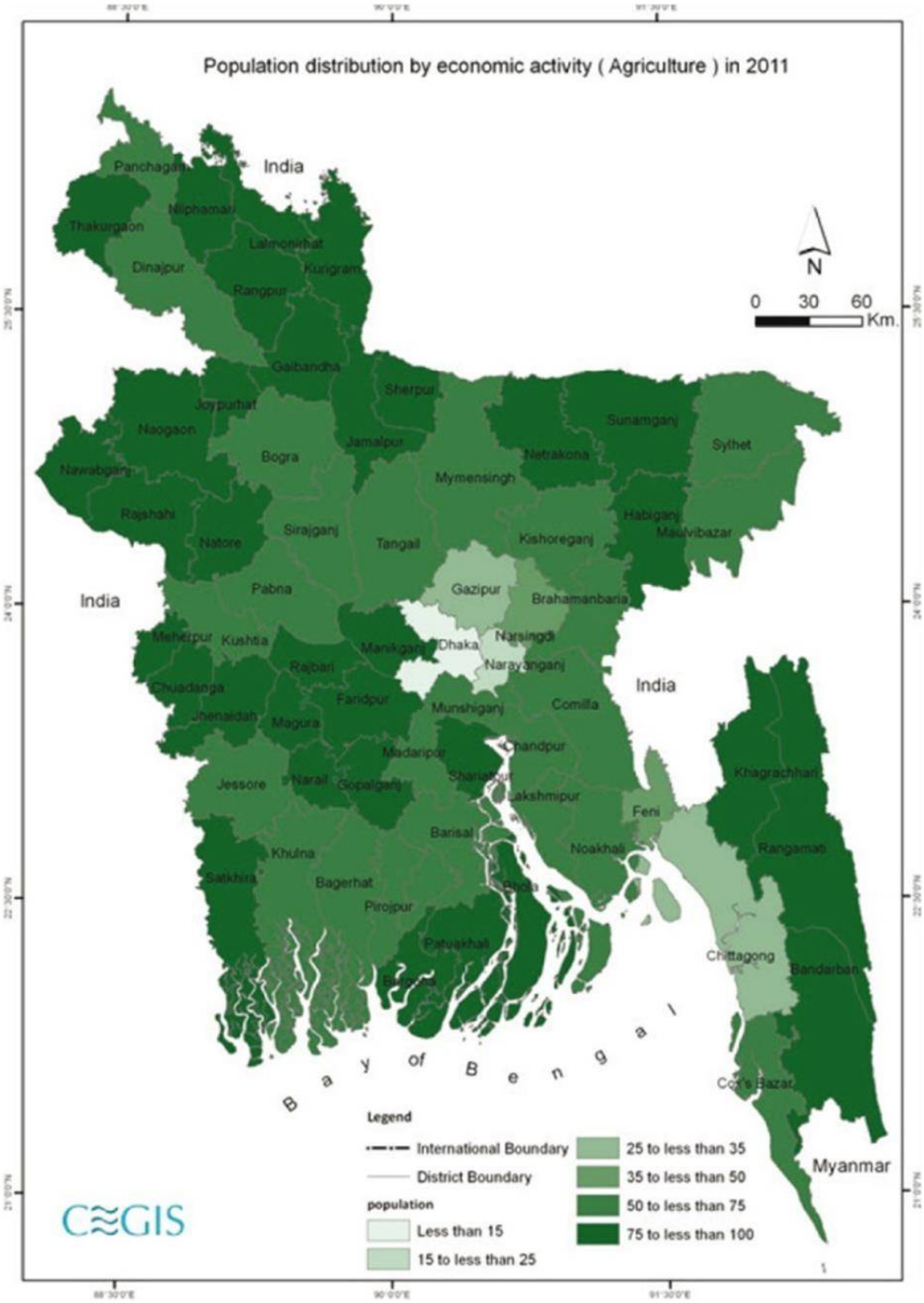


Figure 6 Population distribution by economic activity (Agriculture) in 2011

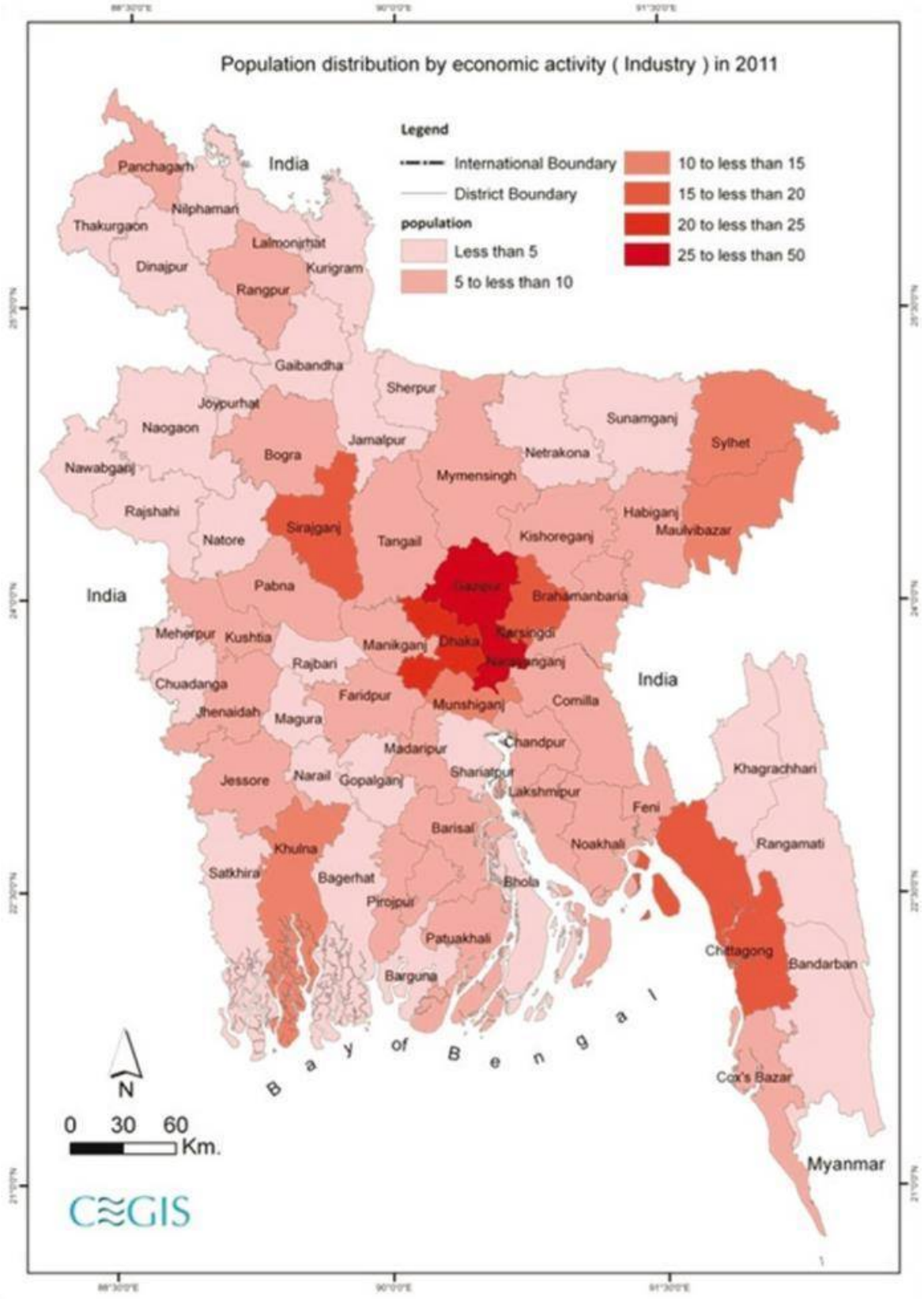


Figure 7 Population distribution by economic activity (Industry) in 2011

Agriculture

Bangladesh being a deltaic country is very much suitable for agricultural activities. Hence, nationally on an average, population in agriculture and related activities are 50%. Region wise analysis revealed that Dhaka and Chittagong districts have lower rates below 35%. Other than that, in the entire coastal zone population involved in agriculture sector is 57.85%. Highest rate is observed in the Chittagong Hill Tracts between 85.9% and 88.4%. Barind and Haor regions have 79.25% and 70% population involved in agricultural activities. There are 30 districts bordering the major rivers and estuaries of the country. Some of the districts fall under other regions such as the Barind, the Haor, and the Coastal zone etc. These districts are highly prone to river flooding, erosion and accretion. However, siltation process creates fertile land which is highly productive for crop production. Agricultural activity ranges from 49.1% to 85.5% in districts along the rivers except the two districts of Dhaka and Narayanganj. Dhaka nd Narayanganj districts have low agricultural activity because of their dominant urban characteristics. The estuarine districts are also vulnerable to erosion and coastal flooding. Despite that, these districts have coverage of agricultural activity between 34.4% and 81.3%.

Industrialization

Industries are major source of employment generation. Development of industries, therefore, begets population. However, industrialization is affected by factors such as availability of resources, transportation facilities, environmental conditions etc. Given these circumstances, industrial activity is found prominent in the cities and the surrounding areas. Then, in the coastal zone with 11% population dependent on industries, followed by 7.76% in Haor region, 5.51% in Barind region and only 3.17% in the CHT area.

In the coastal zone, Chittagong district have the highest rate of industrialization which is 18.40%, Khulna 12.60%. Within the haor region, Sylhet district has the highest rate of 12.50%. Except the Sylhet and Maulvibazar district, the other five districts namely Brahmanbaria, Habiganj, Kishorgonj, Netrakona and Sunamganj district in the Haor region are in midst of depressions known as Haors. Therefore, the industrial development in these six districts has been very low between 3.01 to 7.15%.

Bogra district under the Barind region has the highest rate which is 8%. CHT being a hilly region and lower transportation facilities have relatively lower rate of industrial activity ranging between 2.4% to 3.93%.

Industrial activity along the rivers of Barind region is poor only 3.03 to 7.99%. Similarly, in the coastal districts surrounding the estuary industrial activity ranges from 4.37% to 9.37%. Other ditsrict along the rivers with rates above 10% are Munshiganj, Sirajganj, Narsingdi, Narayanganj and Dhaka.

1.2.3 Rural to urban migration

Migration is (next to birth and death) the biggest variable in demography. Especially rural to urban migration is a common phenomenon in Bangladesh, and is the main contributor to population growth in urban centres. Migration can be broadly defined as the change of residence from one civil division to another with the goal of permanent relocation. Migration is often caused by a combination of push and pull factors.

Amongst the push factors in rural areas are:

- High unemployment rates and low incomes
- Unequal distribution of land, landlessness, Being Evicted from Land
- Prior migration patterns
- Dissatisfaction with housing, education and health facilities
- Lack of food and crop failure,
- Natural Disasters (i.e. river bank erosion, cyclone)

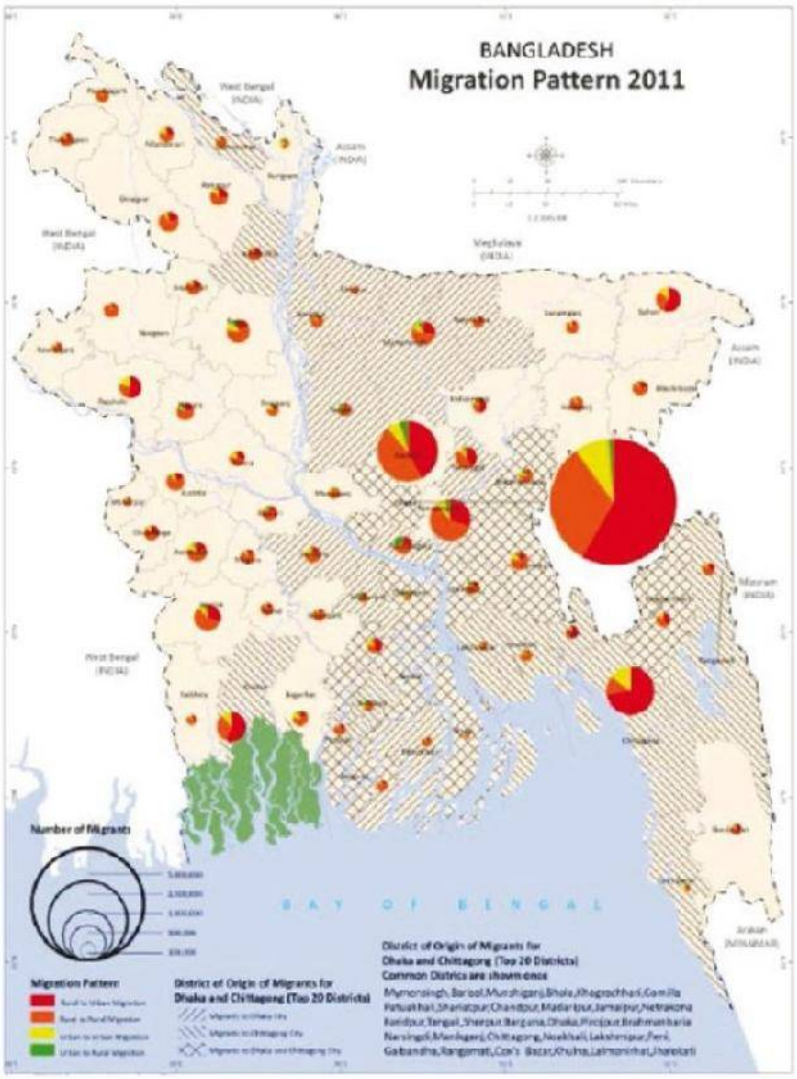


Figure 8 Migration pattern of Bangladesh

Source: FY2016-FY2020, Part 2 sectoral strategies, Programmes and policies, Planning Commission, Ministry of Panning GOB

Amongst the pull factors of the urban area's are:

- Employment opportunity
- Prosper of higher income
- Better facilities and services

Young people in particular are susceptible to the hopes and dream that modern city life promises, and choose to live in the city hoping to build their livelihoods and prosper, rather then working the fields in the countryside. Rural to urban migration was long seen as a positive phenomena in which workers needed for the urban industrial growth were coming from the rural area's. It was for a long time believed rural to urban migration both profited the personal as well as the urban and rural development. Therefore the focus of policies in most development countries was concentrated on Urban development.

There are definitely some benefits from migration, for instance the rural areas developed quicker by knowledge and financial means being returned. However the cons nowadays in Bangladesh outweigh the pros and urban migration is seen as a problematic issue since it contributes to urban unemployment, urban poverty, sum dwelling and unsustainable growth. Though migrants in general earn more money in the urban area's, the cost of urban living is also high, resulting in a lower living standard. Displacement by natural disasters is a contributor to urban migration, when people seek refuge in the cities as they have lost everything.

1.2.4 International migration

International migration can bring opportunities, when re-migrating labourers bring their work experience and knowledge from abroad back home. This creates an influx of knowledge which could offer new potential in both urban and rural areas. In Bangladesh there is a low rate of international high skilled immigrants or experts due to the poor quality of life and lack of amenities and recreational facilities, giving economic disadvantages since major companies are not willing to settle here.

1.2.5 Rural-urban linkages; growth centres

Rural markets are the nexus of commercial, social and cultural activities in rural Bangladesh. These markets vary in form and type; ranging from basic primary markets with limited facilities and catchment area to secondary markets, which are large and more focused on trade, export and processing. Some of these rural markets have been appointed by the Planning Commission as growth centres, based on administrative and socio economic characteristics. Growth centres have better facilities, aimed to serve a large catchment area which can hold multiple villages and smaller markets. For each local rural administrative unit (thana, union) a minimum number of growth centres is set.

The growth centres share market relations with the smaller markets and villages, which supply the centre with goods and vice versa. Around the growth centres some small industry can emerge for processing the agricultural products. The growth centres are the primary interface between the rural countryside and the urban centres; trades will buy up the goods to sell in directly in urban retail markets or to urban wholesale markets for further distribution. Again, road infrastructure is key is this interconnected network of markets. Therefore, the upgrading of roads and market facilities in growth centres and other smaller markets is key when pursuing rural development.

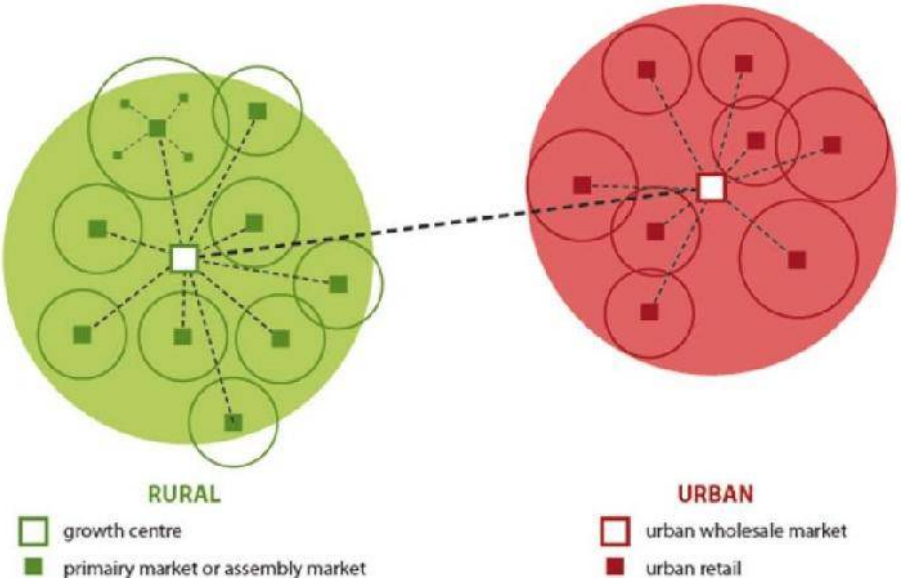


Figure 9 Diagram representing rural urban linkage

Source: Defacto urbanism

1.3 Rural settlements

Though Bangladesh has some very large cities it is a predominantly rural (nearly 76%) country. Low-lying alluvial floodplains comprise the major part of the land, which is a large river basin or delta with annual flooding of the numerous rivers and water bodies that define the landscape.

There are three main types of rural settlement: linear, clustered (or nucleated) and scattered. These patterns are originally related to the different physiographic characteristics.

1.3.1 Scattered settlements

The scattered settlements originate in the deltaic plain. The low moist areas and river valleys are very fertile grounds. During monsoon the areas inundate, therefore the houses are built on raised homesteads. Over time these individual elevations grew into elevated clustered settlements and towns. Such settlements are still being built. Though the settlements are elevated to adapt to the annual flooding, it offers too limited protection to extreme flooding. Connecting the scattered clusters is complicated and costly.

Where high land is not available, earth obtained from excavating ponds or channels is raised into a mound about 2 to 3 meters high depending on the surrounding water level, on which a homestead or "bari" is established. A bari often starts with an individual household and incrementally develops into a settlement of several "ghors" (dwelling units and secondary structures) of inter-generational households belonging to an extended family. Overtime more earth is added to extend the mound as the settlement gradually expands in an amorphous pattern. In many places settlements thus established on raised mounds are scattered throughout the low-lying terrain and in the rainy season virtually become islands.

A special type of the scattered settlement typology is the isolated scattered settlement pattern, which is found on Bangladesh's accreted islands ("chars") in the Bay of Bengal. The grounds of these islands are very fertile, but are also highly susceptible to extreme natural forces such as cyclones and cyclone induced storm surges. A few years after initial accretion of the char, it becomes suitable for cultivation. Typically a single family occupies the island by digging a pond for fresh water and using the ground for a elevation to erect a building on, surrounded with agriculture land. In time more families join and a scattered pattern of isolated houses emerges.

> Scattered (deltaic plain) > Scattered and isolated (Bay of Bengal islands)

Figure 10 sketches and satellite images of different scattered settlement patterns

1.3.2 Linear settlements

The elongated linear type is built on high land along naturally elevated river banks. With that, the area's elevation is above regular annual flood levels. Usually there is sufficient water available and infrastructure is easy to establish. In the case that the river course shifts the settlement pattern remains, hence many linear settlements can be found along dry, swamp or lake areas. Nowadays infrastructure has taken over the structuring role the rivers used to have.

In the Hill tract area near Chittagong we find a scarcely build linear pattern. This is because the for Bangladesh unique topography of hills and green vegetation. Since agriculture is difficult on the flat surfaces and gentle slopes along the streams, terraces are made to make the land suitable for agriculture.

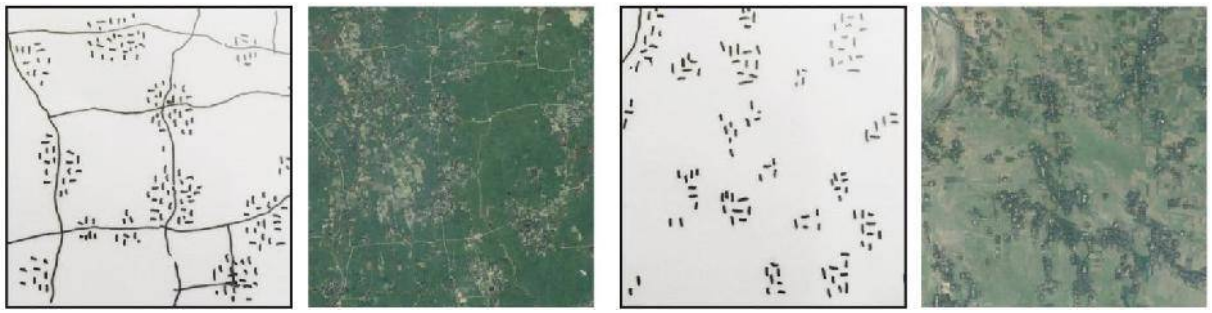
> Linear (river landscape) > Linear scarcely build (Hill tracts)

Figure 11 sketches and satellite images of different linear settlement patterns

1.3.3 Nucleated settlements

The high flat lands in the Northern Piedmont and Barind regions and the high grounds of the Hill tracks are safe from flooding. The settlements here cluster around the main roads.

In the lower areas such as the Haor and part of the South Central Zone dwelling are build on artificially raised mounds. This results in clustered settlements of high density. For those settlements it is costly to provide sociocultural and health facilities.



> Clustered (Northern regions) > Compact clusters (Hoar)

Figure 12 sketches and satellite images of different clustered settlement patterns

Knowledge gap

It would be interesting to study the settlement patters and especially changes of the patterns over time in more depth. Especially to be able to see how for instance the growth of Dhaka, the making of coastal polders and levees, and the establishment of the Upazilla Governance structure have influenced spatial patterns in the past. This knowledge can be used to abstract tools for guiding urbanisation and settlements.

1.4 Urban economy

As economies globalize, Bangladesh's economic structure shifts from agriculture to manufacturing and service. These secondary and tertiary sectors usually evolve in urban areas, because the areas are perceived to provide better infrastructure and proximity to other relevant companies. Urban and industrial agglomerations have several advantages. Economies of scale make it more efficient and effective to share market information, knowledge, new technology, product design and service innovations, and common research and development (R&D) facilities or centres lower the

costs of doing business. (Choe, K. and B. Roberts, 2011, p.1) Table 6 holds the sectoral contribution to GDP over the last decades.

Table 6 Changes in sectoral contribution to GDP in Bangladesh (BBS 2014)

Item	1980	1990	1997	2006
Agriculture	33,2	29,5	25,9	21,8
Industry	17,1	20,8	25,0	29,0
Services	49,7	49,7	49,1	49,2

Over the last decades the GDP share of industry has been rising at the expense of agriculture. This rise has been the product of mainly the export-oriented manufacturing industries and construction. The service sector is the largest source of employment, and it's GDP share will be even higher when including the large informal sector, which in some urban centres includes nearly half of the total workforce.

More information about this can be found in the BDP2100 baseline on Socioeconomic and demographic conditions.

1.5 Urban poverty

Boosted by respectable economic growth and a relative stable inequality, Bangladesh has made real progress in reducing poverty over the past decade. Poverty fell from 49 percent in 2000 to 40 percent in 2005, to 31,5 percent in 2010 (Household Income and Expenditure Survey HIES). Falling by about 1.7 % per year, the regional differences were significantly reduced from 2005 to 2010. Poverty projections suggest Bangladesh has achieved its Millennium development goal of halving its poverty headcount in 2015.

Even though improvement in wellbeing was strong across all regions, poverty continues to be a problem in Bangladesh, about 47 million people still live in poverty and 26 million people in extreme poverty. Moreover, poverty in rural areas continues to be relatively more persistent and extreme than in urban areas, whereas urban areas remain relatively more unequal. The urban poor live with many deprivations (World Bank, 2013);

Limited access to employment opportunities and income; Urban poverty is characterized by low pay and long hours. As an example most women face multiple challenges in balancing employment with childcare and the difficulty to earn income for their families.

Inadequate and insecure housing; with around 9 percent of households living in slum clusters, poorly constructed hut are continuously facing eviction threat. Implicating a constant migration within the urban area.

Violent, unhealthy environments and lake of services; Extreme poor families live usually in one room under plastic or recycled tin sheet roofs, with often Domestic violence. The difficulty to access basic services: water supply, sanitation, Evacuation of sewage, garbage collection implicating unhealthy environments.

Health and education; little or no social protection mechanisms with limited access to adequate health and education opportunities lead to urban poverty damage: Child-work, inadequate nutrition etc.

Urban poverty is also a dynamic condition of vulnerability to risks. When natural hazards (flood, drought, cyclones, riverbank erosion, landslides etc) happen, it activates mechanisms that affect the economic and social life of people in short and long-term. As poor people are more likely to live in disaster-prone areas, escaping from extreme poverty is getting difficult for poor people who lack resources to overcome their financial losses. The vulnerability derives from poverty itself.

Strategies for poverty alleviation generally focus on two elements; improving the physical circumstances and urban services in deprived areas and risky environments, and establishing a social "safety net" designed to protect the poor against loss of income. Special attention is needed to enable women to enter the labor market, such as child care facilities (Jolliffe & Sharif, 2013; Shahabuddin & Ali, 2006).

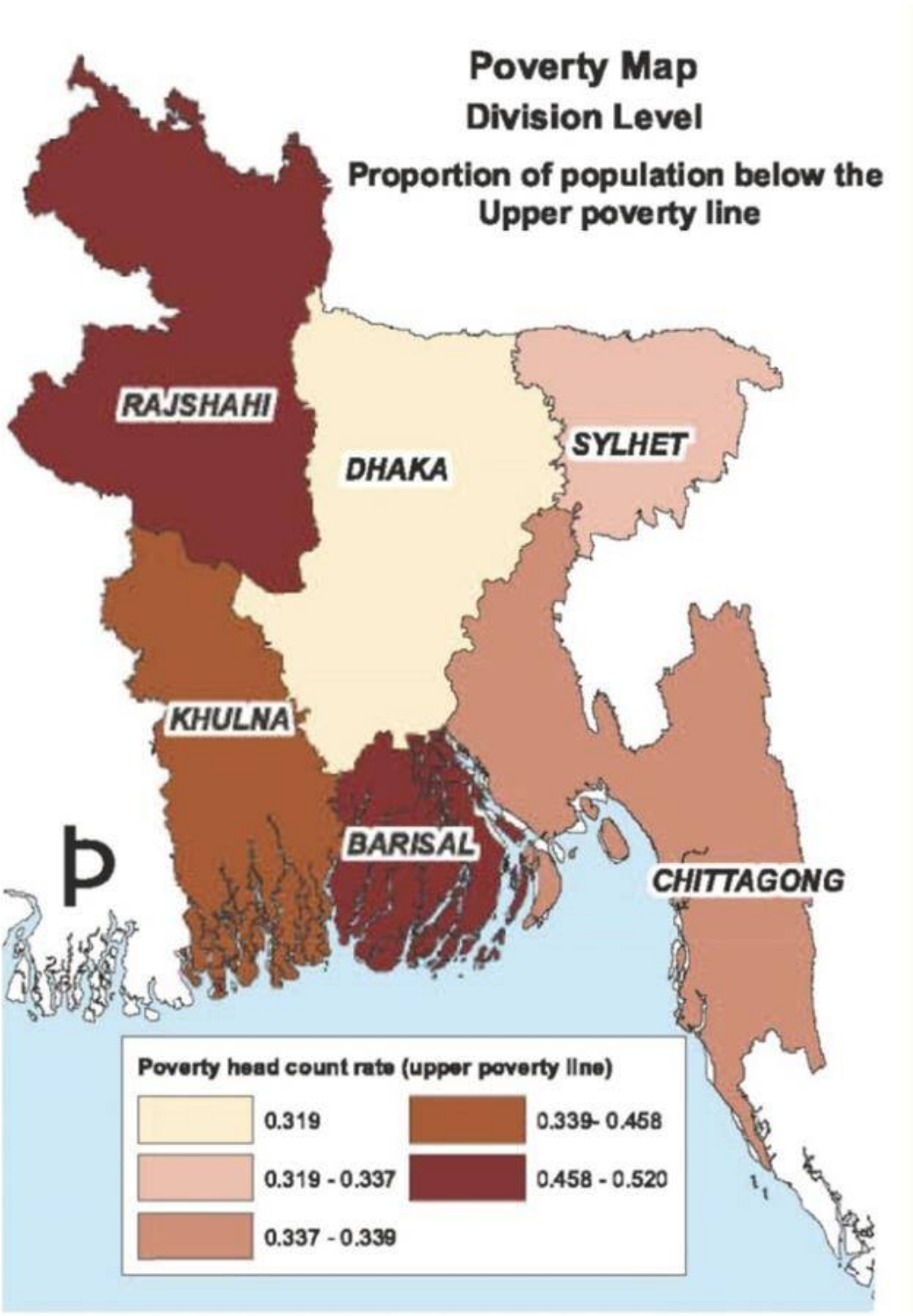


Figure 13 Poverty map division level

Source: Bangladesh Bureau of Statistics (BBS)

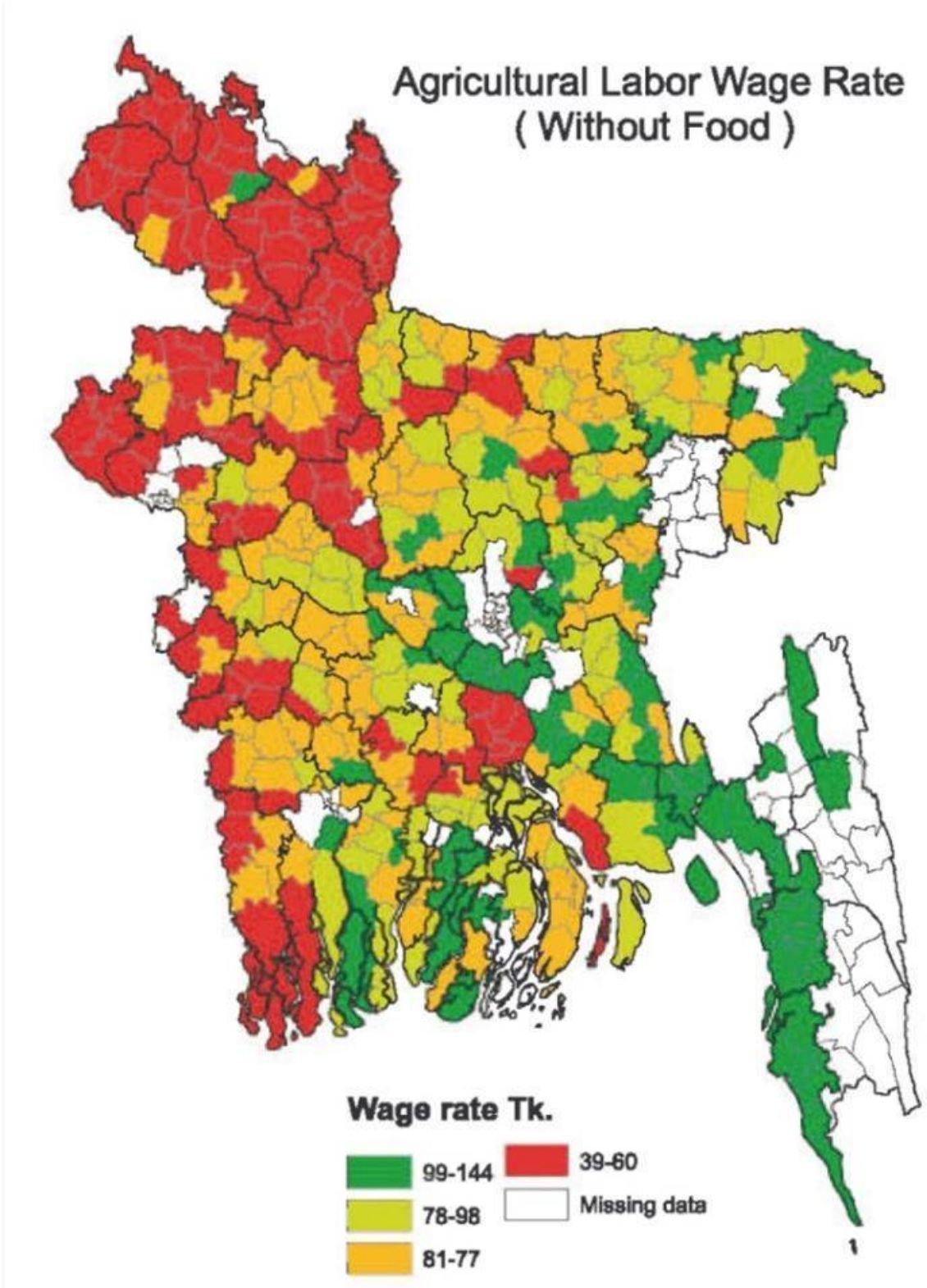


Figure 14 Agricultural labour wage rate (without food)

Source: Department of agriculture 2003

1.6 Population density

Due to the growing population and the limited availability of land, Bangladesh has the highest population density in the world (excluding city-states and small islands). Figure 16 holds a representation of the distribution of people around the world, higher densities are shown in darker colours. It is clearly visible that Bangladesh is one of the most dense areas of the world. According to 2011 census data, the total population density is about 1,015 people per square kilometre and the average urban population density is about 1,900 people per square km. Dhaka City is one of the most densely populated urban areas in the world, with 25,000 people per square kilometre. Especially in Old Dhaka and in slums the density is very high and reaches levels up to 130.000 people/km2.

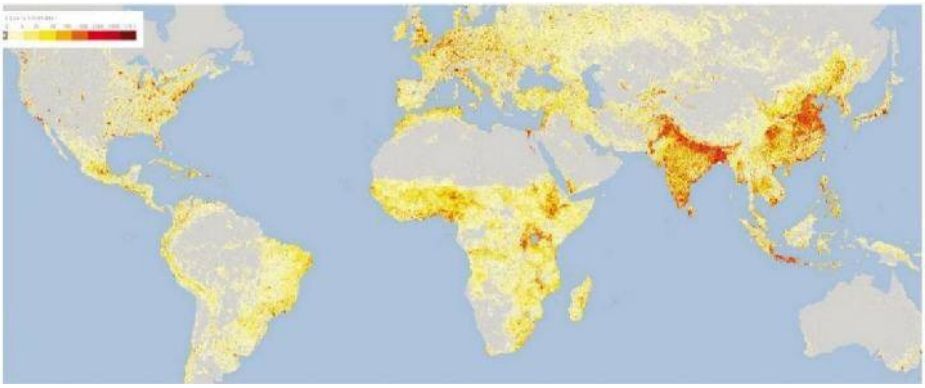


Figure 15 World population density map

Source: Population explorer, 2015

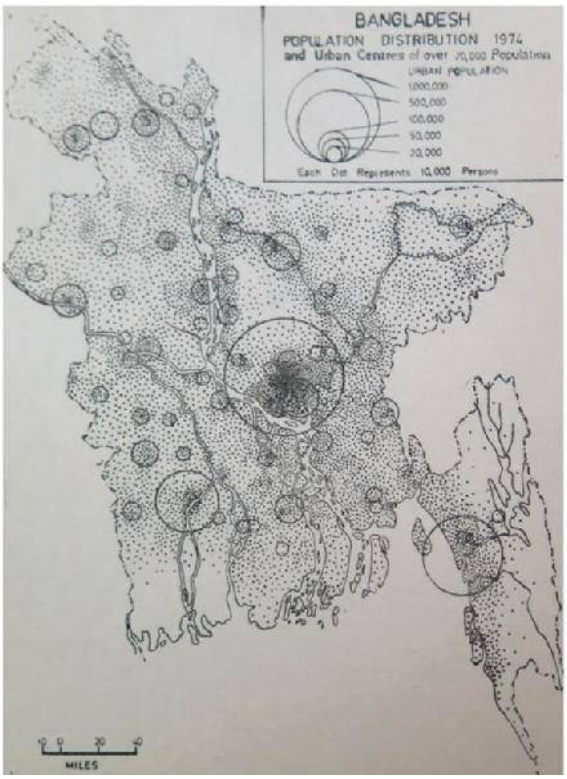


Figure 16 1974 population distribution

Source: UNHABITAT, 1974

In the 1974 population distribution map made by UN habitat (figure 17) as well as in the 2011 density map (figure 15) we see that the main urban centres are concentrated in the harbour cities Dhaka, Chittagong and Khulna. In the rest of the country we see a dispersed density pattern. With exception to the hill areas in the northwest, northeast and the Hilltracs in the southeast are less densely occupied, and the Sundarbans which are sparsely occupied. In the areas along the main rivers (and in the former Jamuna riverbed) we find higher occupation densities. In the area between Dhaka and Khulna a more dense corridor is appearing.

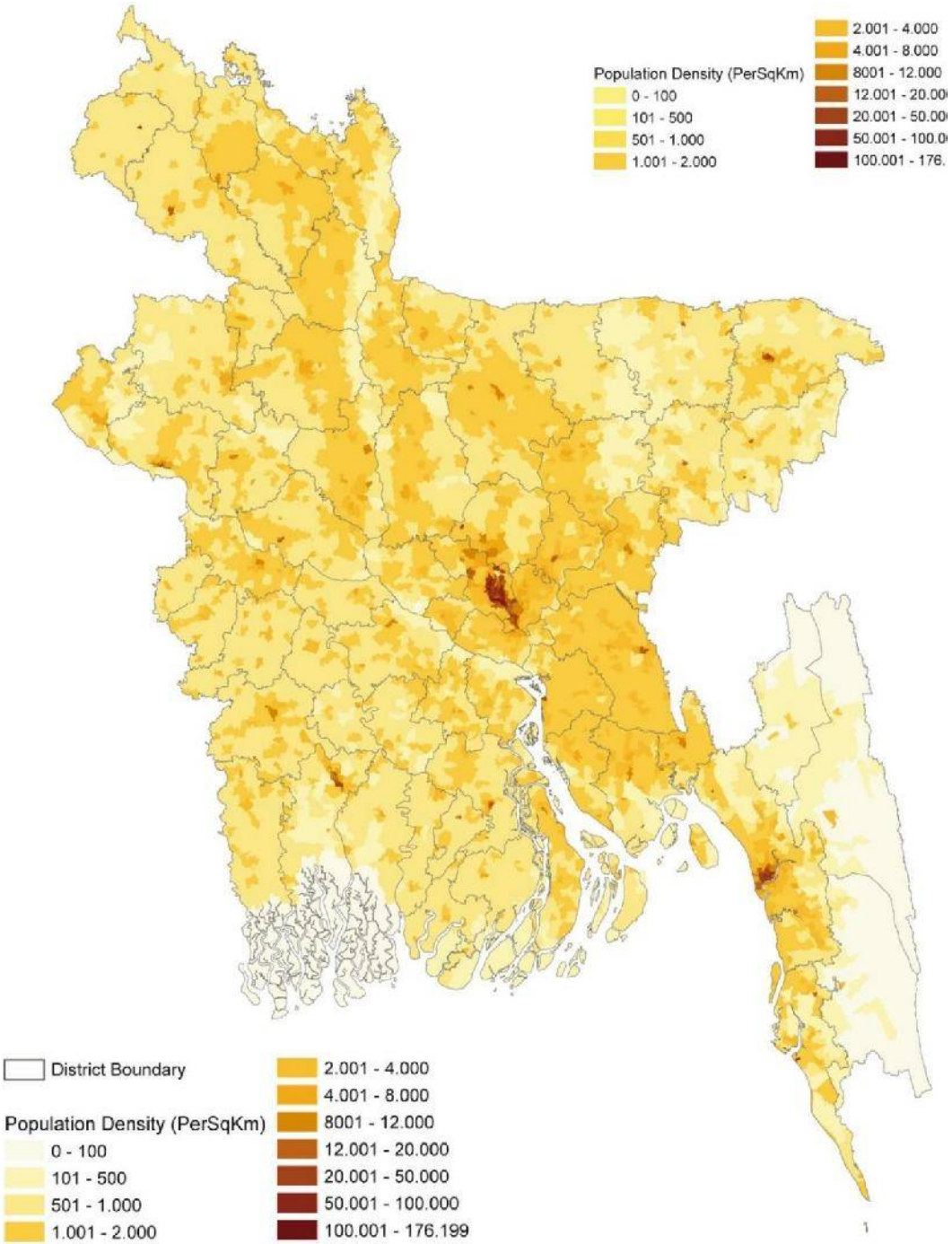


Figure 17 2011 population density map (Defacto Urbanism & CEGIS) based on union level data of the census 2011

1.7 Road network and connectivity

This aspect is mainly covered in the Infrastructure thematic baseline study of the BDP2100 project, here some highlights are shown from a urban perspective.

1.7.1 National networks

Infrastructure brings access to markets and with that potential for economic development and urbanisation. Improved access to markets is an important element of rural development and poverty alleviation. Some parts of Bangladesh are still poorly disclosed, hampered by the natural divisions of the river system. Comparing the Map of Travel Time to Dhaka (figure 18) with the poverty map, correlations between travel time to Dhaka and poverty incidence become apparent. Of course other factors such as floods and drouth patterns also influence the poverty.

Analysis of road density of the six major city corporations shows that cities compared to other parts of the country have higher number of roads. Accessibility to road is best in the Dhaka City Corporation, followed by Khulna, Sylhet, Rajshahi, Chittagong and Barisal with road densities of 12.46 km/sqkm, 9.85 km/sqkm, 9.05 km/sqkm, 7.67 km/sqkm, 5.78 km/sqkm, 4.09 km/sqkm, 0.95 km/sqkm respectively. The high road density in Dhaka is obviously high as it is the capital of the country. Khulna is a port city and Sylhet City Corporation is one of the oldest city corporations. Therefore both Khulna and Sylhet cities have received special attention in terms of development during the tenure of different political parties which is reflected in their higher road density next to the mega city of Dhaka.

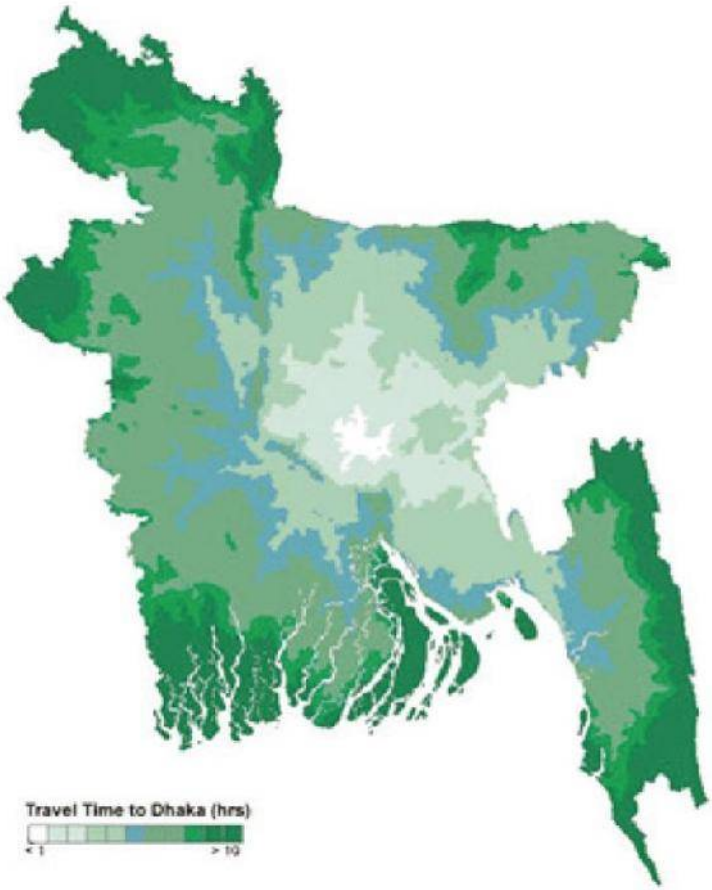


Figure 18 Travel time to Dhaka

Source: BBS, 2009

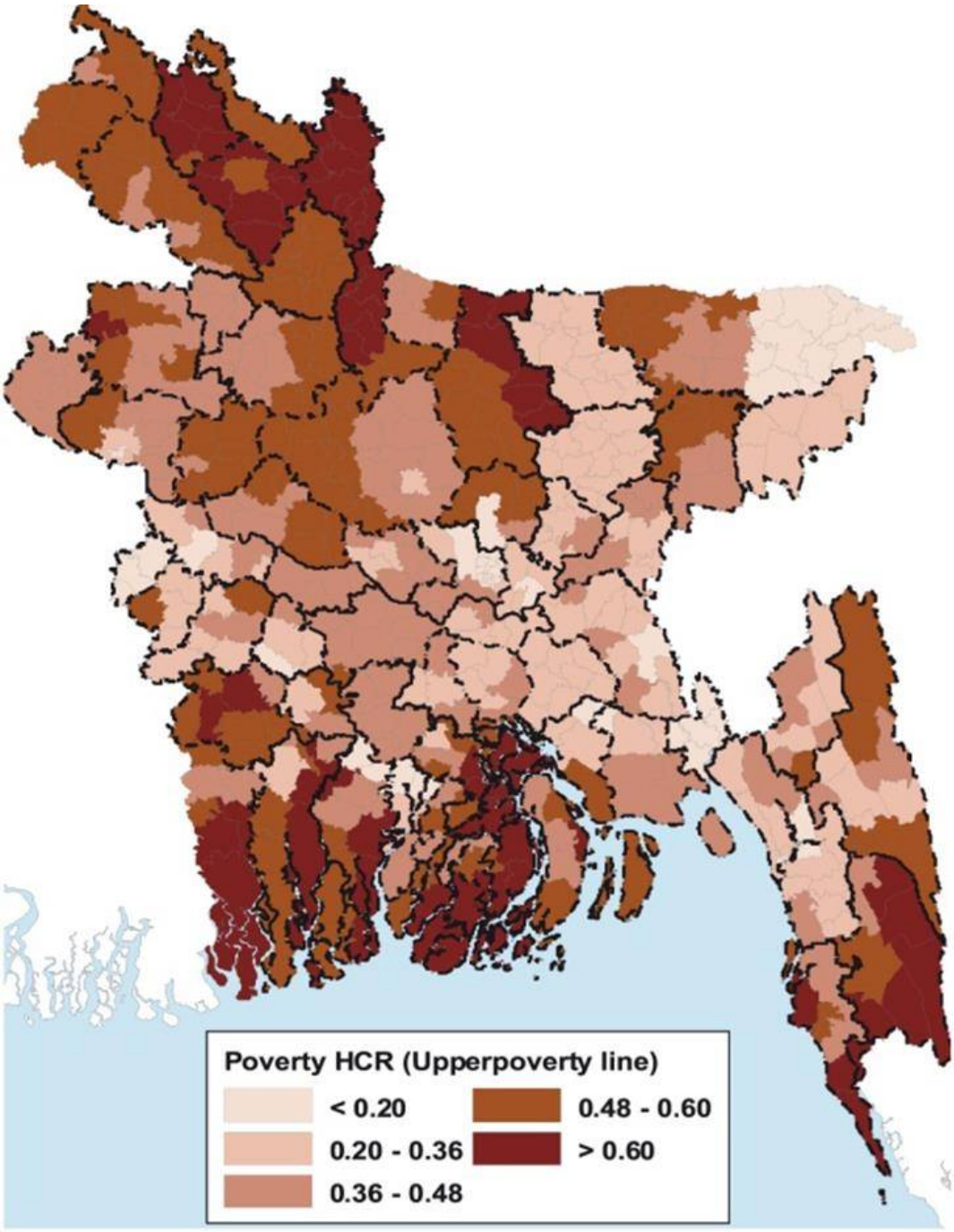


Figure 19 Poverty map Upzilla level

Source: Bangladesh Bureau of Statistics (BBS)

According to the regional analysis, highest density of road network is found in Barind region with density of 0.82 km/sqkm. Next is the coastal zone, with a density of 0.60 km per sqkm. Haor being mostly a wetland area, it is very difficult to construct roads there and so water transportation is the main mode of traffic movement. Hence, road density in the Haor region is very low with 0.52 km per sqkm. Similarly, due to the hilly topography of the CHT region, this region have the lowest density of roads which is only 0.29 km /sqkm.

In figure 20 we see the accessibility index of markets. Bandyopadhyay & Skoufias describe this as: 'The access to market index measures how easily people can reach markets; it is the sum of the population of the markets in the vicinity of a location inversely weighted by the travel time along the transportation network to these markets (Blankespoor and Yoshida, 2010). The index was calculated with the negative exponential potential accessibility model for 202 markets with populations ranging from approximately 15,000 to 6,500,000 (Dhaka) and aggregated at the Upazila level.'

The construction of the Jamuna Bridge was an important step in connecting the north west, boasting the economic perspective of the region. These big infrastructure works are important developments that can shape the country's economic and urban perspective.

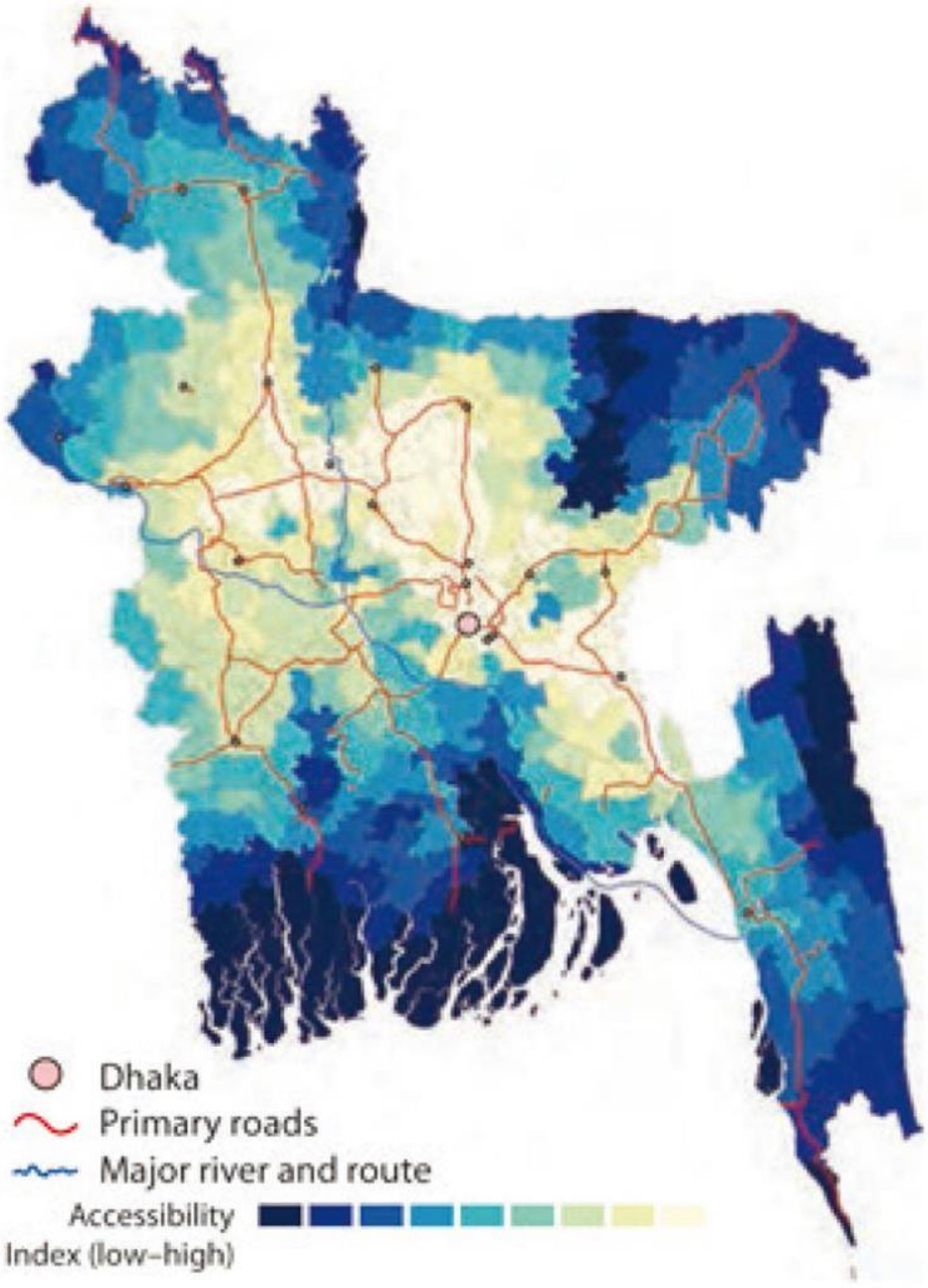


Figure 20 Accessibility to markets in Bangladesh

Source: Muzzini and Apparico 2013

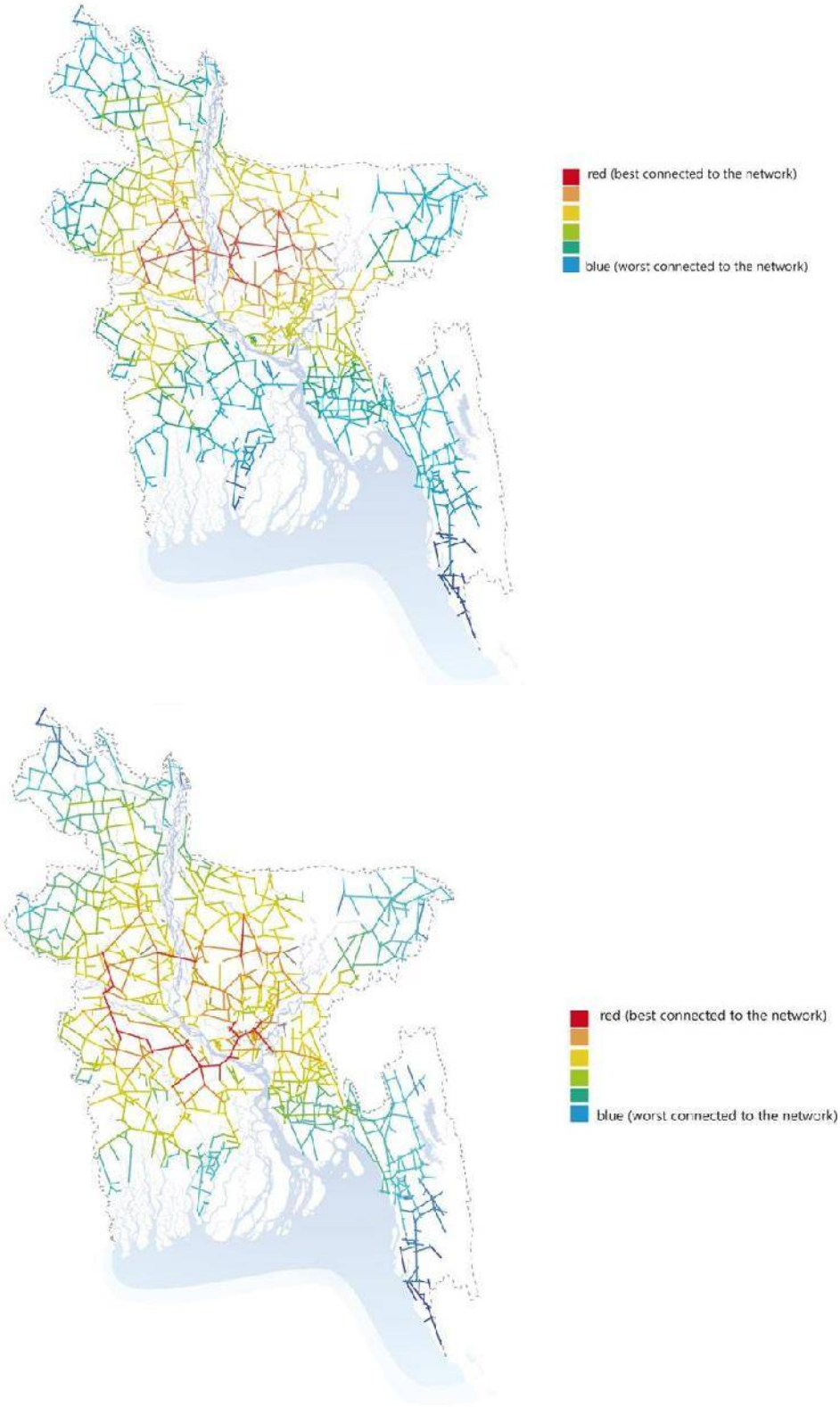


Figure 21 Bangladesh space syntax analysis current situation

Source: Defacto urbanism

Along highways build clusters and markets are forming. Those centres close to the high speed road slow down the traffic since here people park and exit or enter the road, and activities are taking place near to the road. Additionally this proximity of build area next to the road will make it difficult to extend (widen) the road in the future. It can be recommended to have a building free reservation zone along the road; this will prevent accidents, prevent slowing down the traffic and will in the future prevent costs when widening the road. Lack of traffic rules or implementation of those rules on highways are causing dangerous situations. Goast traffic, passing in bends of roads and overloading trucks can cause dangerous situations.

Currently there are a lot of different transport modalities on the road with different speeds of travel: pedestrians, cattle, riksjas, CNG's, cars trucks and busses all use the same road. The connection offered by the highways is essential for trade and transportation, so on the short term it is no wise to prohibit the low speed users from using the highway, since not sufficient alternative route connections are available for them. When the road network has a higher coverages will be develop further it will become possible to create more hierarchy between roads, divert different speeds and create highways for high speed transport.

1.7.2 Inland Waterways

An intricate system of Rivers, canals and the sea serves the navigation purposes in Bangladesh. Waterways are used for carrying both people and goods and applicable for those river channels where water flow is available either perennially or seasonally. This mode of transportation is very suitable for remote location and also those areas which have low accessibility to roads.

Initially in 1963, about 12000 km long navigable waterways were identified. However, in 1989, Bangladesh Inland Water Transport Master Plan was prepared by the DHV consultants in which a revised classification was put forward based on the Least Available Draft (LAD).

Table 7 Types of Waterway routes

Class	Indicated draft (m)	Length (km)	%
I	3.6	683	11
II	2.1	1000	17
III	1.5	1885	32
IV	<1.5	2400	40
Total	5968	1--	

Source: Bangladesh Inland Water Transport Master Plan, 1989

According to the Bangladesh Inland Water Transport Master Plan (BIWTMAS, 1989) the routes existing under these four classes are (Source: Baseline study of Sustainable Transport and Infrastructures, BDP 2100)

Class-I: Comprising the perennial Routes configuring the propeller–shaped spine of the system that interconnects Chittagong-Dhaka/ Narayanganj (and extending to Ashuganj/Bhairabbazar)-Khulna/Mongla via Barisal (Ilsaghat/Hizla) where the largest LAD of 3.60-3.90m is to be maintained all year round with a total length of about 685 km.

Class-II: Routes (perennial) linking major inland ports for the north-west and north-east hinterlands i.e. Baghabari/ Nagarbari (and further north to Chilmari) and the Sylhet region to class-I Routes where the next highest LAD of 2.10-2.40m to be maintained all year round with a total length of 1,000km.

Class-III: Routes, where it is usually not feasible to maintain perennial routes with a LAD exceeding 1.5-1.8m either transit Routes such as Zakiginj-Fencheganj-Ajmiriganj-Dilalpur (Kushiara and Kalni River) or feeder Routes connected with class-I and class-II routes e.g. stretches of the Kangsha, Titas, Lakhya Rivers, route around Dhaka, Karnaphuli River and the tidal rivers in the south-west/ central region with a total length of 1,885km.

Class-IV: Routes basically seasonal, where it is not feasible to maintain a LAD of 1.5m in the dry season with a total length of 2,400km.

Analysis of region wise data shows that Coastal region has the highest length of waterways which is 1573 km followed by Haor region 1160 km, then Barind region 283.06 and Chittagong Hill Tracts with 179.37 km. However, density wise estimates provides a different picture where Haor region have the highest density with 0.06 km/sqkm followed by the coastal zone 0.04 km/sqkm, Barind 0.02 km/sqkm and CHT region 0.013 km/sqkm. Lowest density in CHT region is attributed to its very few waterways because of the hilly topography. People living in midst of the Haor are mainly dependent on country boats for the transport of their goods and services. They also use waterways for accessing facilities like schools, hospitals and markets.

The CHT mainly has waterfalls and creeks whose water is used for drinking and household purposes.

Historically cities around the world have originated along the major rivers. This is how the trade in and outside the city area has flourished and made it possible for it to grow. Similarly, the data of the major city corporation area shows that length wise highest length of waterways is in and around Chittagong City Corporation followed by Dhaka, Barisal, Khulna, Rajshahi and Sylhet city corporations. Estimation according to density revealed a picture similar to the regional analysis where Sylhet city corporation has the highest density (0.34 km/sqkm), followed by Barisal (0.28 km/sqkm) and Khulna (0.25 km/sqkm) located in the coastal zone. Dhaka City Corporation mainly dependent on road transport and Chittagong City Corporation due to its topography have the lowest density of waterways with 0.17 km/sqkm and 0.16 km/sqkm density respectively.

1. Port facilities

Bangladesh has only two ports-one in Mongla, Khulna and another one in Chittagong. Out of these two, the Chittagong port has emerged as the major one because of better connectivity to the capital city of Dhaka and other districts through roads, railways and airport. The Mongla port serves only 6% area in the southeastern and northern parts of Bangladesh. Within Bangladesh there are 21 river ports and the number of landing stations are 380. Most of these lack up to date technical facilities and also some are in a very dilapidated condition (Source: Baseline study of Sustainable Transport and Infrastructures, BDP 2100)

2. Vessels

The inland waterways are mainly responsible for transport of bulk, dry bulk and liquid bulk of construction materials, food grains, fertilizer, clinker, petroleum product etc. As per the estimates of BIWTA, there are 745,000 country boats. The number of boats mentioned in the Masterplan is 1.01 million. Total number of vessels registered under the Inland Shipping Ordinance (As in December 2013) is over nine thousand. (Source: Baseline study of Sustainable Transport and Infrastructures, BDP 2100)

1.7.3 Urban transportation

With rapid urbanization comes the increased need of transportation. As the number of motorized and non-motorized has risen significantly in the last decades, heavy congestion of the transportation network is now a common phenomenon. This limits the growth of cities and ultimately the economic development of the country. Traffic management has been inadequate to cope with this growing demand. The situation can be improved by addressing the following issues:

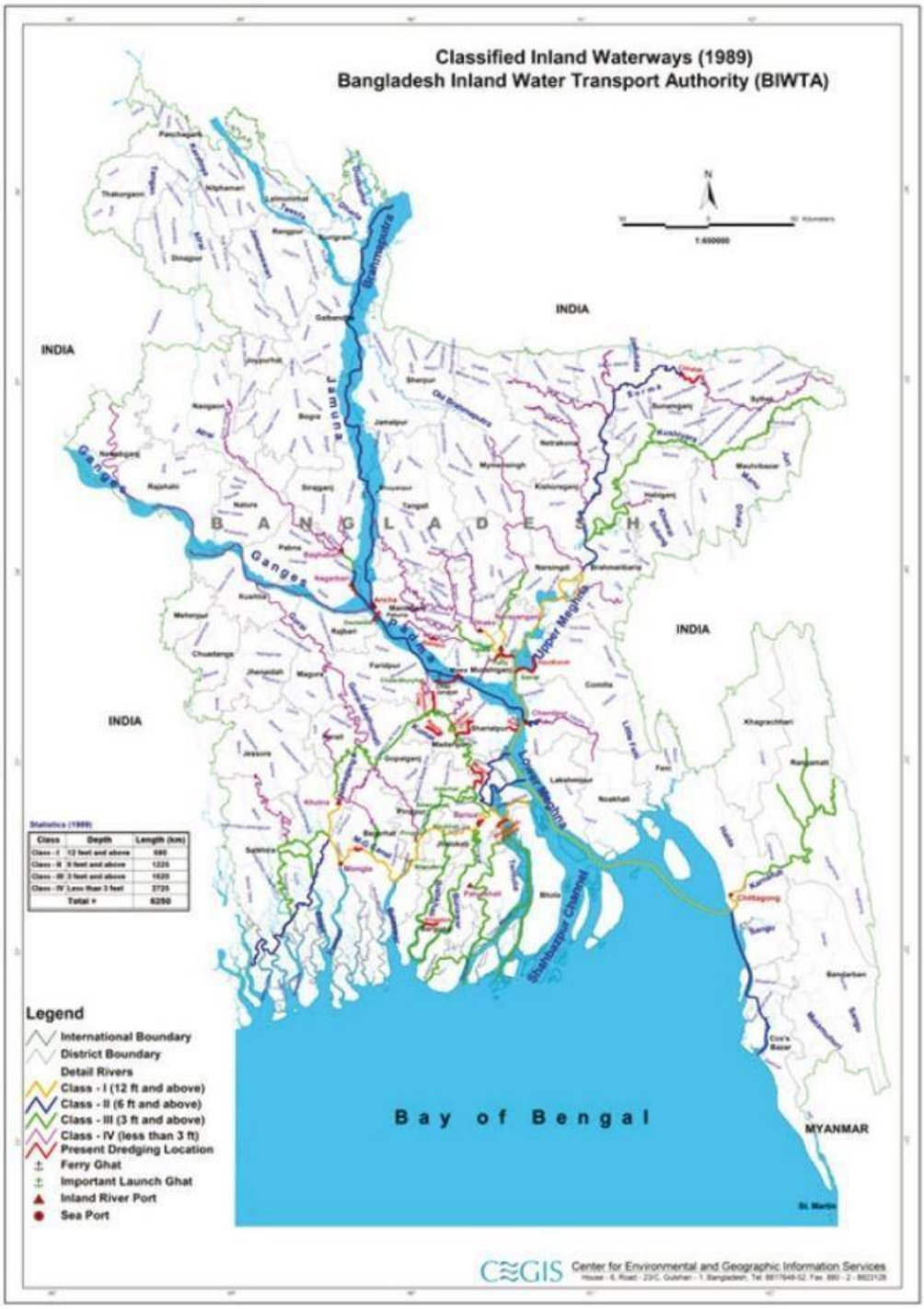


Figure 22 Map of Inland Waterways and facilities

1. Road encroachment

As general land use management and control is poor in Dhaka, roads and sidewalks are taken over by traders and squatters and are subjected to uses for solid waste and building materials and illegal parking of vehicles and rickshaws. This leads to chaotic situations, strongly limiting the capacity of the network.

2. Varied mix of users using the same lanes

Motorized and non-motorized vehicles are forced to use the same lanes in urban traffic. The role of rickshaws, pull carts and other forms of non-motorized vehicles is crucial in the development of Bangladesh's urban transport systems. In Dhaka, about 34 percent of all trips made in 2004 were done by rickshaws. The current failure to disentangle slow and fast moving traffic hampers the smooth flow of traffic. Pedestrian traffic has the largest share of trips made in urban centres, whilst facilities like sidewalks are mostly absent.

3. Inadequate road infrastructure

Roads are mostly developed haphazardly without a strong planning in hierarchy and according dimensions. Upgrading important connecting roads is costly, since no right of way has been established in the past, and plot owners adjacent to these roads have to be compensated. Traffic that want to pass Dhaka has to move through the city centre. The 2013 land use survey shows that roads and railways only take up 2,30% of the capital's total area, whilst this figure is at a minimum 15% in modern, well-developed metropolises.

4. Public transport

Bus transport is the main mode for transporting large groups of people at the same time in the city, as large scale mass transit systems lack. Busses and microbuses are owned by an extreme multiplicity of owners, making transport management and coordination very hard. Modal interfaces (bus stops etc) are very poorly planned and equipped. The lack of a Mass Transport System in Dhaka becomes ever more pressing as its population grows, although there are plans for a metro line.

5. Waterways

In some cities the adjoining waterways could be used for fast urban traffic, as for example in Bangkok. Specifically for Dhaka this could be a potential worth addition to the system. For now, the waterways are not contributing to the urban transport system due to lack of landing stations on eastern sides of the city and again the absence of linkages with other modes. Fast moving boats will have to be introduced to compete with fast road transport.

6. Inadequate traffic management practices

Transportation functions are split between different agencies, with very little coordination, making the transportation system in total very ineffective. The lack of integration between land use management and traffic management leads to sub-optimal situations in every city.

7. Parking

As motorization of the public is progressing, more space is required for parking vehicles. Road lanes that should be available for traffic are occupied by parked vehicles, sometimes taking over more than 2 lanes and completely blocking the road. Non-motorized vehicles like rickshaws and pull carts are also parked everywhere since there is no enforcement of restriction of parking.

1.7.4 Rural traffic

The rural road network is often of poor quality, both with regard to the quality of the road; many roads are unpaved, as with regard to the connection to the main network; many roads are non-contiguous due to a lack of bridges over the large amount of waterways crossing the roads.

Figure 23 shows a 'space syntax analysis' in which the network integration is shown. From red (best connected with other places in the network) to blue (worst connected to the rest of the network) we see the connection of different area's within the overall network. The analysed network contains national, regional and district roads. In this analyses the quality, capacity and congestion of the roads has not been included. If you would include this data it would better

fit the actual situation of connectivity (for instance Dhaka-Chittagong connection is in reality good). In Figure 24 we see how the construction of the Padma bridge would improve the network integration.

Knowledge gap

In the current models constructed by the authors the quality, capacity and congestion of the roads are not included in the network analyses. A model that would include such data and extends to the local scale could be a valuable base for drafting a national infrastructure investment plan. Especially since network integration (especially access to Daka and markets) is closely linked to poverty, using this model the impact of new road connections or improvement to overall network integration could be estimated.

1.7.5 Upcoming infrastructure developments

Major infrastructure developments can have a big impact the rural and urban development. Additional or improved roads and waterways give new opportunities previously unconnected areas, as good (or improved) connectivity is a major settlement condition. New land ports, seaports or industrial areas (such as the economic export processing zones) create job opportunities, and hence attract people that settle in proximity of the new developments.

The main major upcoming infrastructure projects are:

- India -Bangladesh - Myanmar - China corridor, which includes the Padma bridge and the UDD's Kolkatta - Jessore corridor project (figure 26)
- Bangaldesh Ganges barrage
- Upgrading of the Mongla port (near Khulna)
- Sonadia deep sea port (near Cox' Bazar)

Beijing has the ambition to connect central China to South East Asia, improving the geo-economic positions of Kunming and Chengdu by shortening its access to the Indian Ocean drastically. This development can give shape to a Chittagong-Myanmar-Kunming corridor (fig 26). On this strategic scale level Bangladesh's seven national Export Processing Zones (EPZ's), which aim to attract international investments and generate employment, should be regarded as well.

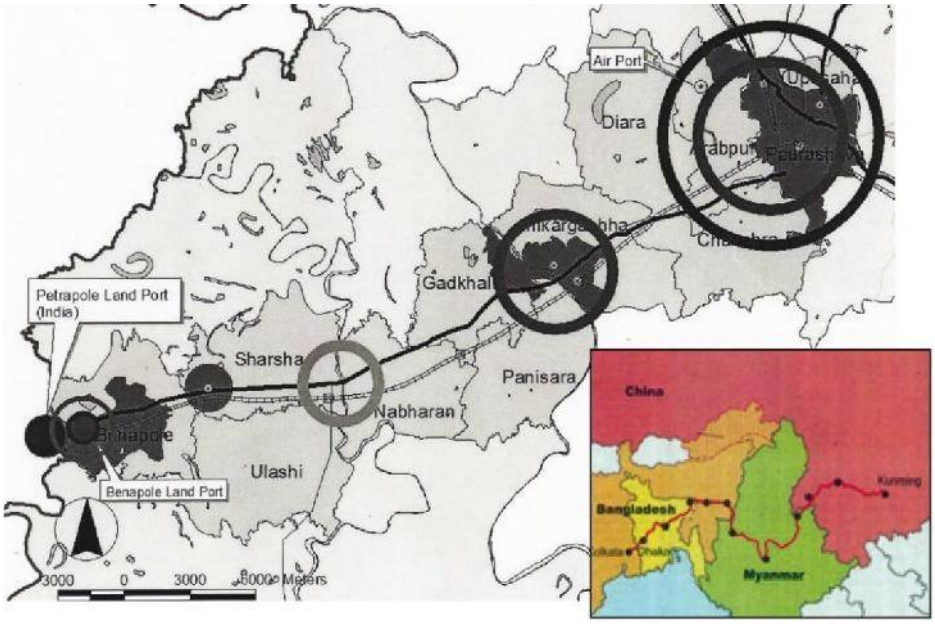


Figure 23 Kolkatta - Benapole - Jessore corridor project (courtesy of UDD) and international highway corridor (courtesy; the Independent)

1.8 Housing

The housing situation in Bangladesh has both a quantitative as a qualitative dimension. There is a huge backlog on the provision of housing in urban areas, which accumulated to 4,6 million units in 2010. The national housing authority estimates that in 2021 this deficit will have risen up to 8,5 million. Especially in the rural and economically depressed regions of the country, the quality of housing is an issue.

Table 8 Housing deficit in urban areas

Year	Housing deficit in urban areas	Total urban Population (mln)
1991	950.000 units *	20,87
2001	1.130.000 units *	28,81
2010	4.600.000 units	43,43
2021	8.500.000 units	60,00

*Source: S. Jahan 2012 *; HIES, 2010; BBS 2001; National housing authority, 2005*

There are four categories of structures found in Bangladesh: pucca (brick/concrete), semi-pucca (partially brick), kutcha (temporary houses made of Tinshed, Bamboo, mud etc) and jhupri (temporary houses made of Bamboo, mud etc). According to the Urban Area Report of BBS 2011, in the country, 11.32% household structures are pucca, 19.61% are semipucca, 66.19% are kutcha and the remaining 2.88% are jhupri. Households in the urban area consist of 31.86% pucca, 32.02% semi-pucca, 33.54% kutcha and 2.59% jhupri. Regionwise analysis shows that the city corporations have higher number of pucca structures than other parts of the country. More than 75% of structures are brick built in the city corporations with 38.55% pucca and 38.22% semi-pucca structures. Pourshavas have 16.04% pucca and 34.06% semi-pucca structures.

The type of structure that is built reflects the local economic conditions as well as the environmental conditions. So, areas that are vulnerable to natural hazards such as floods, erosion, cyclones tend to have poor structure. The cities on the other hand despite being vulnerable to hazardous conditions is inclined to build solid and permanent brick structures because of their improved economic condition. This is why, the hilly CHT region, depressed areas of the Haor region and the districts surrounding the River & estuaries have poor structures compared to the rest of the country.

Among the regions, the coastal zone has the highest rate of pucca structures upto 25% and the Barind have the highest rate of semi-pucca structures upto 37.5%. In the Haor region, structures are of mixed type where 46% to 92% structures are kutcha or jhupri, 1.5% to 21.7% are pucca and 10% to 31.2% are semi-pucca structures. Districts situated along the rivers and estuaries are mostly occupied with Kutcha and jhupri type of structures. These types of temporary structures are also visible in the CHT area with 82%-87% kutcha and 4%-6% jhupri houses.

Another major issue that is underlying the slow provision of housing is the poor access of potential home-buyers to financial services. Only the high income groups have access to the mortgage market, or fund development though equity. The major challenge in the future will be to allow the low and middle-income groups access to the housing market. To allow this, the general availability of long term funding (eg bonds) should be improved in Bangladesh to improve the liquidity of lenders. The rising cost of building materials and the poor state of land administration are potential threats to improving the access to housing of the lower and middle income groups.

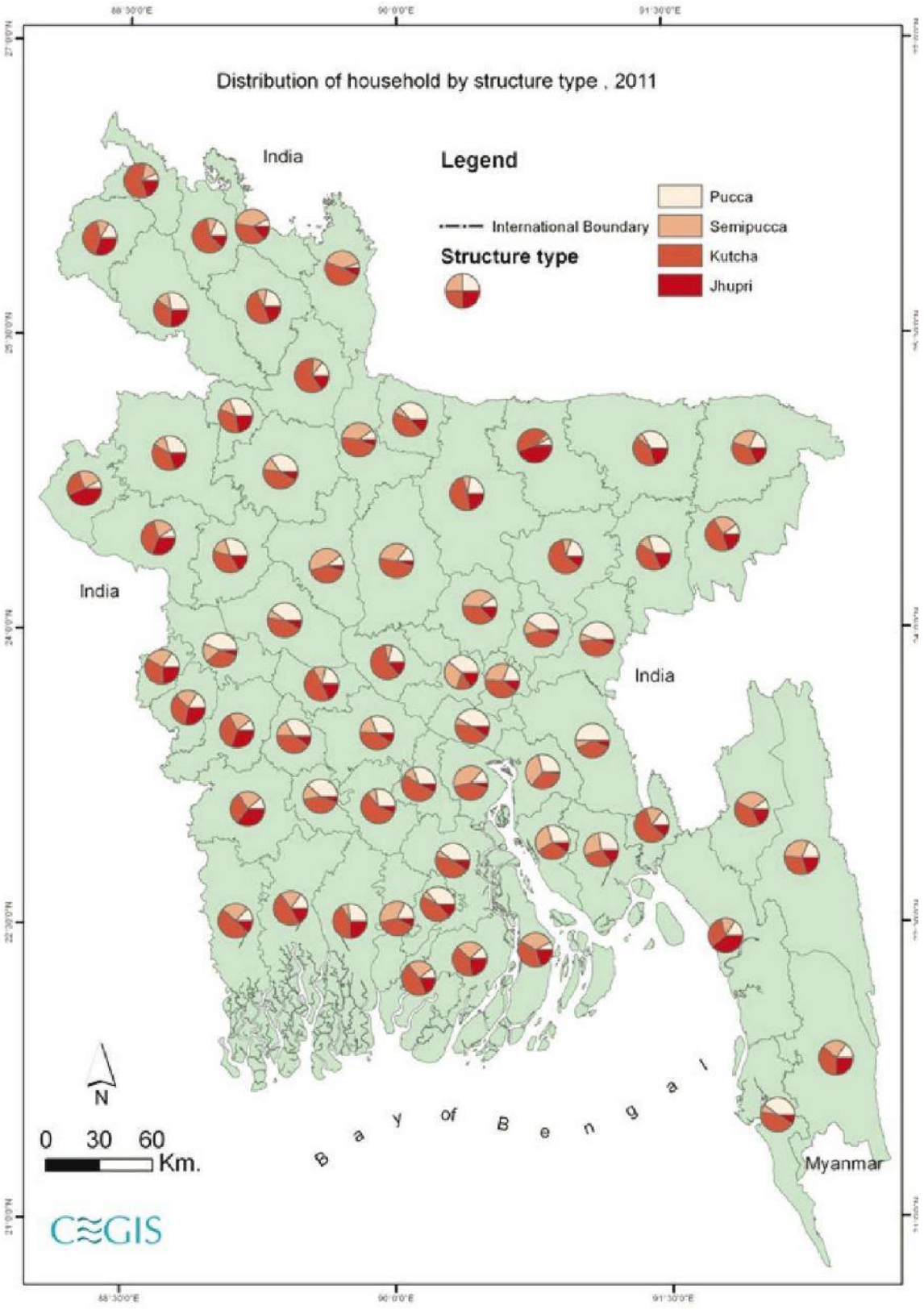


Figure 24 Distribution of household structure type

2 Spatial Planning Structure and Urban Governance

2.1 Ministries and agencies

Three ministries are involved in planning: the Ministry of Planning, the Ministry of Local Government, Rural Development and Co-operatives, Ministry of Housing and Public works.

2.1.1 Ministry of Planning (MoP):

Prepares economic plans for the country. The Five year plan (FYP) provides budgets for sectorial allocation rather the spatial allocation.

2.1.2 Ministry of Local Government, Rural Development and Co-operatives,

Responsible for local government in a strict separation between urban and rural area:

- Rural local Government (division council, district council, Upazila council, Union council)
- Urban local Government: City Corporation (6 + 5 upcoming) and Municipalities (Pourashava; 322)

Although Upazilas fall under rural local government, it can hold multiple villages, which can be turned into Pourashavas (municipalities) when a village reaches 15.000 inhabitants. This does not mean that the complete village turns into a Pourashava, only a part of it will, typically the most dense part. Later, the Pourashava area can be extended. A Pourashava receives additional funds from the central government, and it has more services (depending on their tier or size; A, B, C), therefor its inhabitants have to pay extra taxes. A Pourashava is always confined to a single Upazila. Both the Upazila and Pourashava have elected councils. A common issue of debate is the Upazila budgeting, and how much of the budget should go to the Pourashava, which receives additional funds.

Under this ministry sits the LGED; which produces master plans for local government bodies;

- LGED (Local Government Engineering Department); entrusted for planning of local level rural urban plans and planning and implementation for small scale water resources infrastructure development programs.

Recently, the LGED received the mandate to produce (master) plans for Pourashavas, which was the sole domain of the UDD earlier. As the Bangladesh's urban centres grow, the demand for planning services grows along with it. To cope with this strongly increasing demand for Pourashava Master Plans, the LGED was put forward to increase the total planning capacity. The LGED has many local officers stationed in Pourashavas and some large Upazila villages.

2.1.3 Ministry of Housing and Public works:

Is entrusted with carrying out public sector construction activities and looking after urbanization, city development and housing settlement aspect. Under this falls:

- City Development Authorities of Dhaka (RAJUK), Chittagong (CDA), Khulna (KDA) and Rajshahi (RTDA) have jurisdiction in their metropolitan area. Other divisional towns such as Sylhet and Barisal do not have development authorities, although it was mentioned that these are about to be set up.
- UDD (Urban Development Directorate) the jurisdiction of UDD is the whole urban area except those under jurisdiction of City Development Authorities such as RAJUK, CDA, KDA, RTDA.

Activities for physical development are carried out per Annual Development Plan (ADP), implemented by different national and local authorities of different sectors.

When we look figure 25 we see that within the administrative structure there are exceptions with regard to the Hill tracks: 3 districts fall under the Ministry of Chittagong Hill tracts affairs and the local government special areas.

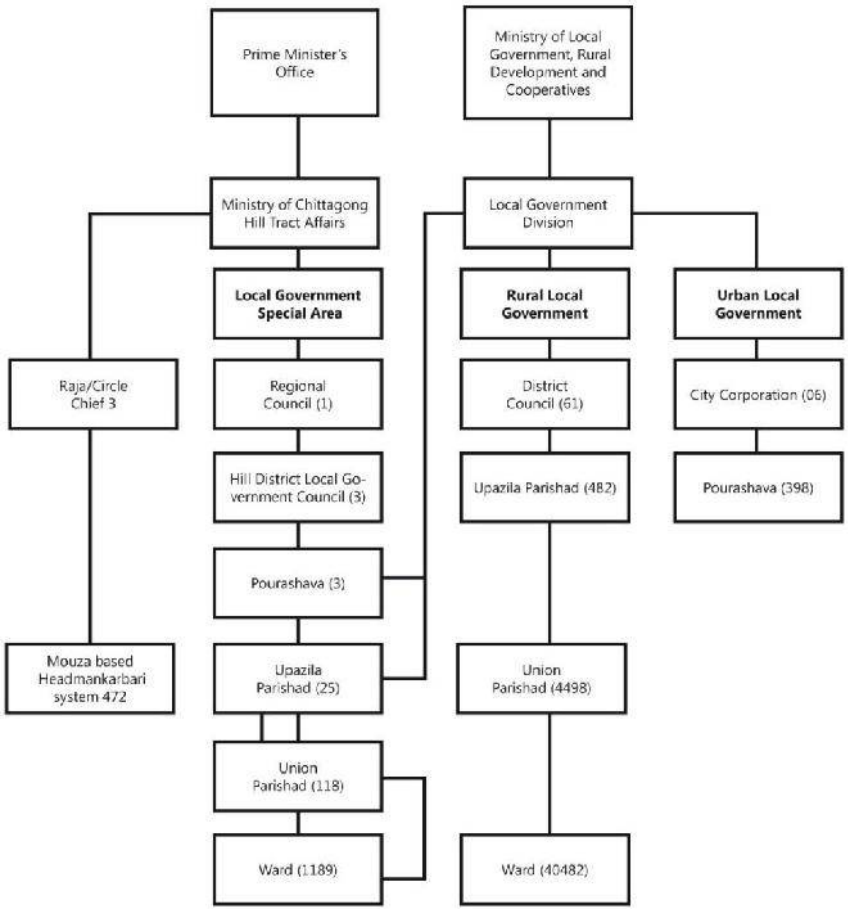


Figure 25 Existing structure of local government in Bangladesh

Source: Panday 2011

2.2 Process for plan preparation

Land use planning and urban planning is performed by the UDD and LGED for all municipalities (all Pourashavas and the City Corporations that to not have a City Development Authority) and some towns (Upazila Headquarters and other smaller Upazila Towns). Both agencies make the same type of plans, however they do not work together on the same plan for one Pourashava for example. Both agencies do some monitoring on the plans they produced, but generally they do not oversee the implementation and enforcement of the plan. This responsibility lays with the local custodian; the Major and Council of the City Corporation, Pourashava or village concerned.

Currently, the UDD currently runs three major projects:

- Benapole – Jessore highway corridor development
- (after instalment of Padma bridge this will be vital economic zone)
- 14 Upazila development plans
- Mandaripur-Rajoir development plan

Large plans the UDD performed earlier are the:

- Cox's Bazar master plan
- Sylhet master plan
- Barisal master plan

The LGED is currently making plans for 223 Pourashavas and some infrastructure; the plans include roads, bridges/culverts, drains, bus terminals and waste dumps. These plans will be completed in June 2015. The LGED also handles water development issues in plans and implementation. The water cycle is seen by the LGED as the main driving force of physical change in Bangladesh. The Project Factsheets Annex holds an overview of all upcoming plans by the LGED and UDD regarding urban and rural development.

2.2.1 General planning structure for master plans produced by the LGED or UDD

The planning process starts by the initiative of a custodian (major, council) asking for a master plan or land use plan, or when by study it becomes clear that an area needs urban and land use planning (e.g. the Benapole - Jessore highway corridor).

Typically, a three tiered planning structure is followed:

- Structure plan (20 yrs) which holds a strategy and policy guidelines
- Urban plan (10 yrs) which comprises a land use plan, a transportation and traffic plan, an a drainage & environmental management plan
- DAP (Detailed Action Plan) (5 yrs), holds a detailed plan for every of the usually 9 wards in the Pourashava and an investment plan

In the inception phase it can be decided to make a regional plan before starting to draft the structure plan, for instance when a Pourashava is located in a corridor.

At the basis of planning stand the socio-economic data produced by the BBS. In some cases, the agencies do their own surveys (sometimes in-house, mostly by consultants). This is also done for more technical (GIS)data (current land use, population, literacy, economic zones, hydraulic conditions, industrial zones etc.). With this information a conclusion is reached on what is the situation now. Additionally, the relevant laws, regulations and policies are reviewed. From there the planners would want to see what will be the needs of the people in 20 years, based on projections (all estimates), and stakeholder consultation. When the projections are made, additional urban, industrial or local infrastructure areas are planned with high regard to the agricultural lands' yields. Disaster risk reduction is also taken into account when planning for new urban areas. New urban areas are never planned on fields with 3 crop rotations. Fields with 2 crop rotations can be assigned as urban extension area, but only when there is no alternative. Lands with only 1 crop rotation are fine to convert into urban area. Large national infrastructure projects (planned by the GED) have no regard for this, they will be constructed anywhere.

Consequently, guidelines and an approach to ensure the plans proper instalment are developed. Lots of stakeholder consultation meetings are set up to ensure local ownership. This is done through the Participatory Rural Appraisal method, or PRA.

When conflicts in land use appear, the agency makes suggestions based on their professional knowledge. For example; every town wants a bigger road, or an industrial terrain in unsuitable places. It is then up to the planners to convince the people to construct a smaller road that better suits the environment, or find a better location for the industrial terrain. General planning structure for master plans produced by the City Development Authorities The city planning authorities develop plans for metropolitan areas. The cities all have a strategic plan (long term 20 year policy), medium term plan (10 years; the framework for the detailed area plan) and detailed area plans (they are implemented because they provide policy maps). Implementation is handled by these agencies as well, and do for instance provide Cadastral Survey (Ownership maps) that are reviewed every 3-5 years.

2.2.2 General planning structure for master plans produced by the LGED for rural areas

In rural areas, the GED appointed many growth centres, which are basically large markets, with some other facilities. This is where the rural economic activities take place. The location of these centres is determined by the national

government and is based on which markets are best reachable by road. Every year a limited number of new growth centres are appointed. One tier under the growth centres are the rural markets, small markets with limited services.

2.3 Urban governance

Governance comprises the complex mechanisms, processes, and institutions through which citizens and groups articulate their interests, negotiate their differences, and exercise their legal rights and obligations. The functioning and efficiency of urban governance systems rely on more than the effort made by the government alone. Although the town/city administration and Mayor have a principal role, the private sector, civil society, community, development partners and international agencies all influence and enact policies and decisions concerning public life, and economic and social development . Generally, good urban governance is ought to be participatory, transparent and accountable. Figure 26 holds a schematic representation of the concept for good urban governance.

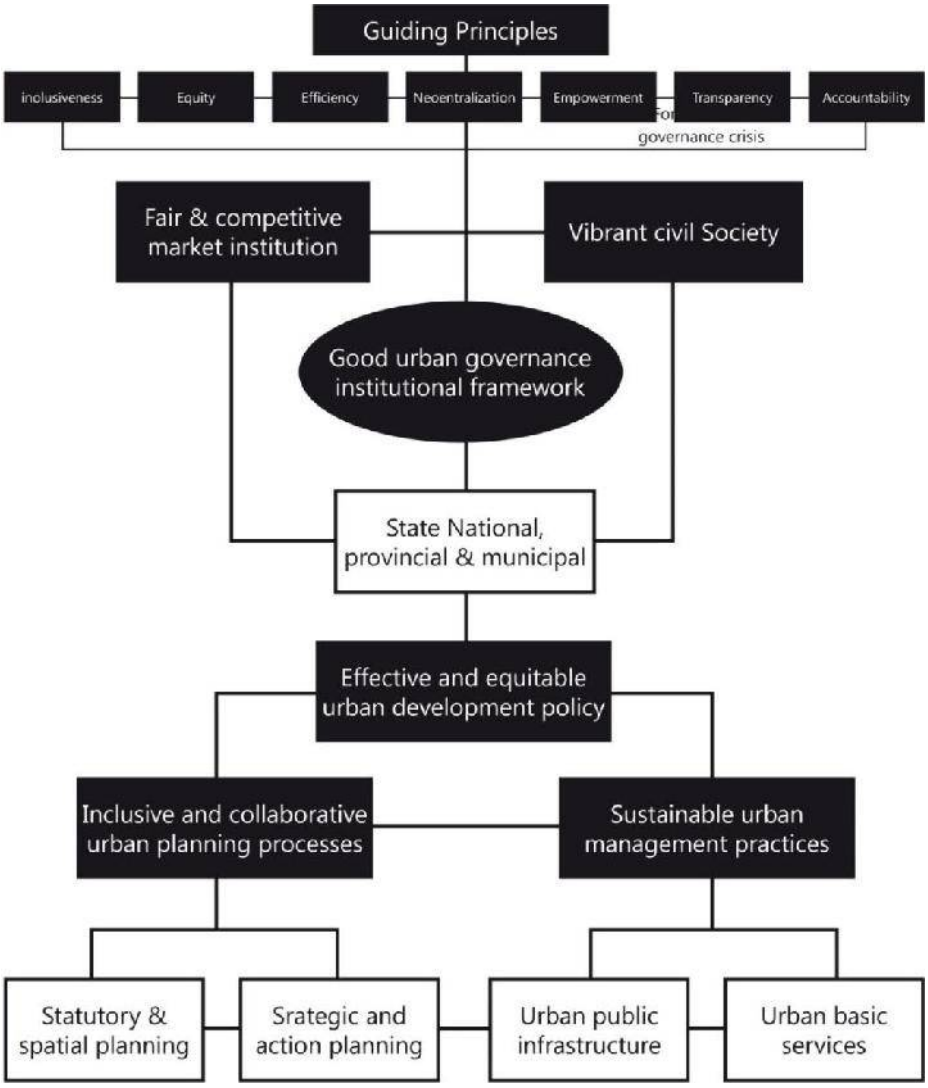


Figure 26 Framework for good urban governance

Source: Sadashiva, 2008

To realize sustainable urban development, good urban governance is key. Rahman (2013) conceptualized the relation between governance and urban development in a conceptual framework (figure 27), exposing the narrative for Bangladesh's current urban governance crisis and the resulting problems in cities.

In this section some of the general problems and phenomena in urban governance in Bangladesh are discussed, which were identified in literature (Islam, 2012; Rahman, 2013) and in several interviews with subject-matter experts and relevant public sector organizations. The specific main urban governance issues are discussed in section 3.7.

Figure 27 Framework for the effects of urban growth on urban governance and development in Bangladesh

Source: Rahman, 2013

2.3.1 Urban governance in Bangladesh

Bangladesh's national government is organized along a traditional centralized management structure, which cannot keep pace with the growing demand. It controls local government through setting strict rules of engagement and strict budgeting, retaining much decision power at the national government level. Illustrative for this is that local spatial and urban planning is performed by agencies under the national government (LGED and UDD).

In their turn, the Mayors and councils who are at the head of urban centres only delegate a very limited amount of power to the lower layers in the local urban governance system; ward (neighbourhood/community level) commissioners have little authority and therefor can only achieve so much in their local communities. Politicization of the mayor's position is heavy, meaning that the mayor often serves as an agent for his/hers respective national political party.

There have been a number of attempts to establish a stronger system of local governance, which have failed due to the lack of high-level political commitment. Illustrative for these actions was how the newly proposed establishing of a metropolitan government for Dhaka, which was backed by all of its mayors and leading experts, was stopped by the central government. Instead it approved the splitting of the DCC (Dhaka City Cooperation) into two (now North DCC and South DCC), aiming to improve services to its inhabitants. Experts now argue that this has only engraved the chaos in Dhaka's governance situation (Rahman, 2013).

Other factors contributing to the poor state of urban governance in Dhaka are:

- Poor participatory planning options
- Centralized mechanism and weak integration with national planning system
- Inappropriate policy plans and poor implementation
- Political and bureaucratic corruption
- Inappropriate legal framework; Dhaka City Corporation and RAJUK are not empowered as top authority
- Weak institutional setting;
    - overlapping responsibility
    - no coordination
    - not decentralized
- Poor capacity and resources with RAJUK and DCC

These factors are illustrative for problematic issues in urban governance throughout the country. The main issues on governance are found in section 3.7.

2.3.2 Instruments and stakeholder participation in urban planning

As Bangladesh's rural to urban transition unfolds, there is a need for effective instruments and measures to control rapid urbanization. When the ambition is to guide this process through sustainable and inclusive development, integral planning with adequate participation of stakeholders and citizens is required. Currently, the planning structure for Metropolises, Cities and Towns in Bangladesh comprises a tiered system of plans (Master Plans, Detailed Area Plans, etc) which allows for some degree of stakeholder participation (see section 2.2). However, the effectuation of actual participatory governance remains a major point of concern. For example in Dhaka, were the civil society urged RAJUK to allow for more participation in their plan preparation processes. Initially, these calls were answered and the government passed various administrative decisions including the Detailed Area Plans in 2009. Ultimately, the government yielded to the pressure of powerful private real estate developers and real change to benefit the people's participation in planning was held off. Now there remains little room for community based organizations to participate in decision making for their own communities.

In the same year, the Pourashava act was enacted, which brought the instalment of Ward Committees (each 10 members, of which 40% have to be women) to enhance citizen participation in municipal management. Additionally, Town Level Coordination Committees (TLCC) were introduced, which hold representatives of the civil society.

Urban Development Planning for the many Pourashavas in Bangladesh is performed under the supervision of the UDD and LGED. Both central government agencies have been consulted through interviews, and conveyed that stakeholder participation to assess the people's needs is an integral part of the planning process for Pourahshava and Upazila Town Structure Plans, Urban plans and Detailed Area Plans. Yet the stimulation of extensive stakeholder participation in City and Town planning, specifically for the Pourashavas, remains as a major task and potential for improving urban governance in Bangladesh (Islam, 2012; Rahman 2013). Ideally, the responsibility of preparing a development plan rests with the local urban authority. Since 2000 the first important steps have been taken through the Urban Governance and Infrastructure Improvement Project (supported by the Asian Development Bank). In this project "Urban Planning Departments" were set-up for all A-category Pourashavas, bringing some essential functions to a lower level of government.

2.3.3 Stakeholder participation in infrastructure planning

Major, large scale infrastructure projects are initiated and managed by the central government, with nominal attention to stakeholder participation processes. Typically, foreign development agencies bring in financial and technical support for these types of projects, which contributes to the lack transparency in the planning and implementation stages. In general the public shows little interest in these kind of major projects. In some cases, the public forces the agencies to pick up major environmental improvement projects, but in the implementation phase there is hardly place and time for citizen participation (e.g. Dhaka's Hatirjheel Lake Development Project).

2.3.4 The role of International Development partners in urban governance

Developments partners and international agencies have adopted an active approach to enhancing urban development and governance in Bangladesh. Take the various UN bodies for example, which have contributed significantly in developing physical infrastructure and enhancing societal resilience in urban areas. Together with the various foreign development agencies and international agencies such as the World Bank and Asian Development bank, they insist on expanding the depth and reach of their participation in decision-making processes on urban planning and governance. Many of the major urban development decisions are now taken with participation of the international development partners accordingly.

2.3.5 The role of civil organizations in urban governance

Civil groups, including NGOs and professional groups, have an important role in to play urban development and governance. In Bangladesh, the awareness of these bodies for urban issues has grown stronger over the last decades.

Social groups such as neighbourhood level environmental groups, slum dwellers organizations and other civil society groups on city or national level are important actors in the new democratic dynamics in urban governance. Various national level civil society groups take an interest in issues connected with urbanization. The civil society's awareness for urban issues has grown stronger, but there is still a long way to go before these groups can play the crucial role that they should have.

2.4 Linkage between spatial planning and national development planning

Two tier of governance system is in practice in Bangladesh- the central and the local government. Central government plays a crucial role in exercising their power over the local government system. Local government performs their tasks as per the guidelines of the central government. The linkage between spatial and national development planning is described as follows (ADB, 2005):

2.4.1 Legislation:

The legislation by which the local government performs its tasks such as the Paurashava Ordinance 1977 is enacted by the central government bodies. Rules and regulation pertaining to the legislation are prepared by the central government which include, conducting elections, business, chairmen's duties, tax assessment preparation of budget, making of contracts, appointment and service matters of local government employment, accounts, audit etc. Central government also holds the power to approve any regulation prepared by the local government authority.

Local government structure:

The territory and also the formation of local bodies including structure and composition are determined by the central government. For example- the appointment and recruitment process of staff of City Corporations and Paurashavas.

2.4.2 Finance:

Financial control by the central government on the local government is evident through the budgetary allocation process. The budget is prepared by the central government and fund is allocated often based on the national priorities. As a result, the local administration receives fund inadequate to fulfill their development objectives. The funding is mainly provided as development fund and block fund. Development fund is spent as per the central government's five year plan and annual development programmes. The local bodies have the freedom to invest the block fund as it feels required. The central government has also the authority to reduce the grant in aid when and if required.

2.4.3 Coordination and monitoring:

A system of coordination and monitoring is applied by the central authority through the formation of coordination committees at different levels such as district, upazila and union. The committees are constituted by representatives of different central government agencies and local government authority. Activities at local level by the implementing agencies are coordinated through these committees.

2.4.4 Judiciary:

The central government oversees the performance of the local administration. It holds the power to carry out investigation or inquiry into any type of allegation that might be raised regarding any administrative, financial or any other issues. If any such allegation is proved true, then the central government has the right to dissolve any local body at any time.

2.4.5 Preparation and implementation of plans

The government uses Five Year Plans as the main planning instrument to fulfill Vision 2021 and the Perspective Plan 2010-2021. The five year plans provides the strategies for implementation of different sectoral projects. At more local level, the Master plans are available for the metropolitan areas, city corporations and the Paurashavas. Master plans are

prepared by the city development authorities or city corporations. Paurashava is empowered to prepare the Master Plan for the area under their jurisdiction by the Paurashava Ordinance 1977. However, in reality, either LGED or UDD prepare the land use and master plans as the Paurashava itself lacks the technical and financial capacity to do so.

2.4.6 Planning and the budgetary process

Planning of projects is interlinked with the budgetary allocation. With the aim of improving the current budgeting in relation to project planning, the government has taken a number of initiatives (SFYP, 2011-2015):

- Change from the incremental traditional to Medium Term Budgetary Framework based (MTBF) process
- Shift from the traditional public-investment focused plans to more strategic and indicative planning that puts emphasis on strategies, programs and policies for the entire economy. The strategies cover economic growth, employment generation and poverty reduction etc.
- Making the plan a living document with the scope of updating through performance evaluation.
- Now the development plans are much more focused on planning priorities. Therefore, the allocations of resources are to be determined by strategies set out in the plans. As such, in support of these initiatives the Sixth Five Year Plan intends to take the following actions to make the planning and budgeting process much more efficient:
- As a start, the sixth five year plan has already moved toward strategy based indicative planning. Sectoral outcomes will be reviewed and accordingly the goals, targets may be changed.
- Strengthening of the line ministries are required to do proper planning and budgeting for the implementation of the MTBF. Also the technical capacity of the Ministry of Finance and the Planning Commission needs to be developed.
- Project approval process in the institutional and Planning Commission level needs improvement to remove all the delays

2.4.7 Budgetary Allocation in Annual Development Programme

Based on the yearly budget approved in the cabinet, the Annual Development Programme (ADP) is prepared by the Planning Commission. While preparing the ADP for each financial year, the goals, objectives and strategic directions as specified in the Five Year Plan is followed. ADP includes list of projects for each of the sectors as well as institutional allocation from different sources of funds (government, JDCF, TA). The ADP is revised due to adjustments in project funding from institutions side or the donor side. In the ADP of 2014-2015, allocation is distributed among 17 sectors namely:

1) Agriculture
2) Rural development and institutions
3) Water resources
4) Industry
5) Electricity
6) Oil, Gas and Natural Resources
7) Transport
8) Road network
   a) Bridge
   b) Railway, Navy and Civil Aviation
   c) Communication
9) Physical Planning, Water Supply and Housing
10) Education and religion
11) Sports and Culture
12) Health, Nutrition, Population and Family Welfare

13) Public Communication
14) Social welfare, Women and Youth Development
15) Administration
16) Science, Information and Communication Technology
17) Labor and employment

The following graph shows the total allocation for each sector for 2014-2015.

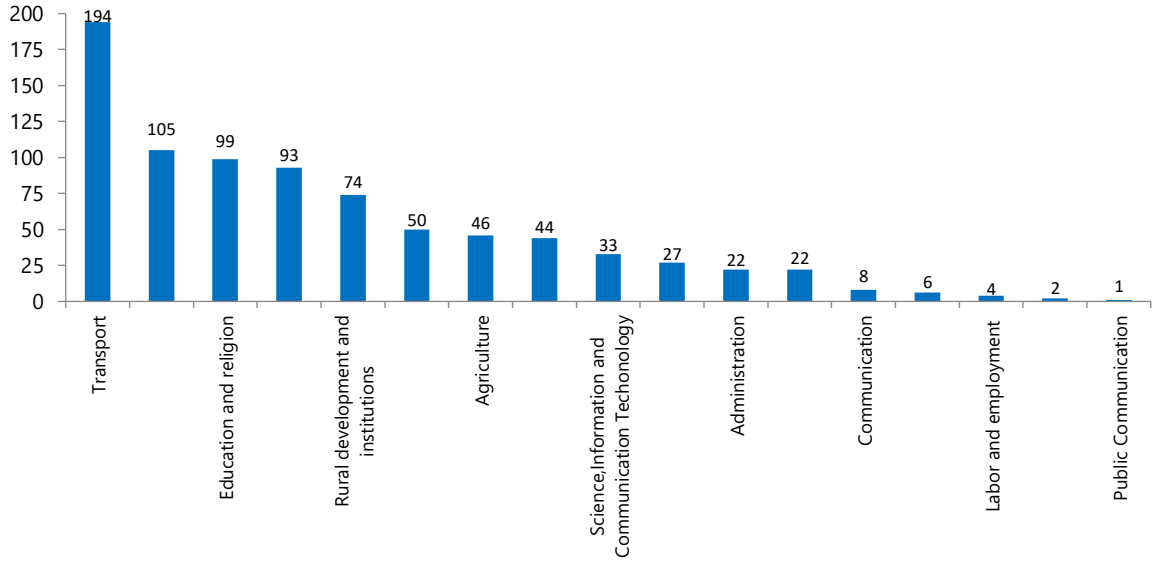


Figure 28 Total allocation for all the sectors in ADP 2014-15 (Allocation (in billion taka) taka)

2.4.8 Rural development and institutions

This sector plays a very important role in the development of the socio-economic condition of the country. Poverty reduction, development of structures and infrastructures at rural scale is the main target of rural development project. Bridge, culverts, roads are constructed by LGED in the rural areas.

Allocation in the rural development & institutions has increased over the years since 2010-2011 (Figure 29). However, the percentage of money allocated in rural development & institutions compared to the total ADP is about 8.98% in the fiscal year 2014-2015 where as it was 12.3% in the fiscal year 2010-2011. So, although the total amount of money is increasing in each fiscal year but the percentage of money allotted in this sector in each fiscal year is decreasing.

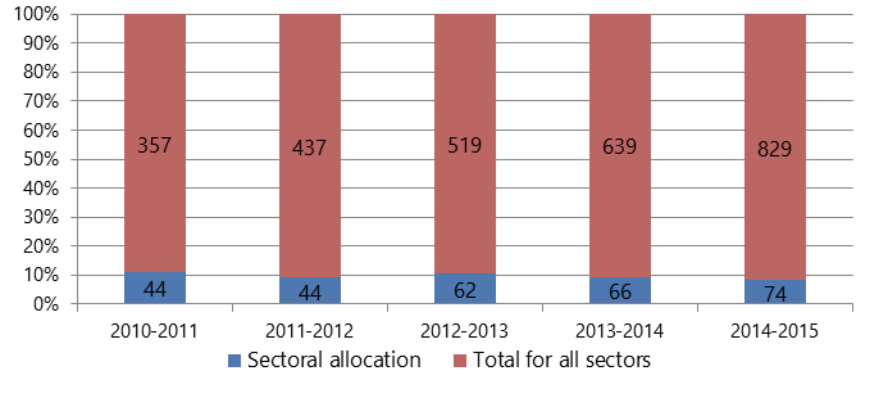


Figure 29 Trend analysis of the budgetary allocation of rural development & institutions sector in the ADP from 2010 to 2015 (Allocation (in billion taka) taka)

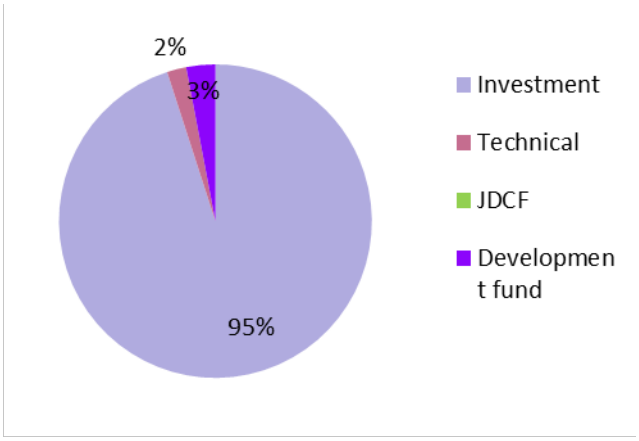


Figure 30 Distribution of projects by source of funding in rural development & institutions sector in ADP 2014-2015

A total of 96 projects have been included in the ADP for the fiscal year of 2014-15 for this sector. Out of which 89 nos are investment projects, 5 nos are TA (technical assistance) projects and the rest 2 projects are funded by JDCF (Japan Development Cooperation Fund). For the implementation of the projects, a total of Taka 74.46 billion has been allocated of which 48.91 billion taka is from GoB and 25.54 billion taka is from project fund. Development fund is taka 2.40 billion. The 89 nos. investment projects have been allocated an amount of taka 70.33 billion (68.25% from GoB and 31.75% from project). The large part of the money is allocated through investment projects which is about 95% compared to the total money in this sector as shown in Figure 30. Only 2% & 3% of money are allocated for technical and development sector projects. Compared to others the contribution of JDCF project is very low. Compared to others the contribution of JDCF project is very low.

2.5 Physical planning, Housing and Water Supply

The main focus is preparing structure and master plans, development of infrastructure of the upazila and district towns, develop housing for government officers and staffs, other civic facilities etc. At the divisional level, flyover, roads, conservation of historical places, Hatirjheel area beautification projects are ongoing. The LGED is implementing projects related to urban planning and infrastructure development in the municipalities with the financial support from ADB, GTZ and KFW. Projects on poverty reduction through participatory approach which are funded by UNDP and DFID are also being implemented by LGED.

The water supply and sanitation projects are being implemented by WASA and DPHE in the cities of Dhaka, Chittagong, Khulna, Rajshahi and other municipalities and rural areas. Recently, as per the government's decision, some new projects have been taken up for the utilization of surface water through purification instead of ground water. In this regard, DWASA has initiated Water Treatment Plant project and Dhaka Environmental Sustainable Water Supply Project to supply pure drinking water to the the Dhaka residents. Similarly, in Chittagong, work on a water treatment plant with 136 MLD capacity and in Khulna, Water Supply project with 110 MLD capacity is ongoing. DPHE is implementing water supply, sanitation and drainage projects in the cities of Sylhet and Barisal and IDA supported Rural Water Supply project in the whole country.

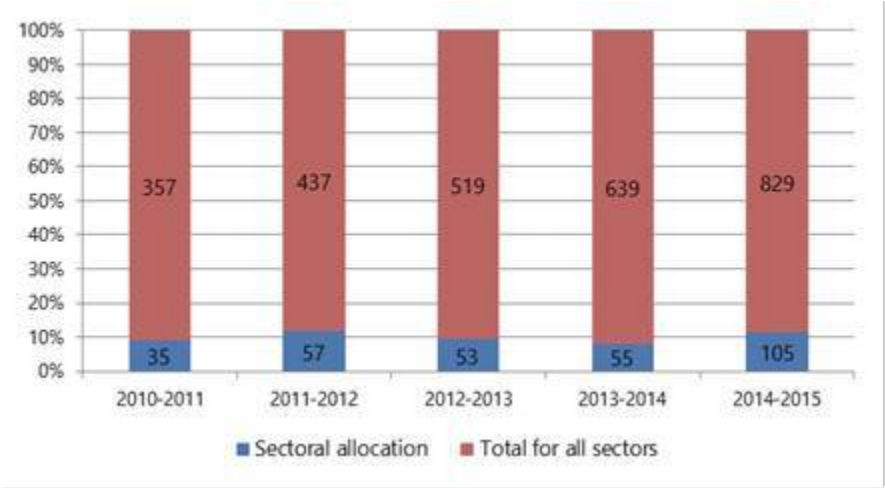


Figure 31 Trend analysis of the budgetary allocation of Physical Planning, Water Supply and Housing sector in the ADP from 2010 to 2015

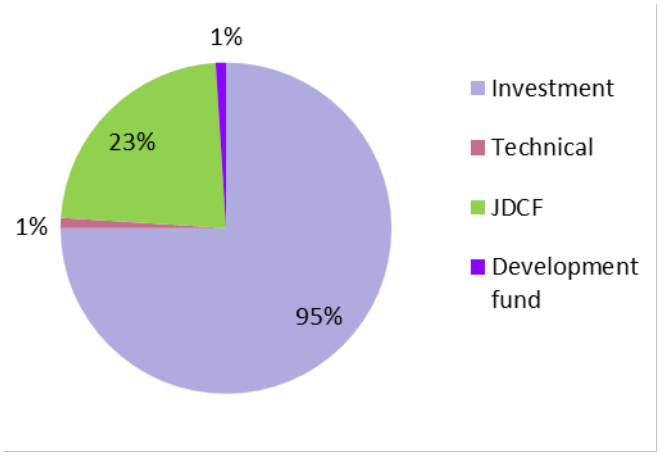


Figure 32 Distribution of projects by source of funding in Physical Planning, Water Supply and Housing sector in ADP 2014-2015

Under this sector, a total of 131 funded projects are included out of which 121 are investment projects and 10 are TA projects. There are 68 self funded projects in the ADP. Analysis shows increasing trend in the total amount allocated for this sector. Percentage of budgetary allocation has also increased in the last five years. Amount allocated to this sector compared to the total ADP is about 12.62% in the fiscal year 2014-2015 where as it was 9.94% in the fiscal year of 2010-2011 (Figure 32). In Figure 35, distribution of projects based on source of funding is shown. The money allocated for investment projects is the highest with 75% followed by JDCF, technical & development projects with 23%, 1% & 1% contribution respectively.

So, for infrastructural development and poverty reduction, more allocation is needed under the rural development and institutions sector. More and more projects are coming funded by the government and international donor agencies for both these sectors. This in future will have positive impact in developing the way of living for the urban as well as the rural people thereby contributing towards socio-economic upliftment of the society.

In the sector wise allocation of the annual budget in the Annual Development Programme of the current fiscal year, the physical planning sector is ranked 2nd and rural development sector is ranked 5th (ADP 2014-15). This shows that government perceiving the urban growth is focusing more on urban development projects. Provision of services is expected to enhance through this increased allocation. Although the rural sector received less allocation in the fiscal year, however, throughout the years consistently this sector has received attention from the policy makers. The role of rural sector development in socio-economic upliftment cannot be ignored. Projects on rural infrastructure enhances connectivity thereby supporting productivity and transport of produced goods as well as creating employment at local level for the poor and the destitute including women.

So, for infrastructural development and poverty reduction, more allocation is needed under the rural development and institutions sector. More and more projects are coming funded by the government and international donor agencies for both these sectors. This in future will have positive impact in developing the way of living for the urban as well as the rural people thereby contributing towards socio-economic upliftment of the society.

3 Issues in Urbanization and Settlement

3.1 Dhaka's primacy and Unbalanced development

Dhaka is a primate city, a city that is at least twice as large as the country's second largest city. Primate cities are a worldwide phenomenon (e.g. Tokyo, Paris, Jakarta, Bangkok), and are often the result of centralized bureaucracies that inevitably favour the capital city and the development of metropolis-oriented economies, at the expense of the economies of other cities. In Bangladesh's economic geography, Dhaka's primacy is clearly visible (figure 36) in Bangladesh's economic geography. The more centralized the government, the larger the capital city.

However, the issue is not whether a primate city is too large but rather how well it's managed how policy biases that may indirectly favour the capital city can be avoided. Typically, low income countries like Bangladesh are ill-equipped and incapable of handling the planning and management challenges in primate cities (Muzzini & Aparicio 2013).

Centralised Government and unbalanced development

Urban population is concentrated in a limited number of cities, with Dhaka holding and attracting the majority of economic and political power and public services. The centralised form of government leads to unequal power and unequal investments in infrastructure and facilities. As a result a national overall strategy for developing infrastructure, connectivity of cities, settlements and facilities is lacking. With that Dhaka has become the centre of all business and administrative powers. All facilities including the medical, educational, legal and government facilities are agglomerated in Dhaka. As long as this continues people will migrate to the city.

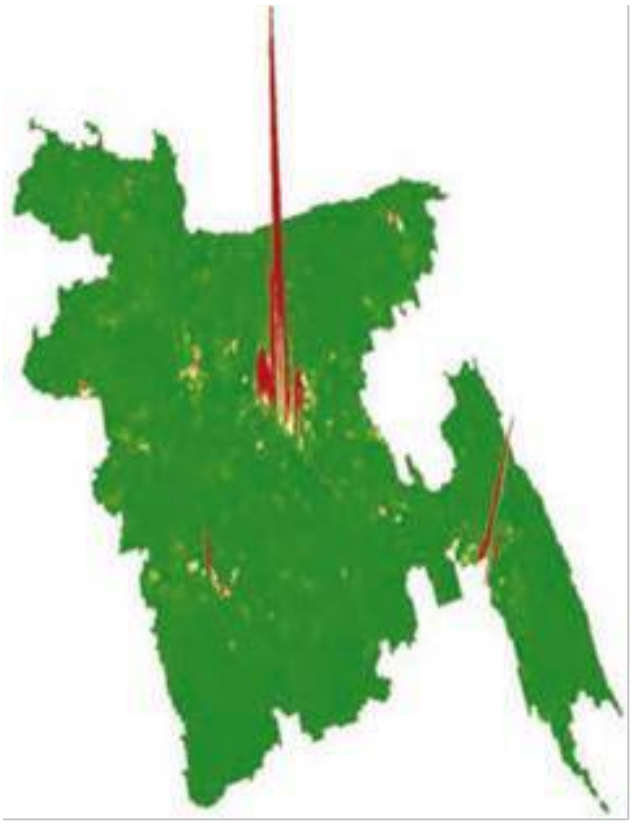


Figure 33 Economic geography of Bangladesh

Source: Muzzini & Aparicio 2013

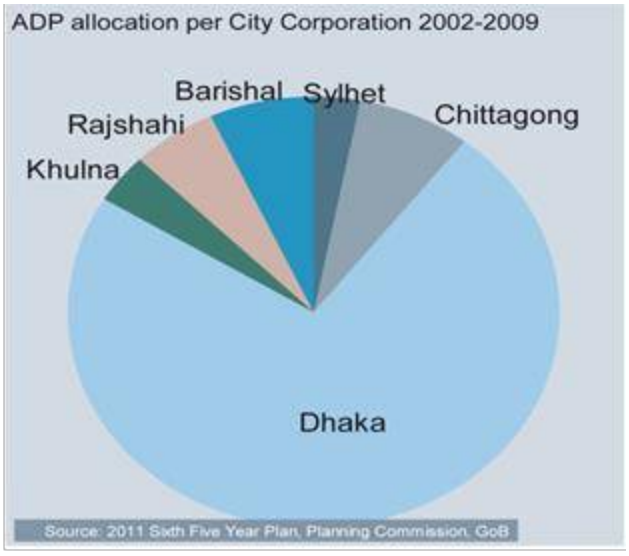


Figure 34 ADP allocation per City Corporation 2002-2009

Source: Sixth Five Year Plan, GOB

3.2 Rapid and unsustainable urban growth

Current population projections indicate that Bangladesh's urban population is growing at the rate of 3% /yr. Between 2040 and 2050, the country will reach the point where its population is predominantly urban. This transition is fuelled by rural-urban migration. Whilst urbanisation contributes greatly to the country's growth and welfare, it entails negative phenomena as well. To a large extend, the process of urbanisation in Bangladesh is uncontrolled because of poor governance and planning (Rahman, 2013). As a result, urbanization is occurring without relationship to an improvement to the overall socioeconomic conditions. As a result instead of being a sign of economic progress urbanisation leads to urban poverty. Informal growth causes cities and settlements to grow in a haphazard way. Its magnitude brings problems in supplying basic services, employment, transport and waste disposal, especially for slum dwellers and the urban poor.

Especially Dhaka has been growing at an enormous speed. From 1991-2001 the population increased with 2 million and from 2001-2011 with 9 million. This results in rapid urban growth, the area of the city expanded from 510 square km in 1981 to 1528 sq km in 2011. The city grows more dense at rapid pace and low-lying and wetlands are urbanised.

The problem with rapid urbanisation is unsustainable growth:

- The density in the inner parts of cities is very high and the city is losing its ecological balance
- The price of land and houses is high and difficult to acquire for poor people, leading to slums
- Insufficient suitable accommodations and services (especially with informal growth)
- Congestion of traffic
- Agriculture, wetlands and flood zones have disappeared

3.2.1 Insufficient affordable and qualitative housing

In rural areas the housing supply is met by individual effort, yet in urban areas there is a big gap between housing supply and demand. The supply of housing in Bangladesh's urban centres is problematic, as there is a huge shortage in housing stock, particularly in Dhaka. During the last three decades, the population in Dhaka grew rapidly, while the supply of housing was lethargic. The resulting housing shortage fuelled chronic house price inflation in the city. As with most other urban amenities and services, the constant influx of migrants leaves the local administration chasing housing goals which are already long-overdue when they are met, creating a huge backlog. There is a large qualitative gap to be filled as well, since the majority of the dwellings are structurally poor, lack services, and are built without proper planning. New housing opportunities produced by the formal private sector developers are generally speaking only affordable to the higher-middle income class and higher income class only, leaving the lower income classes limited to access informal housing only.

Causes of high land value in Dhaka:

- Lack of alternative investment opportunity in other sectors
- Rapid urbanisation and scarcity of land
- Uncontrolled land market
- Lack of comprehensive land policy
- inappropriate taxation policy
- political instability
- High rate of material prices and taxes
- Land speculation by brokers
- Land ownership being regarded as e symbol of social prestige
- Inflow from foreign remittances by Bangladeshis abroad (especially middle east)
- Land purchase by real estate developers

As the government failed to provide adequate housing facilities for the increasing population, private sector housing developers rose to the opportunity. In Dhaka specifically and some other places in large cities where ground prices are high, real estate companies are forced to construct apartment buildings on joint venture basis with the land owner and vice versa. Some (spatial) problems with the quality of apartment blocks are;

- They are built to close together,
- Lack of green space
- No relationship with surrounding building forms
- poor fire safety / emergency planning
- Absence of communal space for children
- Outer view obstructed by unplanned telephone lines
- Bad relation between entrances/ parking pot and the street

Combined with the construction costs the high land value results in high apartment prices, unaffordable for the middle and lower income households. In a developing country as Bangladesh, (and in Dhaka as its capital) these are the households that make up the vast majority of the people. Because of the high land value the lower income households cannot afford to buy land to build their own home. Another effect of the high land prices is that land owners are encouraged to build apartment blocks, fuelling the need for real estate developers to intervene, which boasts house prices.

A great majority of the city's inhabitants have difficulties to find a decent shelter. They live in informal settlements and manage to build and maintain their habitats without direct or with very limited support from the formal and public sectors, often in the face of tenure insecurity. The private and informal entrepreneurs supply scarce and costly housing resources to them. The government, unable to meet the huge housing demand on its own, is slowly supporting a participatory approach involving the private sector to deliver shelter to the poor. In order to expand housing supply in Dhaka, the government recently set-up projects for the purpose of constructing apartments for the city's poor dwellers (Kamruzzaman and Ogura 2006).

Various policies including the National Housing Policy have been drafted to provide well-planned and affordable housing for the poor in Bangladesh. However, the very high levels of land and housing unit prices are the main constrain of urban policies and plans to be implemented in Dhaka. As RAJUK only provides lots no smaller than 100m^2, the acquisition of formally planned land by households is made impossible. The scarcity of formally serviced land has leaved the development of the city to the informal sector, typically in poor compliance to the formally drafted plans, undermining the sustainable development of the city. "Most of the new urbanization in the last 20 years has occurred at the margin of the city, with little or no attention paid to planning regulations or any planning enforcement" (Rahman 2013, p.65).

The land ministry and RAJUK have taken up several projects to provide housing for the landless and the poor. The first results indicate that the costs of the finished dwelling units are at a level that makes it very unlikely that the dwelling will be bought by the intended low-income household types. It is more likely that these public housing units will be bought by the middle income households, unless generous subsidies are provided.

To conclude; little has been achieved in the implementation of the National Housing Policies. In the current housing situation, the public sectors interventions are poorly coordinated, are based on unworkable design standards, and ultimately have not been pro-poor. Improving the housing conditions of the lower income households will requires drastic policy reforms. The current legal and institutional framework in land management is largely ineffective and the Land market remains inaccessible to the low and middle income households.

3.2.2 Informal urban growth (fringe development)

Bangladesh finds itself in a situation where formal housing is inaccessible to the large majority of its people. The urban poor and lower too lower-middle income population groups are forced to turn to the informal market in their search for affordable housing. The effects of the only very limited availability of formal housing is clearly visible in the expansion patterns in and around the large cities. In figure 38 gives an aerial view of the edge of one Dhaka's formal city expansions; the Uttara Model Town (phase 1) built in the 1970's. To the east of the planning border, the Dhaka's informal "Eastern Fringe" expansion can be clearly discerned as a sprawling urban mass with relatively low density.

Figure 35 Satellite imagery of fringe development adjacent to Uttara Model Town, Dhaka

As fringe areas are built informally, they are faced with a typical lack of formal services;

- The areas are unserviced and unregulated; no basic functions are provided such schools, fire-stations, police, clinics etc.
- Infrastructure provision (roads/water/power/sewage) is poor and will have to be self-arranged and self-regulated

Despite these negative traits, fringe areas are usually the only place where the urban poor can find affordable lands and avoid costly land regulations.

Fringe development is a typical product of the lack of control on urban development in Bangladesh. It is already taking its toll in the form of environmental degradation and social injustice. First, the environment is adversely affected in the form of illegal and haphazard development over flood flow areas, retention ponds, agricultural lands and critical natural areas such as wetlands. Second, this unplanned development results in uprooting the local poor people who have been living in those areas for a long time denying them their social right and justice.

3.2.3 Slumming

In developing countries, such as Bangladesh, urban growth induces urban poverty instead of uplifting the urban poor. The very poorest part of the urban population has to turn to slums to find a possibility of establishing a livelihood. Slums are conceptualized as areas of concentrated poverty. However, not all poor people live in slums. A slum is defined as a neighbourhood or residential area with a minimum of 10 households or a mess unit with at least 25 members with four of the following five conditions prevailing within it (Centre for Urban Studies (CUS) et al 2005):

- Predominantly poor housing;

- Very high population density and room crowding;
- Very poor environmental services, particularly water and sanitation facilities;
- Very low socioeconomic status for the majority of residents;
- Lack of security of tenure.

The health situation of the urban poor or slum dwellers is desperate, primarily due to crowding and lack of access to basic services, such as water and sanitation.

3.3 Lack of planning, amenities and livability

Typically plans are drawn up in response to emerging problems rather then compiling a long term spatial strategy framework (Rahman, 2013) As a result urbanisation, services, amenities and infrastructure are not strategically planned and balanced.

3.3.1 Amenities and services

When we look at the amount of amenities and services in the main cities we see that the amount of basic facilities such as hospitals, sewage systems, fire stations, garbage collection, roads and public transport, parking facilities, and the mix of different land uses etc. is not planned nor developed in balance with the contiguously increasing demand of the growing population. As a result there is a lack of facilities and basic services such as garbage collecting, drinking water, energy supply.

More qualitative functions such as walk able neighbourhoods, access to public space, green spaces, recreational facilities, entertainment venues and access to support services are poor. Those amenities are important 'assets of livability' deemed essential to make high density living area's attractive (Kriken 2010). As a result the Bangladesh city's are not an attractive place for expatriates and high skilled international workers. If Bangladesh wants progress towards an economic model based on higher value added industries and services, it is important to retain and attract a high-skilled and international workforce. Hence, the livability of cites will become increasingly important (World Bank 2013).

3.3.2 Environmental pollution

Due to polluting industries poor sewers and waste collection systems and the rapid (informal growth) there is a lot of environmental pollution. Not only do the ground water and streets get polluted; there is also air and noise pollution.

3.3.3 High urban density

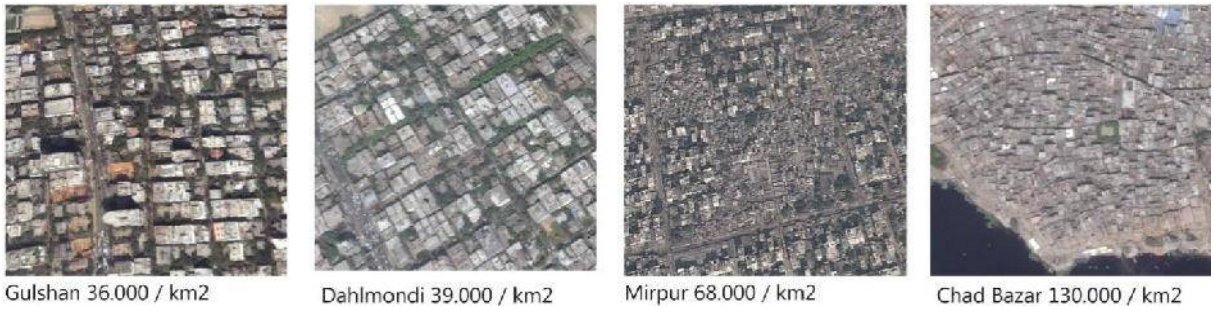


Figure 36 Satellite imagery of selected urban area in Dhaka

Due to the high population numbers and limited amount of land Bangladesh the most densely populated country worldwide (excluding city-states and small islands) with a density of 1,015 people per square kilometre in 2011 (BBS, 2011) and 1.203 people per square km in 2013 (World Bank 2013). This is three times higher than India. The urban population density is about 1,900 people per square km. Dhaka City is one of the most densely populated urban areas in the world, with 25,000 people per square kilometre. Some neighbourhoods of Dhaka such as Chad Bazar reach densities over 100.000 people per square kilometre.

3.4 Land scarcity

Bangladesh's growing population needs to be housed and fed. In general, the competing spatial claims of croplands, nature, cities and settlements make that land is scarce. Settlements are spreading and appearing in areas that are physically challenging or where development or occupation is unwanted, due to other spatial claims.

We see urban sprawl, settlements and development in challenging and hazardous areas such as;

- high flood risk areas, such as riverbeds, mountainous watersheds, coastal flood plains and chars
- cyclone and storm surge risk areas
- eroding areas along the rivers and coasts

We also see (un)planned urban growth and development in areas essential for other functions such as;

- high productive agriculture lands
- forests or other ecological valuable areas
- urban and rural public and cultural spaces
- wetlands and floodplains
- natural flood risk protection bodies such as mangrove forests

3.4.1 Land reclamation

In time the total area of Bangladesh has increased. The outline of the country over time has changed due to erosion, shifting rivers, accretion and land reclamation projects.

Chars are newly accredited land, formed naturally by sediment in the Bangladesh coastal area. When formed, chars are often colonized in the least of time and allocated for agriculture and aquaculture uses. The inhabitants of these areas are extremely vulnerable to tidal surges, cyclones, and other external factors.

In the baseline study on the Coastal zone new plans for land reclamation projects can be found.

3.5 Access to land

Bangladesh's high population density instigates the strong spatial and social pressure on land availability. Although the country is in a process of rapid urbanisation, its population is still predominantly rural. In rural Bangladesh, people are completely dependent on the access to land for generating income. Unfortunately, land access is inequitable throughout Bangladesh, and the number of landless households is growing (USAID, 2010). A complex land-tenure system regulates the relation between land-owners and tenants (farmers). Land ownership and land tenure is insecure due to outdated law and policies. Both in urban and rural areas this results in increasing conflicts over land rights and land grabbing. These inequalities and insecurities induce rural-urban migration, increasing the rates of urban poverty (KIT, 2012). The impacts of climate change will further engrave this situation. Land reclamation or char development is applied to reinstate landless households and protect its poor inhabitants.

Up until 1950, a landlord tenure system enabled a limited number of elite households to acquire most of the land in villages. Although this feudal system was legally abolished, land inequity remains to this day, and is exacerbated by elite land grabs and the government's incapacity to execute legislation on land ownership ceilings. At least 60 per cent of rural families do not own any land at all (the landless) or own less than 1,5 acres (Figure 40). These people are turned into seasonal labourers, working or sharecropping (yield is shared with the land owner) on land belonging to others. Therefore, a range of tenancy arrangements offer an important part of the rural households' access to land (KIT, 2012). The amount of landless households is on the rise (USAID, 2010).

Bangladesh struggles with the implementation of a modern land record system. Land dispute and conflicts are common, mainly because of the poor state of land records and cadastral maps (Mouza maps), of which many go back 100 years. Poor management of the system brought fraud and manipulation in land ownership, clearing the way for land grabbing

practices. The government has made some efforts to introduce digital land records, and in a pilot project a digital database was created for Dhaka.

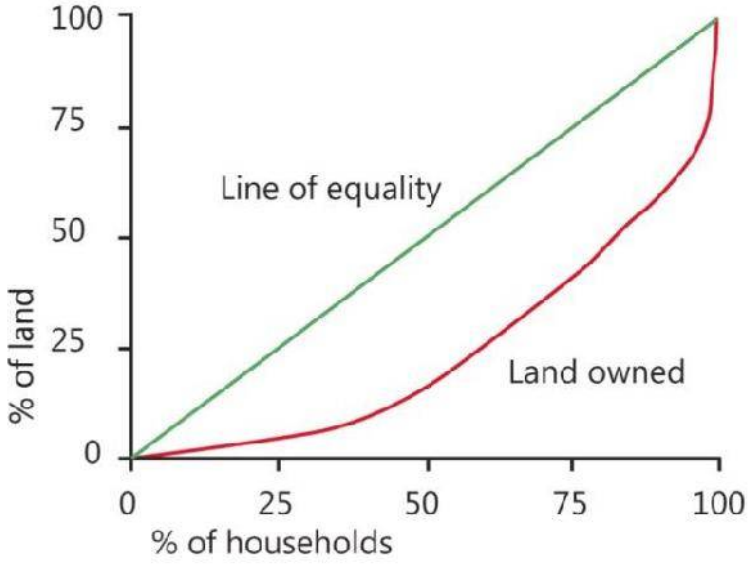


Figure 37 Land inequity in Bangladesh

3.6 Issues in relation to the planning process

3.6.1 Lack of a hierarchical planning system

The lack of a National Physical Plan to set conditions for spatial plans on a lower scale levels is regarded as major issue. Currently, no one bothers making a choice at the national scale level. Population distribution remains unmanaged, and urban area and rural settlement expansion can sprawl the country uncontested.

Additionally, the UDD and LGED stress that there has to be coordination at the intermediate level as well (in between the national scale level and city scale level). Already now we see attention to the intermediate level in the UDD's Benapole – Jessore highway corridor plan and three upcoming regional plans (Rangpur, Khulna, Rajshahi) as first step in this.

3.6.2 Enforcement of spatial plans

Another major issue is the lack of planning enforcement. Urban plans drafted by LGED, UDD or City Development Authorities have to be enforced by the local Mayor and its council and/or the city corporation. In our interviews with the planning agencies, planning enforcement by these custodians was described as "being in a coma".

The main reasons for poor implementation and enforcement are:

- Poorly trained officers
- Lack of awareness with the public
- Low education of the people
- Poor economic conditions
- Bias governance
- Corruption

Illustrative for the lack of enforcement is that multiple agencies that conduct physical interventions completely ignore (sometimes contesting) plans from other agencies. In theory, the custodian will have to make sure that their plans match

other plans affecting land use for example. In practice hardly any consideration takes place between the various plans. All planning agencies are very reliant on the custodian to implement and enforce their plans.

This issue is closely related to the poor state of urban governance. Physical planning can be conducted by a range of agencies and service providers, without any coordination.

3.7 Issues in relation to urban governance

3.7.1 Lack of Coordination & weak institutions

Coordination of the combined deployment of resources in time is key in a complex urban governance system. Generally speaking, the multiplicity of service providers is regarded as the principal culprit in the current urban governance system (Rahman, 2013). The multitude of agencies and companies with unclear and often overlapping mandates combined with poor coordination capacities is at the origin of most current problems and the negative perception of government services (Jahan, 2012).

In Dhaka, about 40 different governmental or autonomous organizations are functionally involved in the city's governance. Coordination between these agencies is a big problem, which results in a waste of resources, limiting the effective and swift implementation of physical and non-physical developments in the city. Various attempts have been made to enhance coordination in Dhaka, of which some have initially been successful but were disregarded later for various (mainly political) reasons.

The same can be said about the situation in other large cities. The resulting gap in community services is filled by community organizations at community level. This informal mode of governance remains to be recognized by the (local) government(s). Coordination between the agencies and the civil sector has been improved through the TLCCs (as described earlier).

3.7.2 Lack of local government autonomy, authority and capacity

The Central government controls local urban governments through setting strict rules of engagement and strict budgeting, retaining much decision power at the national government level. Local government bodies serve as an extension of the central government, where the options for participation of local people are very limited. Many smaller urban settlements are finding it difficult to achieve development goals, due to inadequate financial, human, institutional and legal resources or frameworks, as well as poor political leadership (Jahan, 2012).

3.7.3 Lack of transparency and accountability

Allegations of corruption in local urban bodies are common, and Mayors of large cities are often confronted with serious cases of irregularities, for example in the handling of development projects or partisanship in the appointment to municipal jobs.

3.7.4 Poor Urban financial management & budgetary constraint

Other issues in Urban Governance include poor financial management and financial autonomy for local government. Most municipalities are in fear of increasing their taxes (e.g. by increasing property taxes or by fining new revenues) in fear of losing the people's support. Large cities suffer from budgetary constraint as they fail to collect sufficient taxes (Jahan, 2012), which is a national problems as the relative total tax collection of Bangladesh is amongst the lowest in the world. Urban local authorities are responsible for drafting the annual budget themselves, but generally follow a standard outline in which only limited adjustments are made. Recently, City Corporations and Pourashavas have invited the people to become more involved in budgeting through the TLCC's.

3.7.5 Disregard of the informal sector

Urban authorities and planners in Bangladesh typically ignore the informal economy and its people. Most informal layers of the city are negatively associated, and not accommodated in the local urban governance systems or participation processes. In absence of the formal institutions, lower and middle income groups perform informal governance activities to bridge the gap between their needs and that what is offered (Rahman 2013). This is achieved through local innovation, socially creative strategies and social self-regulation. These activities include local road widening programmes, bazar establishment, relief distribution among flood victims, regulating water and power supply, road building, and community housing projects.

3.7.6 Uncontrolled private sector

Private sector real estate developers take advantage of weak urban governance by anticipating on poor implementation and compliance to acts and laws that should protect the environment and limit unwanted land use. Furthermore, the private sector exacerbates inequality in the large cities by investing only in luxury housing projects, neglecting the urban poor and the lower and middle income classes. The poor get pushed out of the housing market and are forced to relocate to areas of marginal quality in fringe developments or slums. The government's control on these developers is minimal, as they have a strong lobby with in the Parliament and the land acquisition and development legislation processes are complex and non-transparent.

3.8 Rural issues

Impoverishment, the lack of a safe living environment, weak infrastructure, inadequate accesses to facilities, scarcity of space, and maintaining the protected areas specially the wet-lands to retain biodiversity are some of the major challenges for rural Bangladesh. Development gaps on employment opportunities, lack of agricultural supplies, inclusive growth, lack of proper regulation and adequate enforcement, critical infrastructure and technological development remain.

Lack of water supply and sanitation is one of the major issues for the rural areas. People are vulnerable to frequently occurring natural hazards and climate change. These hazards have caused migration and displacement from rural to urban areas. After being displaced, the people often have to other choice than to migrate to large cities (Dhaka, Rajshahi, Khulna and Chittagong) to sustain their livelihoods. It is expected that by the year 2020, many of those displaced persons would nearly double the urban population to 50% mostly ending up in ever growing slums (Zaman, 2011).

Connectivity of the rural areas is poor, although there are road networks between the national highways, zila (district) and upazila roads. Connectivity routes between upazila and village level roads (mostly unpaved) is insufficient especially in the remote areas of the Haor and the Chittagong Hill Tracts. Inland waterways are used mostly in areas where the road connectivity is missing or poor.

Settlement development is going in a very haphazard manner, resulting in a very low density. Low density development requires more infrastructures and puts more spatial stress on agricultural land, so increasing the density in Pourashavas and Upazila villages is one of the goals of the UDD.

Farmers currently work in cooperatives to run machinery and such. Land consolidation is very controversial here and will never happen because of the cultural sentiments; one's lands are the most important possession.

3.9 Gender related issues in urban slums

Adopted from out BDP 2100 gender specialist; Kathun (2014)

Urbanization is characterized by growing numbers of slum dwellers, environmental degradation and visible inequalities between the rich and the poor. Slum women and adolescent girls are generally more vulnerable to poverty; they suffer

reproductive health related illness, water borne and skin diseases due to poor sanitation and inadequate access to clean water.

- Some NGOs are implementing water, health care and skill development programmes in urban slum areas. Particularly since the skills development programmes are not tailored to the needs of the poor women and not linked with any employment avenue, in most cases these fail to bring income for the families. However, some girls after receiving training on tailoring have been able to manage works in garments industries and in some privately managed tailoring shops.
- Slum women need to do huge amount of work each day – her own household work including cooking, cleaning, taking care of children plus her work which she does as helping hands. She hardly receive any time to rest, she does not get any weekly holiday. She lives an inhuman life. She is economically-socially-physically vulnerable.
- Most of the slums are located on government land near railway station, near drains and canals. Drainage congestions that are mostly due to bad management of solid wastes by rich people, slum dwellers suffer serious problems of over flooded drains causing damp floors, mosquitoes and insects, etc. Slum women are the worst victims of all these.

A baseline study undertaken by icddr, b in the slums of Mohakhali, Mohammadpur and Jatrabari in 2012, revealed that women and girls' sexual and reproductive health rights were consistently being violated, with gender-based violence occurring at alarming rates.

Unmarried adolescent girls also experience multiple forms of violence at home, in romantic relationships and in the community. Because circumstances in the slums have begun to shift to allow girls to become important contributors to family income, girls have become more mobile and independent. Unfortunately, these new roles have advanced more quickly than the traditional, patriarchal ideology that condones the control of girls through further restrictions and violence.

3.9.1 Land ownership

Women in Bangladesh rarely have equal property rights, regardless of the constitutional ban on the discrimination on gender (KIT, 2012). Social and customary practices effectively exclude women from direct access to land.

4 Long term drivers Urbanisation and Settlement

4.1 Population growth

The latest UNPD population prospects indicate that the Bangladesh population will grow from its current 150 million inhabitants to about 200 million people in 2050 (figure 29) (UNDESA PD 2014). Following the medium variant for the 2100 population forecasts, a peak population of 205 million people is reached around 2060. Ultimately the population is forecasted to decline to 160 million in 2100 (figure 41). Consistent with its high population density, Bangladesh already experiences a high pressure on land. The ongoing process of urbanisation will further aggravate the pressure on land. The amount of people living in disaster prone areas will increase both from a population growth perspective as well as from a climate change perspective which increases the area of disaster prone areas within the country.

4.1.1 Growth of urban population

The UNPD figures indicate that around 2040 the country's transition to a predominantly urban society is foreseen (figure 41-44). Bangladesh is one of the most densely populated countries in the world, and its urbanisation rate is still relatively low at about 28% in 2010. Hence, in the coming decades the country will see an enormous rural-urban transition for its people and a large proportion of its land.

4.1.2 Increasing densities

When we project the population growth spatially we see the densities of cities increasing further, to a level not seen in other countries worldwide. If no strategy for sustainable growth is provided the negative effects related to rapid unsustainable urban growth will increase further. Especially with a moderate of low economic growth, high densities will result in poor living conditions.

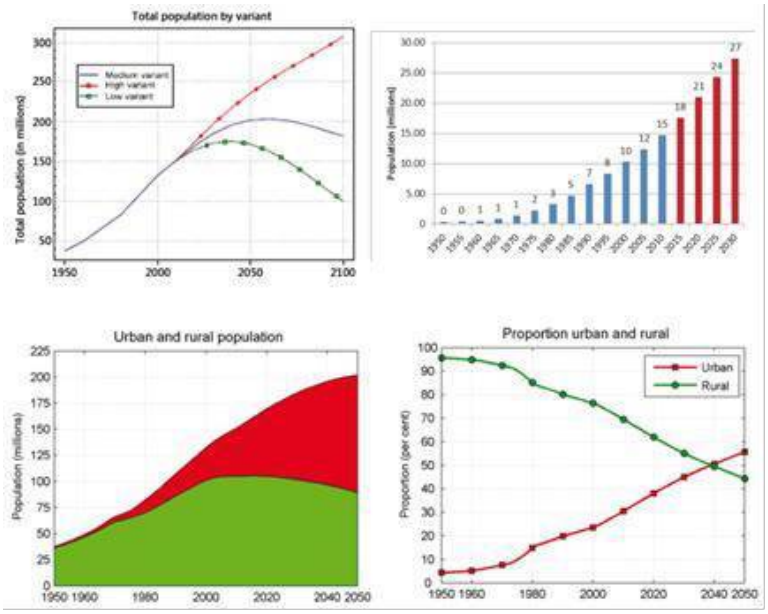


Figure 38 (left) Total population forecast for 2100 (UNDESA PD 2014), (right) Actual and projected population of Dhaka, 1950-2030. Source: United Nations, Department of Economic and Social Affairs, Population Division (2014), (left) Total population forecast for 2050 (UNDESA PD 2014), (right) Projected development of the share of urban and rural population up to 2050 (UNDESA PD 2014)

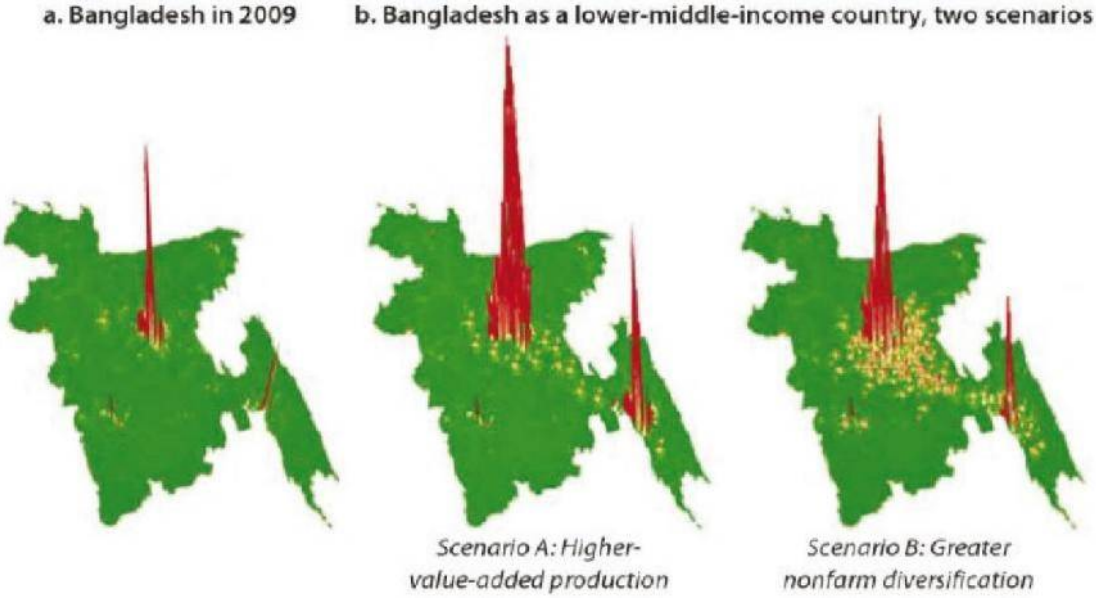


Figure 39 Two scenarios for middle income status

Source: Muzzini and Aparicio 2013

4.1.3 Growth of welfare

The potential growth of prosperity could potentially change values and needs of the population. In generally the growth of welfare will feed the need for more qualitative living environments and the need for additional recreational functions. It is important to take those potential future values into consideration while working on a long term plan.

4.2 Climate change

The effects of climate change will negatively influence the availability and productivity of cropland (Hasan et al. 2013) and further increase the pressure on the available land and potentially increase the extend of rural to urban migration. Also will climate change increase the urban heat effect and the frequency and severeness of (urban)flooding. If cities are not developed in a more climate change resilient way, the energy provided to cool buildings will increase.

4.3 Impact major interventions

Interventions such as improved urban amenities, new road connections bridges or the development of new harbour and economic centres will probably stir the urban development. As will major flood risk interventions such as barriers or interventions providing land for urbanization.

5 Policies, Plans and Acts for Urban Planning

5.1 National Housing Policy 1993 and 2001

The National housing Authority is the authority responsible to implement the NHP, which has been updated in 1999 and 2004. The goal of the NHP is to ensure housing for all strata of society, especially the poor by reducing the necessity of housing in slums and improving the existing ones. The policy also focuses on the rehabilitation of disaster affected houses, developing financial institutions from personal savings; engage local available materials, strengthening housing institutions and developing property tax. One of the policies focuses on balanced urbanisation in order to address the high land values in cities.

The major emphasis of the policy approved in 2001 by the Ministry of Housing and Works in 2001 is on resource mobilization, land availability, incentives for homeownership, incentives to developers and constructors and promotion of research and development activities to make construction cost effective. The objective is to create affordability, specially, for the middle and low income groups. One of the corner stone of the Policy is to ensure development of housing for the poor and needy and housing for the majority rural population through the use of different instruments like free land, cross-subsidy and concessionary finance, etc.

The goal of the NHP is to ensure housing for all strata of society, especially the poor by reducing the necessity of housing in slums and improving the existing ones. But the reality is not the same. The GOB and private landowners regularly demolish existing slum settlements without prior notices and rehabilitation. Over the years thousands of people have been made homeless through evictions in the name of slum clearance without provision of any alternative shelter. The policy also focuses on the rehabilitation of disaster affected houses, developing financial institutions from personal savings; engage local available materials, strengthening housing institutions and developing property tax. But, there is no particular rule or regulation to monitor these activities.

In the current housing situation, the public sectors interventions are poorly coordinated, are based on unworkable design standards, and ultimately have not been pro-poor. Improving the housing conditions of the lower income households will requires drastic policy reforms. The current legal and institutional framework in land management is largely ineffective and the Land market remains inaccessible to the low and middle income households.

5.2 National Urban Sector Policy

The National Urban Sector Policy is developed by Ministry of Local Government, Rural Development and Cooperatives Local Government Division in 2011.

The major objectives of National Urban Sector Policy for Bangladesh, therefore, will be to ensure regionally balanced urbanization through decentralized development and hierarchically structured urban system;

- facilitate economic development, employment generation, reduction of inequality and poverty eradication through appropriate regulatory frameworks and infrastructure provisions;
- ensure optimum utilization of land resources and meet increased demand for housing and urban services through public- private and other partnerships;
- protect, preserve and enhance the urban environment, particularly water bodies;
- devolve authority at the local urban level and strengthen local governments through appropriate powers, resources and capabilities so that these can take effective responsibility for a wide range of functions;
- involve all sectors of the community, including women and the poor, in participatory decision-making and implementation processes;
- ensure social justice and inclusion by measures designed to increase the security of poor people through their access to varied livelihood opportunities, secure tenure and basic affordable services;
- take into account particular needs of women, men, children, youth, the elderly and the disabled in developing policy responses and implementation;
- assure health, safety and security of all citizens through multifaceted initiatives to reduce crime and violence;
- protect, preserve and enhance the historical and cultural heritage of cities and enhance their aesthetic beauty;
- develop and implement urban management strategies and governance arrangements for enhancing complementary roles of urban and rural areas in sustainable development; and
- ensure good governance by enhancing transparency and establishing accountability.

The National Urban Policy envisions strengthening the beneficial aspects of urbanization and at the same time effectively dealing with its negative consequences so as to achieve sustainable urbanization, keeping in view the multi-dimensional nature of the urbanization process. The policy also envisions a decentralized and participatory process of urban development in which the central government, the local government, the private sector, the civil society and the people all has their roles to play. The policy therefore, covers spatial, economic, social, cultural, aesthetic and environmental aspects of urban life directed towards achieving an urban reality that can ensure freedom from hunger and poverty; capacity to live a healthy life; access to education, shelter, and basic services, and a secure and liveable environment at home and at the workplace. The policy will be gender sensitive and friendly to children, the aged and the disadvantaged.

5.2.1 Patterns and Process of Urbanization

The policy recognizes the existing spatial or regional imbalance in the pattern of urbanization in the country and also the rapid pace of urban population growth, particularly of Mega City Dhaka and other large cities. The recommendations are designed to reduce spatial imbalance of urbanization and to guide the pattern of urban growth through positive measures of investment location and moderation of internal migration.

5.2.2 Infrastructure and Services

Provision of adequate infrastructure and services, such as water supply, sewerage and sanitation, drainage, electricity, energy, waste disposal, telecommunication in urban centres and their proper maintenance have major contributions in advancing the cause of sustainable and environmentally sound development. Therefore, proper consideration of urban infrastructure and services should be included in the urban planning process.

5.2.3 Urban Transportation

Transport interventions in urban areas should aim at improving transport and traffic infrastructure and its policy priorities. In urban areas roads are the main system of transportation and policies must be made to make better use of existing road infrastructure and giving highest priority to pedestrians and to environmental protection. Mass rapid transit, rather than private cars, should receive greater preference.

5.2.4 Recreation, Playground, Park, Open Spaces and Graveyards

Open spaces are special and important for healthy and environment friendly living in urban areas. Every city should have fixed areas in proportionate to the population for playgrounds, parks as recreational places to serve the urban population. The city planning bodies must give emphasis on maintaining these essential services. City authorities should also keep adequate provision for graveyards and burning ghats.

5.2.5 Rural-Urban Linkages

Sustainable urban development' and sustainable rural development' cannot be separated which underlines the need for balanced and mutually supportive approach to development of the two areas. Therefore, there is a need to promote urban-rural linkages through judicious policies which may include the following activities

Patterns and Process of Urbanization: This deserves more attention, particularly in terms of discussion on the quality of urbanization being planned. Particular issues are the encouragement of industrialization in urban centres other than Dhaka.

Local Urban Planning: Firstly, re-consideration of the focus urban planning would be helpful– including specific recognition of the poor.

Local Economic Development and Employment: The majority of the nation's GDP is generated in urban areas, and therefore, economic development and employment policies have the potential to reshape the overall growth process, ensuring that it is more inclusive, and therefore, more poverty reducing. Proposals here should be more thoroughly researched and supported.

Urban Land Management: Pro-poor management of Khas lands and land sharing has the potential to address critical housing issues. As such, they warrant greater attention in the draft.

Litigation over Urban Land and Housing: The extremely high level of litigation over land and housing, and its impact on the justice system, merits detailed discussion. Policy responses might include the introduction of alternative dispute resolution mechanisms such as arbitration.

Urban Policy & Slum Improvement: Special representation arrangements might be examined for slum areas based on a clear delineation of such areas. Specifically, the question of land tenure within slum areas needs to be resolved. Greater attention should also be given to service coordination between centre and locality (especially health and education provision). This includes the location of provision.

5.3 Sixth-five Year Plan (SFYP)

FY2011-FY2015 focuses on a number of core targets to monitor the progress of the Sixth Plan. These targets have been set according to the vision and objectives of the Outline Perspective Plan 2021 as well as the goals of the MDGs. These targets fall in seven broad categories:

- Income and Poverty
- Human Resource Development
- Water and Sanitation
- Energy and Infrastructure

- Gender Equality and Empowerment
- Environment Sustainability
- ICT

All these categories could be directly or indirectly linked to the Delta plan. Points that relate to the water sector are:

- Safe drinking water to be made available for all urban population and proportion of rural population with access to safe drinking water to be increased to 96.5%
- Proportion of urban population with access to sanitary latrines to be increased to 100% and proportion of rural population with access to sanitary latrines to be raised to 90%
- Maintenance of ecological balance and overall progress and development of the country through protection and improvement of the environment
- Protection of the country from natural disasters
- Identification and control of all types of activities related to pollution and degradation of the environment
- Environmentally sound development programmes undertaken in all sectors

It has recognized in the plan that rapid urbanization is taking place due to socio-economic, political and demographic factors. Business and income opportunities beget rural to urban migration leading to the urbanization. Dhaka is expected to reach a population of 14.3 million (World Urbanization Prospects: The 2009 Revision, UN). It has been estimated that by 2010 and 2016 the population in the Dhaka City Corporation (DCC) area will be 9 million and 10 million and in the Dhaka metropolitan Development Plan (DMDP) area it will be 14.88 million and 18.00 million respectively. The city is expected to reach the 5th position with 20.9 million people in 2025. The existing problems along with urbanization are poor city management, low efficiency, massive corruption, traffic congestion and lack of proper traffic management, air and water pollution, slums etc. There are 2.8 million slum dwellers living in 4300 slums and squatter settlements (CUS, 2005).

Similarly, 1.8 million slum dwellers occupy 1814 slums in the Chittagong City Corporation, 0.17 million slum dwellers occupy 470 slums in the Khulna City Corporation and 0.148 million slum dwellers occupy539 slums in the Rajshahi City Corporation. The challenge therefore is to provide the basic necessities e.g. housing, sanitation, water supply and urban transport for meeting the needs of the growing urban population. Growth of urban population is evident from the population data that shows that urban population has reached 23.1% from 9%, in a period of 25 years (1974-2001). The major strategies in the plan are:

- Benefiting from higher labour force growth (demographic dividend) and ensuring labour quality: Improving factor productivity through information technology:
- Reducing the growth of population:
- Ensuring food security:
- Addressing the land constraint:
- Managing the spatial dimensions of growth:
- Reducing income inequality:
- Ensuring social protection for the under-privileged population:
- Ensuring Gender Parity:
- Ensuring environmental sustainability:
- Improving governance:
- Enhancing administrative capacity:

5.3.1 Major Strategies for Water Resources Management in SYFP:

For water resources management, several strategies have been taken into consideration in sixth five year plan (2011-2015). They are noted below:

- River dredging will be executed in combination with river bank protection

- Water sharing options of the trans boundary rivers will be prioritized addressing dry season water scarcity
- Basin-wide water resources development initiative will be taken
- The Ganges Barrage project with ancillary infrastructure will be taken in concern
- Participatory water management will be followed in all water resources sector projects
- O&M of completed projects related to flood control, drainage and irrigation with the participation of stakeholders for ensuring targeted benefits
- BADC, BMDA and BWDB will continue to pursue command area development activities in surface water irrigation project and to explore expansion of irrigation.
- Proper management of coastal zones will be ensured.
- Public-private partnership model will be explored.
- Climate change issue will be assessed on a realistic scale.
- Projects and steps will be taken for land reclamation.

5.3.2 Major Strategies for Rural Development;

- Rural infrastructure development plan will be based on results of impact studies of LGED
- Government approved Rural Road Master Plan will be followed for infrastructure development projects, i.e bridges, culverts, roads and growth centers/markets etc.
- Major rural road improvement will be prioritized
- Provision of maintenance will be assured for sustainability of rural infrastructure
- Maintenance efficiency will be improved and local participation will be ensured
- Labor based construction techniques for road improvement will be adopted.
- Guideline for investment prioritization and selectivity will be developed and calculation of economic rate of return will be adopted
- The first priority will be maintenance of all Upazila Roads, Union Roads and Village Roads including bridges/culverts and upgrade growth centres having connection with railway and waterway in order to promote and integrate multimodal transport system.
- The second priority will be improvement/upgrading of remaining Upazila Roads, Prioritized Union Roads and Village Roads-A including culverts/bridges which have strategic importance to connect railway and waterway.
- The third priority will be to improve Growth Centers and construction of ghat facilities at Growth Centers located on the bank of inland waterways to ensure better integration of road and water ways and thereby stimulating the rural transport and trading system.
- The fourth priority will be to selectively add roads to the maintainable core road network through rehabilitation and reconstruction, including spot improvement of drainage and badly damaged road sections.
- Priority will be given to the creation of macro and micro-level interactions
- Proper decentralization of design, implementation and management of rural infrastructure programs will be adopted
- Procurement functions and process and quality assurance including technical audit will be enhanced
- Environmental and social dimensions will be incorporated into the engineering design
- Road Safety activities for Upazila and Union Roads will be undertaken and gradually expanded

5.3.3 Major Strategies undertaken for Urban Development:

The major strategic plans undertaken for development of urbanization include the following:

- Improvement of city governance through institutional reforms, decentralization of responsibilities, civil societies participation, facilitation of networking at all levels and building capacity in all sectors for contributing in urban development process.
- Promoting Balanced Development of Urban Centers through encouraging labour intensive sectors of the economy, support small, medium and micro-enterprises (SMMEs) and enforcing regulatory framework that creates an environment conducive to investment

- Resource Mobilization in urban area through improvement of land and property valuation, better tax collection through improvements in property tax administration, and setting prices for urban services.
- Development of a sound real estate market will be assured through restructuring of House Building Finance Corporation and encouraging housing finance in lower income households.
- NGO Involvement in housing will be facilitated for poor people.
- Sustainable land use planning will be promoted through integrated and environmentally sound physical planning and land use zoning.
- Economic incentives and disincentives will also be used to encourage land development.
- Promoting cleaner environment, control pollution and protect public health from environmental hazards.
- Development of sustainable urban transport system through increasing the number of large-size buses, introducing Rapid Bus Transit, Elevated expressways and rail-based mass transit systems.
- Provision will be made for infrastructure and services focusing on demand equity and accessibility, economic efficiency and cost recovery, public-private partnerships and capacity buildings of local governments.
- Urban poverty reduction strategy will be implemented through emphasizing urban policies.

5.3.4 Major Strategies undertaken for attaining sustainable environment:

The focus of the Sixth Plan's environmental protection strategy would be the conservation and maintenance of natural resources, reducing air and water pollution, and liberating encroached rivers, water bodies, forest areas and khas land. The Sixth Plan will take effective steps in collaboration with the international community to help Bangladesh address the adverse consequences of climate change. An acceptable and workable collaboration strategy must include fair and just burden sharing for mitigation as well as adaptation strategies across nations.

- Environment committees at Division, District and Upazila levels will be activated with the participation of all stakeholders.
- Existing environmental laws and regulations will be amended to address new environmental issues.
- Department of Environment will be strengthened in the light of existing Environment Policy, Environmental Act, Rules and Environment Management Action Plan in order to coordinate, monitor and implement these activities.
- Drafting of EIA guidelines for all sectors under the Environment Conservation Act (ECA) 1995 will be formulated.
- Sectoral legislations are to be reviewed and redrafted in light of Bangladesh's commitments expressed through signing and ratifying of a number of International Conventions and Protocols on environment.
- Polluters Pay Principle will be followed in order to ensure strict compliance of environment legislation.
- Incentives, in the form of tax-rebate, tax-holiday etc. will be provided and incremental cost incurred by the Environment-friendly entrepreneurs will be met in various forms/sources.
- National Environment Fund will be established in order to provide assistance to the victims of environment degradation caused by the natural disasters and anthropogenic activities.
- Environmental Impact Assessment will be made while processing each development project requiring approval of the Government.
- Enhance whole of government's capacity to mainstream poverty-environment-climate nexus in the development project design, budgetary process, project implementation and monitoring process.

5.3.5 Gaps identified for different sectors

In depicting the urban development challenges, the demographics of the metropolitan areas of Dhaka, Chittagong, Khulna, Rajshahi, and Sylhet have been covered leaving out Barisal and other major cities. The spatial distribution of poverty shows that most of the border areas are poorer than the rest of Bangladesh. The SFYP have presented the current status of urban poor in Dhaka, Chittagong, Khulna and Rajshahi according to the CUS survey of 2005, which needs to be updated.

Urban areas of Bangladesh have been emerged as one of the most densely populated zones among world. Therefore, land and other non-renewable natural resources are becoming scarce due to intensified population pressure. Proper

land management should be ensured through efficient land administration system. Unfortunately, prevailing lack of coordination in land administration system is one of the major constraints for land management. The challenge of ensuring good governance has been sustained in Bangladesh which includes capacity constraints in public administration, occasional weaknesses in economic management, and corruption at the heart of overall national governance system. These long term challenges require long term coordinated and sustained effort to overcome the shortcomings.

In addition to ensuring better connectivity between the growth centres within the country, the policy promotes connectivity with regional growth centres in the neighbouring countries. However, in the SFYP, the areas and the regional growth centres requiring strategic investment have not been specified. For making strategic investment, economically prosperous and depressed regions have not been identified in the Plan. Pourashavas are entrusted to prepare the Master plans and manage the urban areas. Development authorities such as the Dhaka (RAJUK), Chittagong (CDA), Khulna (KDA) and Rajshahi (RDA) were created later on for making plans as well as implement development activities housing, commercial and industrial use. The policy recognized that the administrative, financial and technical capabilities of the Pourashava and Development Authorities are inadequate to manage urban areas. In addition to these factors, duplicity of responsibilities of multiple institutions, uncoordinated development, non-integration among the agencies, and lack of public participation create obstacles in tackling the fast urban growth. However, the policy does not include any guideline and framework to deal with the urban development challenges.

The strategies on rural development do not have any mention about the rural development plans. The integration of rural development planning with the regional and national scale planning is also missing which is necessary for ensuring budgetary allocation. The strategies do not include safety net programmes are an integral part of initiating projects in rural areas.

In case of formulating the strategies in water management sector, the state of water in Bangladesh needs continuous updating and monitoring in perspective of time and socio-economic setting. Major constraints in formulating the strategies is lack of public participation, scarcity of resources, lack of budget etc.

To mitigate the climate change impacts and formulate the strategies, all stakeholder's commitment in environmental resource management and climate change adaptation is necessary. Low public awareness capacity, occasional weakness in economic management and persistent corruption deteriorate the overall situation.

5.4 Road Master Plan (RMP: 2010-24)

The RHD's Road Master Plan (RMP: 2010-24) includes the following important roads and bridges to be constructed by 2024:

- 4-lane roads: Dhaka-Chittagong, Dhaka-Mymensingh (to Mawa), Dhaka-Bhariab, Bhairab- Moulvibazar, Habiganj-Sylhet, Dhaka-Tangail, Dhaka-Baniajuri, Jessore-Benapole, Chakaria-Chittagong, Baneshwar-Belephur.
- Other important roads and bridges: Mynamati-Brahmanbaria, Sylhet-Sunamganj, Bhatiapara-Narail-Jessore Road (upgrading), Dhaka Eastern Bypass, Dhaka Western Bypass, Chittagong Bypass, Hatazari Link Road, 2nd Meghna Bridge, 2nd Meghna Gumati Bridge; and the Padma Bridge.
- In addition, 13 other new roads, bridges (Padma 2) and upgrading to 4-lane roads have been identified.

5.4.1 Improving Railways

Priority to be given to railways over other forms of transport.

By 2021, all routes should be dual gauge so that meter and broad gauge trains can operate effectively between the East and West Zones.

Identification of main corridors (e.g. the Dhaka-Laksham chord will shorten the Chittagong-Dhaka route by 60 km, and cut travel time by one hour).

5.4.2 Improving Inland Waterways

- To ensure that waterways can be used throughout the year, steps should be taken to double all-season routes from the present length of 3,600 kilometers through dredging by BIWTA/Water Development Board and the private sector.
- Intensification of the dredging programme by procuring dredgers to develop channel conditions of inland waterways. Smooth navigation of water craft will be ensured through navigation aids.
- Establishment of inland container river port on priority basis.
- Priority upgrading of port facilities (both cargo and passenger) and storage facilities for prompt vessel loading/unloading, mechanical equipment will be introduced for handling of cargo in place of head-load system.

5.4.3 Air Transport

- Second runway in Hazrat Shahjalal International Airport for cargo planes.
- Second international airport near Dhaka.
- Expanded runways at Chittagong and Sylhet.
- Greater accessibility for foreign carriers.
- Buildings near the Hazrat Shahjalal International Airport that pose risks to air navigation should be identified for appropriate medium to long term remedial measures.

5.4.4 Rural Transport

- The strategies may be adoption of a Rural Road Master Plan and Maintenance Plan with priority accorded on maintenance over new construction;
- more involvement of LGIs and ensuring utilization and maintenance of constructed facilities.

5.4.5 Multi-modal Transport

Multi-modal transport has the potential to reduce transport expenditure and time. The modes should be integrated and the communication system should be improved to facilitate tracing the vehicles and sharing information among different stakeholders, such as importers/exporters, shippers, port authority and shippers. Computerized connectivity will improve communication, and adoption of the Digital Bangladesh policy will help further. Transport corridors, especially the Dhaka-Chittagong Highway, should be upgraded to facilitate the movement of container lorries. In the long term, another ICD should be constructed in the periphery of Dhaka, at major river and road junctions. This ICD can assist in distributing freight to all parts of the country and be the focal point for multi-modal transport. Long distance, international trans-shipment of goods will take place automatically.

5.5 Bangladesh National Building Codes 2010

Bangladesh National Building Code (BNBC) was first drafted in 1993 by Bangladesh University of Engineering and Technology (BUET) and recently in 2010 updated again by BUET. The national building code is the legal document that provides codes for the design, construction, materials, use, maintenance, occupancy and location of all buildings. Also fire and earthquake resistance. The buildings are categorized according to their use: residential, commercial, industrial, educational, medical, industrial, storage etc. The officers of the Development authorities are supposed to consult the code with inspections and building permissions.

Bangladesh National Building Code (BNBC) was first drafted in 1993 and recently in 2010 updated by Bangladesh University of Engineering and Technology (BUET). In the updated version, major changes have taken place in every discipline of the code. In the former code, building elevation was restricted zone wise, but in the new edition this restriction is removed and now building height has a proportional relation with the adjacent land. But this change has major implications as density of already densely populated area in the metropolitan cities will increase due to this new rule. The Code lacks any guideline on developments following planning procedures. In case of open space provision, at least 50 per cent of the mandatory open space in a plot shall remain unpaved with or without vegetation to allow water

penetration, which is not practiced in our country due to the lack of proper monitoring. In many cases, the open space is converted into paved area inhibiting drainage.

Part-6 "Structural Design" chapter in the Updated Code has included two new chapters, one on Bamboo Structure and the other on Steel-Concrete Composite Structures. The former is intended for use in the rural areas. The use of well-designed and economic bamboo structures is expected to be attractive to the rural people. The Steel Concrete composite structures are expected to be widely used in the industries. In urban areas this type of structure is expected to find application in high rise construction. But in Bangladesh perspective, neither bamboo nor steel structure is acceptable.

5.6 Dhaka Metropolitan Building Construction Rules 2008

Dhaka Metropolitan Building Construction Rules 2008 is developed by Bangladesh University of Engineering and Technology (BUET). The rules covered mainly the issue of Maximal ground coverage of plots in Dhaka

This statue is only applicable in the Rajuk jurisdiction. One of the crucial elements of the statue is the Floor area ratio indicating the maximum floor area in relation to the area of the plot it is located on. The ground coverings is maximised to ensure proper circulation of light and air around the building. Examples of rules within this policy are the mandatory involvement of architects/ engineers in building construction, discouraging non-residential functions in residential areas (through occupancy certificates), narrow roads should remain or become at least 20 feet wide. The Urban Development Comity has been established with the power to resist violations of the rules.

Dhaka Metropolitan Building Construction Rules 2008 is developed by Bangladesh University of Engineering and Technology (BUET). The rules covered mainly the issue of Maximal ground coverage of plots in Dhaka. The construction rule is only applicable in the Rajuk jurisdiction area. So, it is not applicable directly in any other city. The rule has given more importance on the floor area ratio (FAR) mandatory open space (maximum land coverage of 40 to 60% of total plot area) removing the restriction on maximum building heights. This may lead to growth of higher rise building thereby increasing the population density of already dense areas.

5.7 Private Housing Project Land Development Rule 2004

Private Housing Project Land Development Rule 2004 is developed by Ministry of Housing and Public Works. The main issue covered was Consistency of private developments with the Dhaka Metropolitan Development Plan (DMDP). Only formulated for the greater Dhaka area. To prevent building in valuable wetlands and building without sufficient public facilities required for a residential neighbourhood. Private land developers have to consult DMDP to check if the land use and space standard is consistent. You have to submit the plan to the authorities in charge with regard to transportation, water supply, electricity, telephone, environment, geology and other authorities if the site is located in proximity of their establishments.

All private land developers have to consult the DMDP to justify the consistency of land use and prepare a detailed plan. The plans are subject to the permission of the authorities in charge of transportation, water supply, electricity, telephone, environment, ecology, geology and other authorities.

The stature provides rules for liveable residential neighbourhoods. For instance the size of roads (primary roads 60 feet wide, secondary roads 40 feet wide, tertiary roads 25 feet wide. This rule gets critique since it is a waste of space with small developments; it is suggested that rules should be provided that cover the relation between roads and the amount of users or size of the project area.

Private Housing Project Land Development Rule 2004 is developed by Ministry of Housing and Public Works. It is only formulated for the greater Dhaka City, which is not applicable for other cities of Bangladesh. The development rule is unable to ensure sufficient public facilities required for a residential neighbourhood. The stature provides rules for liveable residential neighbourhoods. For instance the size of roads (primary roads 60 feet wide, secondary roads 40 feet

wide, tertiary roads 25 feet wide) gets critique since it is a waste of space with small developments; it is suggested that rules should be provided that is proportionate with the surrounding roads and the size of the project area and the number of users.

5.8 Urban and Regional Planning Act, 2014 (Draft)

Urban and Regional Planning Act, 2014 is developed by Urban Development Directorate (UDD) under the Ministry of Housing and Public Works to ensure proper urbanization and implementation of short term, medium and long term urban and regional planning and land use.

Objective:

- To increase the efficiency of feasible urbanization
- To establish proper land use management
- To implement Urban and regional Planning (Short, medium, long term)
- To ensure legitimate postulate of fundamental planning for combined progress.
- To ensure planned improvement of land's upper and lower material or mineral asset
- To improve the socio-economical, cultural and political status of the people of Bangladesh.

The Advisory and Executive Councils

The Act provides for the formation of The Urban and Regional Planning Advisory Council: This council consists of 18 members and is headed by the Minister of Housing and Public Works. Under that council an Urban and Regional Planning Executive Council will be formed which consists of 19 members and is headed by the Secretary of Housing and Public Works. For the violation of this act minimum 1 year and maximum 5 year jail or minimum 5 lakh and maximum 50 lakh taka penalty will be given.

Activities of the council is as follows:

- Planning, approval and implementation of the Urban and Regional planning and land use management rules and regulations, also other ordinance related activities.
- Assist the implementation of the National Government Plan.
- Integrate the development works taken by national organizations with the plans enacted under the Urban and Regional Act, 2014 and vice versa.
- Provide recommendations to control land use management carried out by professionals (involved directly or indirectly with development work) and government and non-government organizations related with plan preparation and implementation.
- Guide the planning and landuse management and related activities of government institutions, agencies and departments.
- Conduct government instructed urban and regional planning and land use management related other activities.
- Define and determine the standards for the planning, landuse management and development related elements, determine planning typology, science based and public participation oriented planning process, development control, relevant public hearing methodology and process.
- Assist different government agencies in the physical planning, land development planning and land use related all necessary activities through periodic evaluation and guidance.
- The council, if required, can include the Urban Development Directorate to assist the government organizations in the planning and land use management and other related works.

The act rightfully addressed the issue of ensuring public participation in the planning process (e.g. public hearing) which will give scope for incorporating the people's opinion. Implementation of short term and medium term regional planning is feasible, but in the long term the planning act may not be applicable due to political and socio-economical changes in the future. There is lacking in defining urban planning, regional planning, rural areas, establishing proper

land use management, ensuring legitimate postulate of fundamental planning for integrative management and planned improvement of land. The implementing agencies are to carry out their assigned tasks in the areas under their jurisdiction following the Act.

The Act also suggested the preparation of the Urban and Regional Planning Guideline without which implementation of the act will be incomplete. UDD will act as the coordinator of urban and regional planning and land use management activities. The council will be responsible for centrally collecting all the data for land use management, physical planning and development. The advisory council is to integrate the planning and land use management activities of all the government agencies. Land reclamation process by the assigned agencies should also abide by the land use management guidelines. These rules will no doubt ensure collective multi-agency efforts but at the same time will be very difficult to achieve given the involvement of different organizations (development authorities, city corporations, pourashavas, LGED) in such activities.

Any agency, institution or individual directly or indirectly involved with the planning and land use management and related development works are obliged to get a clearance certificate as per the Act prior to the initiation of such work. This procedure will create duplicity of mandates between the land development agencies and land ministry. The punitive measures suggested should have been stricter. The monetary punishment, for instance, in violation of the act is too liberal. The agencies or individuals responsible for carrying out development work not compliant with the land use management guidelines and the act, will face charges including immediate stoppage of the work, public hearing and reverting to the original land use type. However, it will be quite impossible to revert back to the original land use pattern if the vegetation including trees is cut off and waterbodies is filled up. So option for more stringent measures is required.

This act is in draft stage and has not yet been approved therefore there is still scope for improvement.

5.9 National Land use Policy, 2001

Land use is an important natural resource and the provider of foods, industrial goods, settlement and other services. More than fifty percent of the land use in Bangladesh is used for agriculture. Huge population growth and urbanization is increasing the settlement area and reducing the agricultural land. With the intention of proper utilization of land resources, the Government prepared the National Land Use policy in 2001. The major objectives of the policy were: a) To prevent the reduction of land used for food production; b) To prevent misuse of land; c) To give directives for the optimum utilization of land of different regions by its type; d) To ensure that the use of land is harmonized with the natural environment; e) To ensure maximum utilization of land for poverty reduction and creation of employment opportunities. The land use in Bangladesh mainly covers: Agriculture, settlement, forest, rivers, irrigation and drainage canals, ponds, jolmohol, roads, railways, commercial institutes and industries, tea and rubber garden, horticulture garden, coastal region, chars and islands etc. This policy highlighted the need for land use zoning for each urban and rural area to ensure proper utilization of land. Placement of residential areas far away from the industrial area has been also emphasized.

The policy lacks land use guidelines on education, health, communications, energy etc. People who have become landless or have been displaced due to disasters or eviction will be resettled on a priority basis on the newly accreted charlands.

5.10 UN Millennium Development Goals

The Millennium Development Goals (MDG) have been set by the UN to trigger the growth of the developing countries and bring them in line with the economic growth trend of developed countries. MDGs have been adopted by 189 nations during the UN Millennium Summit in September 2000. The issues that have been addressed are: poverty and hunger, education, maternal and child health, the prevalence of diseases including HIV/AIDs, gender equality, the environment, debt, trade justice and aid.

The goals are:

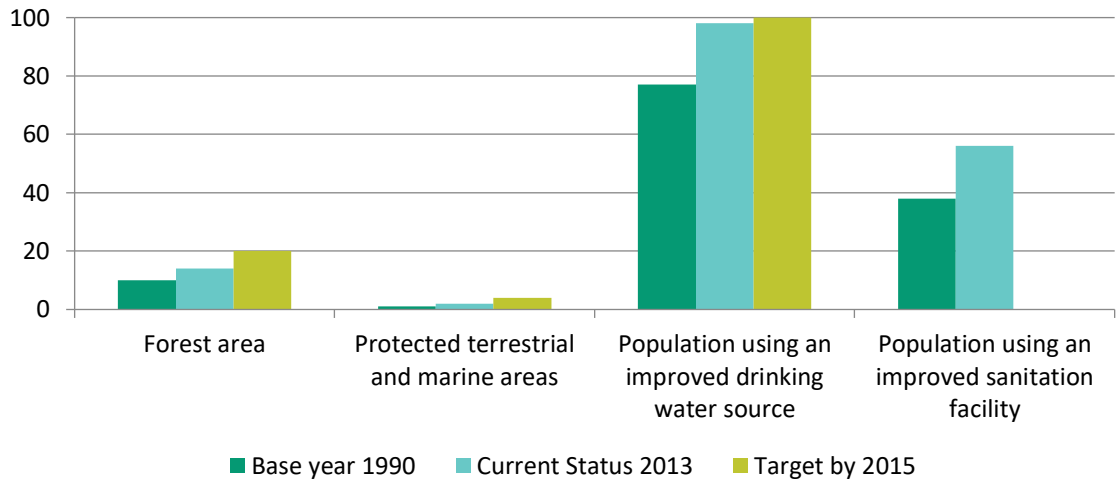
a) Eradication of poverty and hunger
b) Achievement of Universal Primary Education
c) Promotion of gender equality and empowerment of women
d) Reduction of child mortality
e) Improvement of maternal health
f) Combating HIV/AIDS, malaria and other diseases
g) Ensuring environmental sustainability
h) Development of a global partnership for development

The themes under the BDP will address some or all of these goals in its own way either directly or indirectly. The specific targets set under the goal 'Ensuring environmental sustainability' applicable in the context of spatial planning including urbanization is as follows:

Table 9 UNMG targets applicable to spatial planning and urbanization

Targets	**Indicators**
Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources.	Proportion of land area covered by forest
	CO2 emissions, total, per capita and per $ 1 GDP(PPP)
Reduce biodiversity loss, achieving by 2010, a significant reduction in the rate of loss.	Consumption of ozone-depleting substances
	Proportion of stocks within safe biological limits
	Proportion of total water resources used
	Proportion of terrestrial and marine areas protected
	Proportion of species threatened with extinction
Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation.	Proportion of population using an improved drinking water source
Halve, by 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers.	Proportion of population using an improved sanitation facility
	Proportion of urban population living in slums

Bangladesh has made quite a good progress in achieving the targets set for each goal. The targets achieved so far are shown in the following graph:



The MDG is limited to only 8 goals. These might be extended to include other goals such adequate housing, adequate access to basic needs such as health, educational facilities, market and growth centres etc. The MDG report itself has some gaps. For example- the basic data for some of the MDG goals—such as the number of births and deaths, the number and quality of jobs, and data on agricultural productivity-are still missing. The availability, frequency, and quality of poverty monitoring data have remained low, especially as institutional, political, and financial obstacles have continued to hamper data collection, analysis, and public access. Data sources used to produce development indicators in some cases are poor and in some cases have not been exploited sufficiently.

5.11 National Development Goals

Bangladesh is a country with six, clearly defined National Goals, which are set by the National Water Policy (NWPo) and National Water Management Plan (NWMP) are:

- Economic Development
- Public Health and Safety
- Poverty Alleviation
- Decent standard of living for the people
- Food Security
- Protection of the Natural Environment

Bangladesh has already met several targets of the NDGs like reducing poverty gap ratio, attaining gender parity at primary and secondary education, under-five mortality rate reduction, containing HIV infection with access to antiretroviral drugs, children under five sleeping under insecticide treated bed nets, detection and cure rate of tuberculosis under directly observed treatment short course and others. In addition, Bangladesh has made remarkable progress in the areas of poverty reduction, reducing the prevalence of underweight children, increasing enrolment at primary schools, lowering the infant mortality rate and maternal mortality ratio, improving immunization coverage and reducing the incidence of communicable diseases.

The Household Income and Expenditure Survey of 2010 data show that the incidence of poverty is declining at a rate of 2.47 percent per year since 1991-92 in Bangladesh. It can be said that the target of halving the population living below the poverty line is already achieved in 2012.'On the other hand, areas in need of greater attention are hunger-poverty reduction and employment generation, increases in primary school completion and adult literacy rates, creation of decent wage employment for women, increase in the presence of skilled health professionals at delivery, increase in correct and comprehensive knowledge on HIV/AIDS, increase in forest coverage, and coverage of information and communication technology.

Three different implementation rates for each remaining option were then considered in order to reflect various strategic prioritisation of the National Goals, defined as follows:

- Balanced Development Strategy-where, in selecting Institutional Measures and Development Measures, equal importance is given to all six National Goals.

This analysis resulted in a range of development options or programmes relevant to a particular sub-sector and region which are appropriate, either in nature or timing, for each strategy. En-passant, the analysis also suggested or defined additional cross cutting needs or opportunities. These were added to those identified earlier during the needs assessment exercises. Finally, the Government was invited to consider which of the three strategies would be addressed by the Plan proper: the Balanced Strategy was selected.

5.12 National Environment Policy and Implementation Plan, 1992

The major objectives are:

- Maintain the ecological balance through preservation of environment and development,
- To save the country from natural disasters,
- Identify and control the all types of pollution and environmental degradation activities,
- Ensure environment friendly development.

This policy was prepared by the Ministry of Environment and Forest.

The specific statements regarding water resources management, flood control, forest, wildlife and biodiversity, fisheries and livestock are:

- Keep the rivers, canals, ponds, lakes, haors, baors and all other water bodies and water resources free from pollution.
- Preservation and development of all the wetlands and migratory birds.
- Prevent activities which diminish the wetlands/natural habitats of fish and encourage rehabilitative measures in this area.

The policy gives directive to keep the water areas such as rivers, haor, baor etc free from pollution. Moreover, the haor and wetland have been identifies as important habitat of thousands of migratory birds hence should be preserved.

5.13 National Forest Policy, 1994

This policy was prepared by the Ministry of Environment and Forest. The major objectives are:

- to afforest about 20% of the total area of the country by initiating various afforestation programmes in forest lands, fallow lands, lands not useful for agriculture, hinterlands and other possible areas to meet the basic needs of the present and future generations and to ensure greater contribution of the forestry sector to economic development ;
- to enrich biodiversity in the existing degraded forests by conserving the remaining natural habitats of birds and animals ;
- to strengthen agriculture by extending assistance to those sectors related with forest development, especially by conserving land and water resources ;
- to fulfil national responsibilities and commitments by implementing various efforts and government ratified agreements relating to global warming, desertification and the control of trade and commerce of wild birds and animals ;
- to prevent illegal occupation of forest lands, illegal tree felling and hunting of wild animals through the promotion of participation of local people ;
- to encourage effective use and utilization of forest products at various stages of processing ;

- to provide for and implement afforestation programmes on both public and private lands.

Regarding forestry and tourism the specific statements are:

5.13.1 Forestry

Attempts will be made to bring about 20% of the country's land under the afforestation programs of the government and private sector by year 2015. Because of limited amount of forestland, effective measures will be taken for afforestation in rural areas, in the newly accreted char in the coastal areas and in the denuded Unclassed State Forest.

Private initiatives will be encouraged to implement programs of tree plantation and afforestation on fallow and hinterland, the banks of the ponds and homestead lands. Tree plantation near the country yards of rural organization such as Union Parishad, school, Eidgah, mosque-moktob, temple, club, orphanage home, madrasa. Massive afforestation on either side of land surrounding road, rail, dam and road, rail, dam and khas tank through the partnership of the local people. Protected area i.e. National Parks, Wildlife Sanctuaries and Game Reserves' area will be increased by 10 per cent of the reserved forestland by the year 2015. Inaccessible areas such as slopes of the hills, fragile watersheds, swamps, etc. will be identified and kept as protected forests.

5.13.2 Tourism

Ecotourism, related to forest and wildlife, is recognized as forestry related activity, which will be promoted taking into consideration the carrying capacity of nature.

The policy has a set a target to bring 20% area of Bangladesh under the afforestation programs. The policy also gives directives about taking up afforestation program in rural areas, roadside land, fallow and hinterland, the banks of the ponds and homestead lands. It will be very difficult to achieve this target as currently 17% (BBS, 2011) land is under forest area and haphazard felling of trees is continuing. The expansion of the coverage of forestry as per the policy may create a conflict with other existing uses of land such as agriculture, infrastructure, industry etc. So the space for creating more green spaces should be clearly mentioned in the policy.

5.14 National Sustainable Development Strategy, 2013

National Sustainable Development Strategy has been developed for solving the problems and challenges arisen by climate change and other pressures on economic, social and environmental sustainability of economy. Prior to the development of the overall condition and ensuring sustainable development, certain issues should be considered like population growth, poverty and inequality, unplanned urbanization, energy security, inefficient water resources management, natural disasters and climate change. In this regard, five Strategic Priority areas have been identified: sustained economic growth, development of priority sectors, social security and protection, environment, natural resources and disaster management. In addition to these five areas the other three cross cutting areas include: disaster risk reduction and climate, good governance and gender.

The urban sector has been addressed very comprehensively in the NSDS. For urban area development, some strategies have been developed concerning issues like urban housing, water supply and sanitation, pollution management, urban transport and urban risk reduction. Some of the strategies include improved public commuting system, dispersion of cities, adaptation of the environment friendly green building concept in the context of building design, developing the practice of applying land zoning and rules of National Building Code, preservations of the existing natural ecosystem surrounding the urban areas and wetlands for environmental sustainability and providing secured tenure for slum dwellers. For improvements of economy, slum upgradation, re-allocation and security for slum dwellers, access to infrastructure, promotion of income generating activity, provision of social safety net coverage for generation of employment opportunities for youth, developing options for water supply and sanitation sources, enforcement of environmental rules and regulation, industrial zoning and water quality monitoring, advancement of mass transport system, prioritization of pedestrian traffic. Urban Community Risk Assessment (UCRA) should be considered as an

important part of vulnerability reduction through awareness raising, compliance to safety regulations, self-investment of urban dwellers and additional risk reduction activities. For all the cities, Urban Risk Reduction Action Plans (URRAP) will be developed.

Provision for proper land use management and spatial planning of urban area is considered as major challenge. Rapid urban development and over exploitation trigger the degradation of soils which is considered as one of the major issues in case of strategic development of sustainable agriculture. Various strategic attempts have been taken like land zoning, prevention of soil and land loss through agronomic practices and river training works, land reclamation in coastal areas, restoration of soil fertility and monitoring of salinity intrusion in coastal zones and desertification in northwest region.

Consideration of climate change issues in development of national strategies to upgrade the investments in disaster risk reduction to create a suitable environment for social and economic development. The strategic elements in this regard include rehabilitation and climate proofing of coastal polders with especial focus on removing water logging, disaster risk reduction, mainstreaming disaster risk reduction and climate change, coastal char land afforestation, development of climate stress tolerant crop varieties and utilization of climate change funds.

The strategy document, NSDS reviewed various policies and strategies: National Conservation Strategy (NCS), National Environmental Management Action Plan (NEMAP), National Bio-diversity Strategy and Action Plan (NBSAP), National Action Programme (NAP) for Combating Desertification in Bangladesh, Bio-safety Guideline for Bangladesh, National Adaptation Programme of Action (NAPA) to address climate change, National Capacity Self Assessment (NCSA), and Bangladesh Climate Change Strategy and Action Plan (BCCSAP,2009). However, it overlooked major strategies-the Coastal Development Strategy (CDS), Poverty Reduction Strategy Paper (PRSP), and other sectoral policies many of which include strategic guidance on relevant themes.

The vision set for the implementation of the strategies is "Achieving a happy, prosperous and enlightened Bangladesh which is free from hunger, poverty, inequality, illiteracy, and corruption and belongs completely to its citizens and maintains a healthy environment." This is concurrent with what the Bangladesh Delta Plan aims to achieve and so, the strategies will provide a good basis for developing strategic framework for the Bangladesh Delta Plan. Strategies set for the transportation sector include prioritization of railway sector (e.g. double tracking of major railway corridors), construction of Padma Bridge, maintenance and up-gradation of existing road network (e.g. 4 to 6 lane national highways) and revival of inland water transport system through dredging (both capital and maintenance dredging). Balance growth of multi-modal transport however, requires integrated planning, timely implementation and huge investment. The social security and protection sections included gender aspects especially on women's advancement and rights. Gender parity have been stressed in respect of attaining education, improving nutritional status of female health, creating gender friendly settlement areas (e.g sanitation facilities) and for achieving an economic growth that is sustained, inclusive, and equitable. Making the governance gender sensitive in this regard is the most challenging task.

5.15 Water related issues urbanization and settlement

Since the scope of the Bangladesh Delta Plan 2100 is primarily water related, in this section we describe the important issues with regard to water management in urban and rural areas.

5.15.1 Water logging & urban drainage

Urban drainage refers to the removal of all unwanted water from urban areas: this includes wastewater, (from industries, sewerage water and domestic use water) and rain and storm water. Industrial wastewater is often heavy polluted. Together with sewerage water this is referred to as black water. This water should preferably be collected in a separate closed system and treated more intensify then for instance rain water or domestic use water. Currently the black water is not always collected in a closed system but ends up directly and untreated in the surface water: either by disposing it directly in open water or by collecting it through open sewage systems that in case of heavy rainfall flood and spreads through the cities.

Grey water, or 'sullage', is domestic wastewater predominately from baths, basins and washing machines. This water can best be disposed of in a sewage system for polluted water, or by first treating it and then diverting, storing or using it. Additional to this domestic and industrial wastewater, the urban areas in Bangladesh deal with drainage problems in relation to rainwater and peak river discharges especially during the monsoon period. Poor drainage capacity can cause waterlogging in cities.

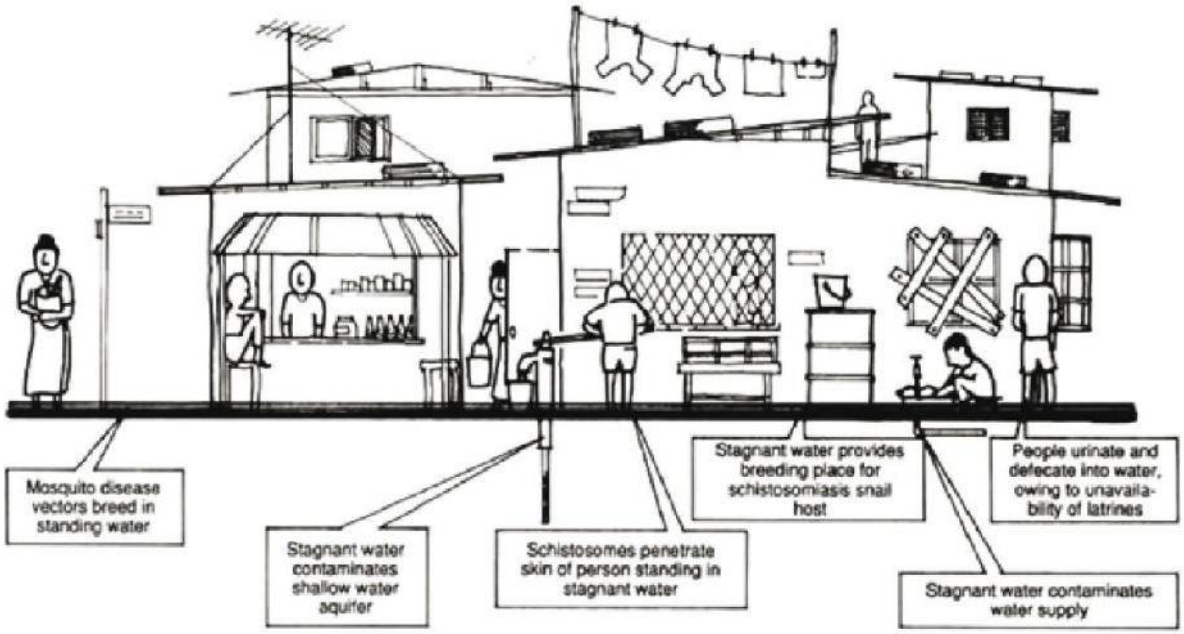


Figure 40 Waterlogging in urban areas can lead to health risks

Source: Cairncross and Ouano, 1991

Poor drainage capacity can be caused by:

- No sewage or drainage network is available
- Insufficient capacity of existing or planned drainage network
- Blockages such as bridges, buildings or cables
- Poor maintenance of existing drainage canals: they often are filled with litter, silt or building ground
- (Informal) development in (natural) drainage canals and appointed storage or discharge areas
- Vegetation, a natural retention body, is decreased in urban areas, also increasing runoff
- Rural settlements are constructed with little consideration of water drainage strategies
- The urban hardening of surfaces reduces the permeability of ground surfaces and increases runoff

Figure 41 Images of blockages of drainage canals in Dhaka and Chittagong

When rainwater does not permeate but runs through built-up areas it gets polluted since it touches and mixes with waste (especially when no proper waste collection system is in place) pollutants and waste water. Additional the rainwater can overflow mixed waste canals spreading sewerage water in the urban area. The water that is logged in the city can in that way cause health issues and further pollution. Image 47 shows the causal effect between water logging and health threat. Next to health issues the logged water can also disrupt traffic, power and communication networks and make agriculture land useless. In order to drain the logged water, the public sometimes opens up embankments. In Dhaka rules have been established with regard to the maximum plot coverage of a building, in order to keep sufficient permeate area, however under the open part of the plot often there are car parkings constructed that limit the permeability.

The poor are disproportionately affected; they often reside in informal settlements located on marginal land - low-lying land, riverbanks, floodplains and steep hillsides- that the formal housing market does not want or need (Parkinson 2003). Also in the rural areas the water login areas are mainly inhabited by the poor.

Figure 42 water logging map for Chittagong from the Chittagong drainage masterplan

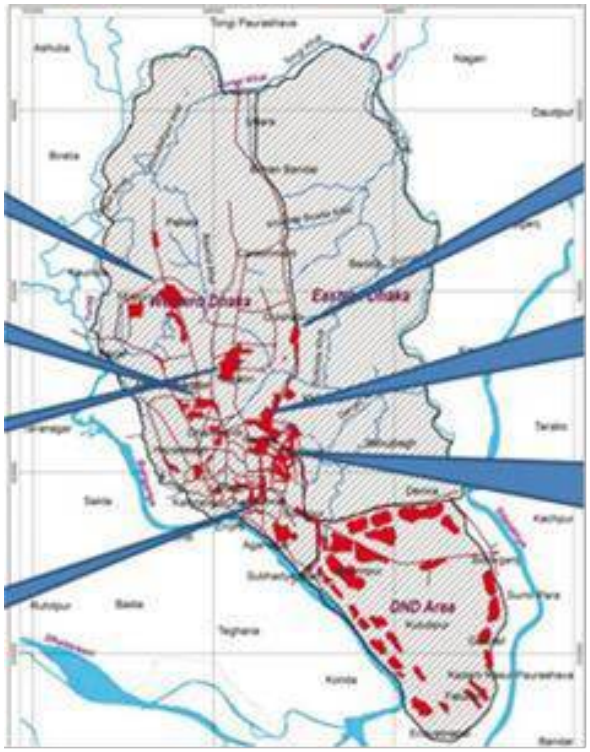


Figure 43 water logging map for Dhaka from the storm water drainage plan Dhaka

Table 10 the direct and indirect effects of floods on urban centres are listed.

	Social or Human effects	Physical effects	Economic effects
Primary effects	Deaths, injuries, loss of income or employment opportunities, homelessness, etc.	Structural and non-structural damage and collapse of buildings and infrastructure.	Disruption of business due to damage to buildings, damage to industrial plants and equipment, loss of productive workforce, disruption of communication networks, cost of response, etc.
Secondary effects	Disease and epidemics, psychological impact of injury, bereavement, shock, political unrest where government response is perceived as inadequate.	Progressive deterioration of damaged buildings and infrastructure that are not repaired.	Losses in the insurance industry and increased premiums, loss of confidence in investors, costs of repair, rehabilitation, medical and welfare assistance.

To assist in the analysis of problems related to storm water runoff and urban drainage, and the impacts on urban communities, Parkinson described three broad categories of flood types with there own flooding characteristics and impacts. These are summarized in relation to their physical and environmental health impacts, which are discussed below.

- Type A - Localized flooding caused by inadequate drainage of storm water runoff, which can happen virtually every time it rains where the provision of drainage infrastructure is very poor. The main impacts of these events are related to a deterioration in environmental health conditions – notably those related to water-related diseases.
- Type B - Flood events of this type occur less frequently than type A floods, but affect larger areas. The impacts may include temporary disruption to transportation systems and inconveniences to city life. These events contribute to the propagation of water-related diseases and can cause structural damage, but not as severe as those related to type C events.
- Type C - Large-scale inundation causing widespread disruption and damage affecting communities and businesses throughout cities. These events are infrequent and often reach the headlines due to the dramatic scale of the impacts and structural damage.

With this classification it is mentioned that 'although floods are often associated with large-scale events with disastrous consequences, there is also more frequent flooding related to factors at a local level, which can cause many problems in the urban environment, although they are often a less immediate and obvious cause for concern.'

In order to address urban drainage there should be a coherent planned strategy for a sewage and drainage system that might include clearing natural drainage canals.

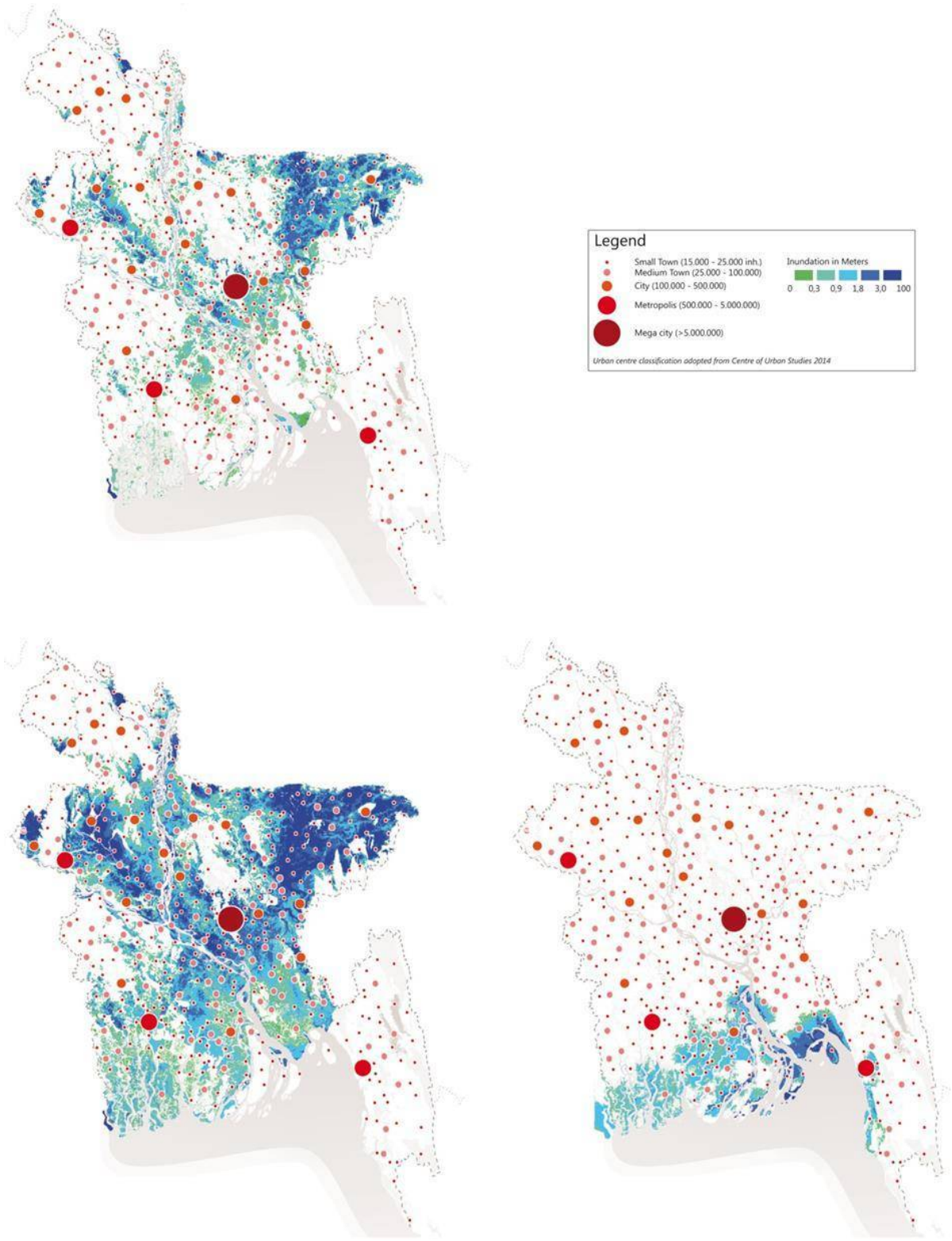


Figure 44 Riverine and coastal flood inundation depths (data CGIS, maps by Defacto Urbanism)

Riverine flooding return period T:1
Riverine flooding return period T:25
Coastal flooding return period T:25

5.15.2 Flooding

Regular flooding affects about fifth of the country annually, but have reached more serious proportions once every 10-15 years historically. Extreme flooding gravely disrupts normal life patterns and affects the physical, environmental, economic and qualitative aspects of urban centres and rural settlements. Some of these effects can be discerned immediately, others only long after the floods have subsided.

1. Extreme flooding in urban centres

In general, the inner-city areas of most urban centres are located on relatively high grounds. Rapid and uncontrolled urbanization has caused the development of formal urban extensions and informal urban fringe development within naturally vulnerable locations such as floodplains, wetlands and other low-lying areas. Additionally, erosion from areas under development produces sedimentation, which obstructs (natural) drainage capacities and development in floodplains limits natural flood-water storage.

Many towns (e.g. Dhaka and Rajshahi) have flood protection infrastructure in place. People affected by floods in urban area usually have less difficulty in finding alternative shelter when they are forced to evacuate their houses. Emergency supply of food and medicine is relatively better compared to rural areas. As emergency response is generally adequate in urban centres, death and injuries during and after the event are expected to be less. As cities have a large concentration of resources, vital infrastructure and national and/or regional administrative and service functions, the consequences of urban flooding can be felt in a city's hinterland and region, or in the case of Dhaka, the entirety of Bangladesh. Within cities itself, flooding and its consequence are felt hardest by already marginalized groups, who are forced to live in the most hazardous areas (Maniruzzaman 2006). Accessibility is a large problem during an urban flood, limiting disaster relief and the mobility of goods and people.

2. Extreme flooding in rural settlements

Rural Bangladesh is made up of scattered and fragmented settlements, extensions are organically grown over the years without any guidance. Most of the settlements are located in the floodplain, making flooding a common phenomenon. Hence, these settlement are highly vulnerable to extreme flooding.

The location of newly erected dwellings is based on the availability (ownership or tenure) of land rather than its suitability for human settlement. Underlying ground is elevated, so that the house and its yard are above regular monsoon flooding. As regular water levels rise under the influence of climate change, or the area is confronted with extreme flooding, the protection that these small artificial mounds offer is slowly dwindling. The same applies for other non-residential buildings or structures. Available building materials for rural dwellings do not provide adequate protection against normal natural elements, and are highly vulnerable to natural disasters (Rahman, 2006).

Only the major regional roads are elevated to be above regular flooding levels. As the most basic form of connectivity is a major precondition for the rural economy, the effects of extreme flooding can be felt long after the event, causing setbacks for the already usually poor rural dwellers (Hassan, 2006).

5.15.3 Water availability and quality

The availability of fresh water is likely to a limiting factor in Bangladesh's fast-paced urban development. Water is becoming increasingly scarce, whilst sanitation is not improving. In the baseline study on water supply and sanitation issues with regard to the water supply, the distracting of water from the groundwater sources and the quality of water are discussed in detail.

Availability of drinking water is an important bases for health and quality of life in urban and rural areas. According to the BBS in 2010 36% of people in Bangladesh are provided with tap water (in Dhaka this is 90% of residence, in Chittagong 50%, in Rajshahi 40 %. in Khulna 40 % and in district towns an average of 19%). In total 59% of people is serviced through Tube-wells and 5% uses open water as a source for water supply.

Most of Dhaka's water supply is extracted from groundwater, and a limited amount from the Shitalakshya river to the east, which is becoming more polluted every day. The many high rise building in the city are equipped with deep tube wells, further draining the local aquifer. A transition from ground water supply to surface water could ease the strain on the quickly lowering ground water levels, had it not been that industrial and domestic wastes (including heavy metals) contaminate potential supply due to an inadequate sewerage system. Only Chittagong and Dhaka are equipped with piped, water-based sewerage systems, although it is old an poorly maintained and serves only 30% of its inhabitants. Others are dependent on the use of septic tanks or are face with a complete lack of basic sanitation, which further worsens the condition of local surface water (Streatfield and Karar 2008).

Table 11 Drinking water

Year	Drinking Water			
	Tap	**Tube-well**	**well**	**Pond/River/Canal/Other**
1991	28.6	67.5	2.7	1.2
2002	33.6	66.3	-	0.2
2004	28.8	70.9	0.2	0.2
2010	35.57	59.18	0.15	5.1

Source data: BBS, 2005a; HIES Survey, 2010, BBS, source table: 7TH FY, Planning Commision GOB.

Figure 45 Wetland encroachment for new urban development along Dhaka's ring dike

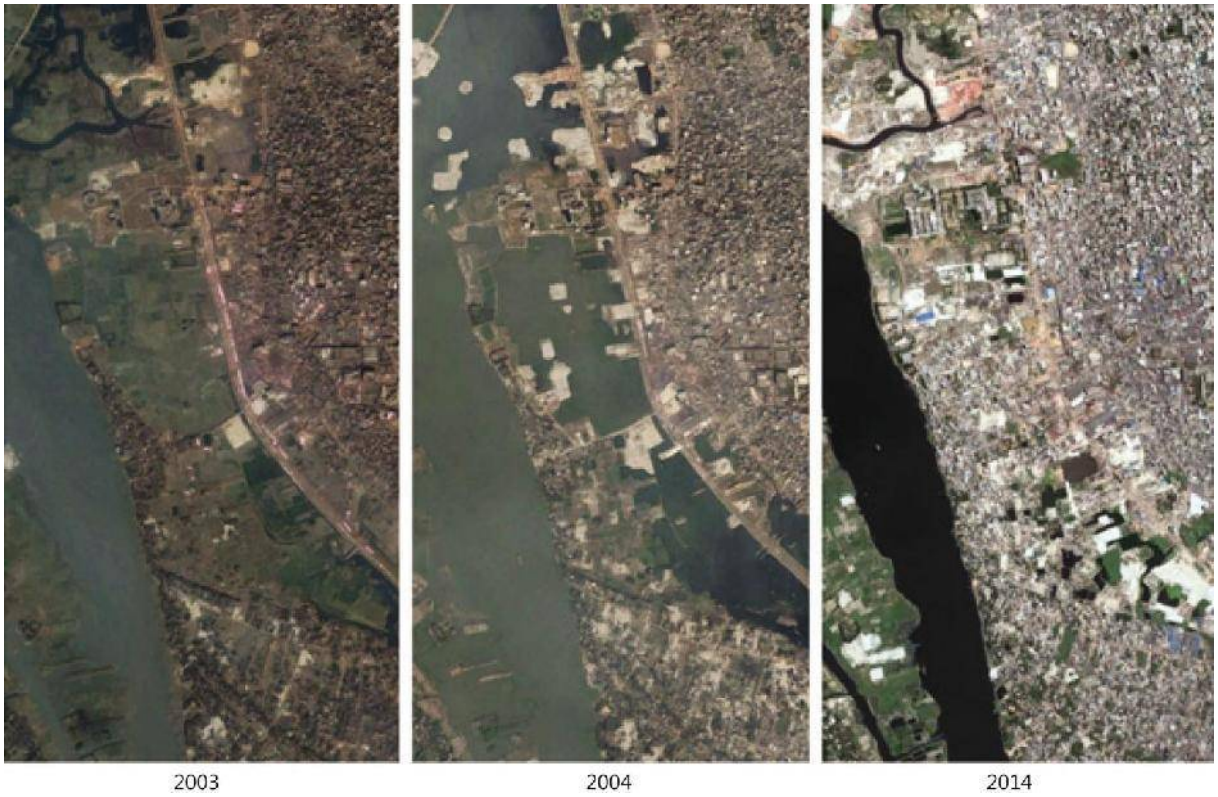


Figure 46 Encroachment of wetlands in Dhaka (Kamrangirchar) (Satellite imagery)

5.15.4 Encroachment of water bodies and wetlands

Water bodies and wetlands are vital in limiting the adverse effects of heavy monsoon rainfall in Bangladesh's cities. Current haphazard, informal urban growth is a major threat to these areas, as the huge demand for new land inspires the grabbing and filling of these areas for new development. There are several protective policies and regulations in place, however people can easily find ways to work around regulations; especially the vague definition of water bodies leads to problems. The consequences to the encroachment of water bodies and wetlands are listed below:

1. **Increasing flood vulnerability**

Wetlands and water bodies can acts as storm water retention areas, limiting (the extent of) water logging events. When large proportions of the wetlands located in the active floodplain of a river are developed, river water levels and flow velocities increase. Combined with extensive land filling around the embankments, (natural) drainage options are limited as excess water can't reach the riverbed.

2. **Decreasing ground water levels**

The many (deep) tube wells in urban areas put a large strain on local ground water levels. With the decline of natural infiltration areas such as wetlands and water bodies, the recharge of ground water levels is limited. In Dhaka, 95% of the cities water supply is drawn from ground water.

3. **Drainage system failure**

Storm water accumulates in wetlands and water bodies in and around the city, and will have to be drained to the major river(s) through natural or artificial canals. Encroachment on canals can cripple the drainage system. In Dhaka, where 43 major canals are used to drain out waste waters and storm runoff to the surrounding rivers, the drainage system is faced with heavy encroachment processes, particularly in the city's fringes.

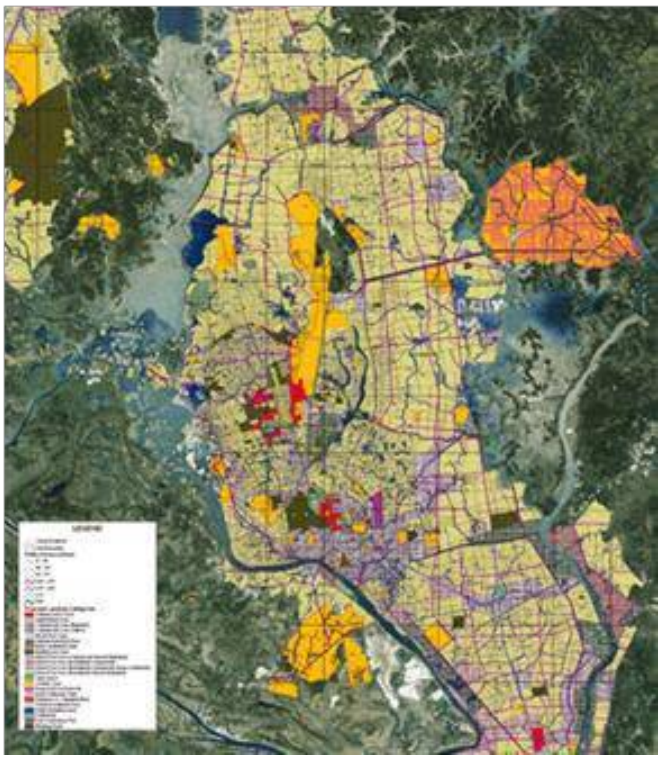


Figure 47 The 2010-2015 DAP urban area and extensions in relation to Dhaka's flood plains

Source: Defacto urbanism

4. **Negative effects on ecology and agriculture**

Wetlands and canals house specific habitats to various animal species. Additionally, the fertile flood plains have agricultural value, in which paddy and other corps can be cultivated in the dry season. In the wet season the wetlands merge with the adjacent rivers and can be used as fishing grounds. As encroachment limits fishing and farming activities it directly affects the local economy.

5. **Loss of urban quality**

The open space and options for recreation that water bodies and its surroundings bring are key to establishing an attractive urban environment. Encroachment will lead to a further loss of quality in Bangladesh's already dense cities. As a result, real estate value near encroached-on water bodies can drop.

5.15.5 Erosion

River bank erosion a severe problem in Bangladesh, and affects a large number of people every year, particularly along the major rivers; Padma, Brahmaputra and Meghna. When complete settlements are washed away, displaced households often have to choose between resettling in other, usually more disaster prone areas (e.g. fresh chars in the floodplain, government owned land) or to migrate to the city to provide for themselves, as they lack the resources to buy new land. It is estimated that 15 to 20 million people are at risk from the effects of erosion. About one million people in 94 Upazilas in about 50 districts are affected yearly. Over 50% of the landless rural households are victims of riverbank erosion. The north-west region is particularly vulnerable and is also one of the most economically depressed regions in Bangladesh. Impoverishment is exacerbated by the five consequences of river bank erosion (RMMRU, 2007);

- loss of income
- lack of adequate land

- inadequate food production
- high rates of unemployment
- lack of livelihood options

Victims of land erosion are thrown into a vicious cycle of poverty. As they loose everything, they are forced to live on the most physically vulnerable an unstable lands, where they have to cope annually with floods and river bank erosion and are unable to build up their livelihoods. Resettlement programmes, in which government owned lands ('khas') is distributed to the most vulnerable people are poorly coordinated. A national settlement policy or plan is lacking to coordinate the shelter and accompanying employment opportunities of thousands of displeased yearly. Such a plan could ultimately limit river-bank-erosion induced rural to urban migration movements.

Figure 48 River bank erosion along the Jamuna River near Guthail (Satellite imagery)

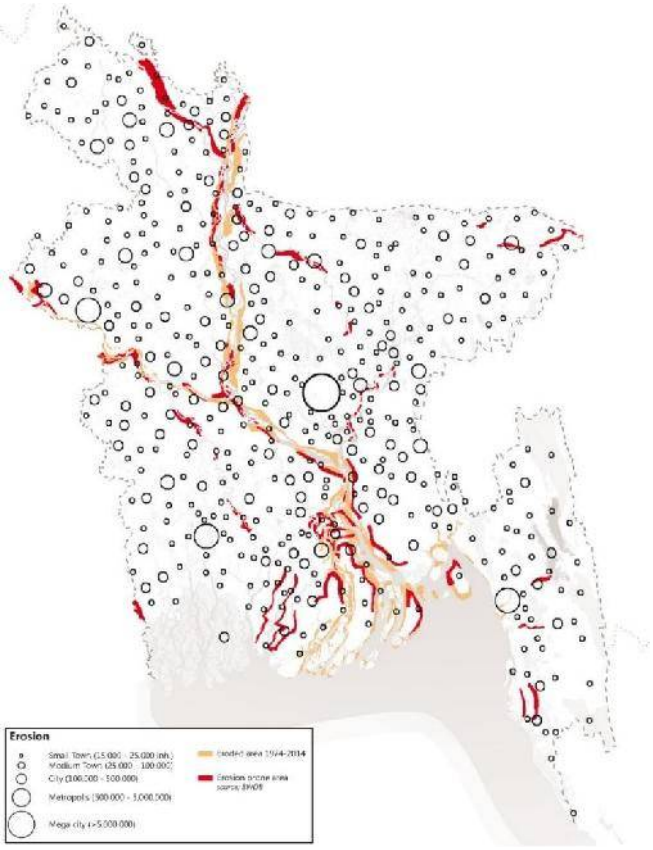


Figure 49 Historically eroded area, erosion prone area and urban centres data

Source: CEGIS and Defacto Urbanism

6 Policies Acts and Plans for Water Management

6.1 National Wetland Policy (Draft)

The principal objective of the Wetland Policy is to promote the conservation of Wetlands in Bangladesh, in order to sustain their ecological and socio-economic functions and thereby further the aims of sustainable resource development. In this regard the Wetland policy provided guidance for the conservation of fish habitats, production of both capture and culture fisheries and its management.

The wetland policy (section 6.6.14, NWPo) placed higher priority on the preservation and development of fisheries over agriculture and conservation of biodiversity for the haors and wetlands. Thus optimum fisheries development will be ensured and some provision for crop cultivation and grazing will be made. Some beels, haors and baors should be specifically set aside for fisheries, and a few baors, beels and haors should be set aside for biodiversity conservation.

Fisheries needs, will have higher importance except where irrigation or navigation requirements are considered more significant (section 7.6, NWPo). In the Wetland policy (section 6.6.14, NWPo), agricultural development of wetland area has been identified as tertiary objective to be achieved next to fisheries.

Again, through the siltation process new land or char is formed in some places and at the same time erosion occurs in other areas (section 7.8, NWPo). So dredging should be undertaken after due consideration of wetland ecosystems.

The Wetland policy made clear the need to assess the zoological and botanical resources of the wetland and accordingly prepare a report on 'Wetland resources' (section 7.2, NWPo) while placing high priority on biodiversity value during the assessment (section 7.4, NWPo).

The policy aims for sustainable resource development through ensuring sustainability of ecological and socio-economic functions, preventing unsustainable practices, maintaining and integrating wetland functions in resource management, economic development and decision- making, with particular regard to sectoral policies and programmes in the water, fisheries, environment, forestry, agriculture, industries, tourism and infrastructure sectors.

The policy issues are of four different levels namely national level, sectoral level, sub sectoral level and grassroot level. The policy identified five Ministries and 12 other government agencies responsible for management of wetland resources. However, the policy failed to identify any single ministry or institution for the task. More importantly it has left out Bangladesh Haor and Wetland Development Board (BHWDB) one of the key agency responsible for the integrated development of haor and wetland of Bangladesh as per the government approved resolution. The issue of coordination is also not clearly chalked out in the policy whereas BHWDB is mandated to coordinate the activities and formulate projects relating to the development of haors and wetlands in Bangladesh. The institutional role of MoWR is also missing in the policy.

The policy also failed to mention the ECA'a such as Tanguar Haor which is vital for conservation of biodiversity. International and regional cooperation has been sought in support of protecting the wetlands (e.g Sundarbans) including the forests, fisheries and migratory birds from marine pollution, oil spills etc.

6.2 National Water Policy, 1999

The national water policy prepared by the Ministry of Water Resources, stressed the need for integrated planning approach with people's participation for preparation of any plans related to the water sector (section 4.2, NWPo 2004). Also it is mentioned that projects on water sector development such as flood control, irrigation and drainage (FCD/I) projects, may be taken up with minimum disruption to fisheries habitat and movement (section 4.9, NWPo 1999), navigation. Mini hydropower schemes may be developed after due consideration of the economical and environmental considerations (section 4.11, NWPo 2004). The objectives are broadly:

- To address issues related to the harnessing and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner;
- To ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children;
- To accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing;
- To bring institutional changes that will help to decentralize the management of water resources and enhance the role of women in water management;
- To develop a legal and regulatory environment that will help the process of decentralization, sound environmental management, and improve the investment climate for the private sector in water development and management;
- To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation.

The policy specifically mentions the need for preserving the natural water bodies including haors, baors and beels for maintaining environmental quality, facilitating drainage. Integrated projects should promote production of fisheries in the preserved waterbodies.

The policy emphasizes the need for conservation of waterbodies like haor, baor, beels and its ecosystem and provides necessary measures for its preservation and maintenance. The policy states that fisheries sector accrues huge economic benefit for the country and is important source of nutrition, livelihood, and poverty alleviation. Therefore development of fisheries should be given importance during water resource planning through maintaining wetland ecosystem.

6.3 Coastal Zone Policy, 2005

The Government has formulated the coastal zone policy (CZPo) to provide a general guidance to all concerned for the management and development of the coastal zone in a manner so that the coastal people are able to pursue their life and livelihoods within secure and conducive environment. The coastal zone policy is unique in the sense that it is a harmonized policy that transcends beyond sectoral perspectives. The CZPo initiated the coastal zone management process that commits different Ministries, Departments and Agencies to agree to harmonize and coordinate their activities in the coastal zone and elaborates the basis for a firm co-ordination mechanism. The goal of integrated coastal zone management is to create conditions, in which the reduction of poverty, development of sustainable livelihoods and the integration of the coastal zone into national processes can take place to meet the national goal for economic growth. Among others equitable distribution; empowerment of communities; women's development and gender equity; conservation and enhancement of critical ecosystems, are some of the key issues that have been covered under this policy.

Three indicators have been considered for determining the landward boundaries of the coastal zone of Bangladesh. These are: influence of tidal waters, salinity intrusion and cyclones/storm surges. 19 districts of the country are being affected directly or indirectly by some of these phenomena. The districts are considered including all upazilas/thanas. A total of 48 upazilas/thanas are considered as 'exposed' directly to vulnerabilities from natural disasters. The exclusive economic zone (EEZ) is regarded as the seaward coastal zone. One-third of the country belongs to the coastal zone.

6.3.1 Reduction of vulnerabilities

Majority households in the coastal zone are vulnerable to climate change and due to disasters like cyclone, drainage congestion, land erosion and drought that take toll on life and property. In this regard, Government policy is as follows:

- Integration will be made with 'Comprehensive Disaster Management Plan' on aspects concerning the coastal zone;
- Effective measures will be taken for protection against erosion and for rehabilitation of the victims of erosion;

- Safety measures will be enhanced by combining cyclone shelters, multi-purpose embankments, killas, road system and disaster warning system. It should include special measures for children, women, the disabled and the old;
- Sea-dykes will be regularly maintained as first line of defense against storm surges and afforestation on it according to the existing policy;
- Adequate provision will be made for safety of livestock during disaster and post-disaster period;
- Programs shall be taken to encourage all for tree plantation in a planned manner in the coastal zone. Emphasis will be given to social forestry and other forms of plantations, plant care and maintenance;

6.3.2 Land

- Planning will be done under land use policy to control unplanned and indiscriminate use of land resources. Strategies for new chars will be developed. Zoning regulations would be formulated and enforced in due course;
- Through its responsible agencies, the Government will proper plan and implement schemes for reclamation of balanced land from the sea and rivers.

6.3.3 Water

- Rainwater harvesting and conservation shall be promoted;
- Ponds and tanks will be excavated for conservation of water and local technology for water treatment (such as, pond sand filtering - P.S.F.) will be used for the supply of safe water;

6.3.4 Afforestation

- Measures will be taken for afforestation in the coastal areas including newly accreted chars;
- Effective measures will be taken for conservation of forests;
- Social forestry will be encouraged and extended.

6.3.5 Energy

- Special projects will be identified, for example power plants in the offshore islands. Plans for the generation of electricity in isolated and remote areas like offshore islands will be prepared separately.

6.3.6 Equitable distribution

- Actions will be designed to reach the poorest and the remote rural areas (including the cyclone prone coastal regions, chars and river erosion affected areas), which are vulnerable to adverse ecological processes and those with high concentrations of socially disadvantaged;
- In order to ensure equitable distribution of national economic benefits, priority will be given to exposed upazilas and coastal islands;
- In order to ensure equity, the thrust should be on human development of the poor for raising their capability through education, health, nutrition, employment-oriented skill training and social interventions;
- Measures will be adopted that increase access to natural resources for the poor and the disadvantaged (on which they are dependent for their livelihood).

6.3.7 Empowerment of communities

- Equal participation of all stakeholders shall be ensured and establishing effective co-operation between the government agencies, local government institutions and non-governmental organizations;
- Co-management procedures shall be established that will bring decision-making power to the grass root levels;
- Specific vulnerabilities of the coastal communities shall be addressed: like farmers in the saline zone, marine fishers, salt producers, dry fish processors, people living on forestry resources, ship breaking workers, vulnerable ethnic communities and so forth;
- Vesting on local government institutions, at the union, upazila and district levels, the power and responsibilities for design, formulation and implementation of local level development programs and projects;

The Coastal Zone Policy initiates a process that commits the ministries, departments and agencies to toning and organising their activities in the coastal zone and elaborates the basis for a firm co-ordination mechanism. But so far not much has been done for the development of the coastal zone. Disaster management has been one of the major

focus areas. However, the policy does not include any strategy for distribution of land among the erosion victims. The issue of urban development should be mainstreamed with other which cannot be dealt with separately

6.4 Jalmohal Management Policy (JMPo), 2009

Prepared by the Ministry of Land, the objective behind the preparation of the policy was the conservation, increased production and bio diversity conservation of fisheries resources as well as tenuring khas waterbodies in favour of real fishers and earns revenue.

As per the Jalmohal policy (section 25, JMPo 2009), the Ministry of Land will be responsible for designating some waterbodies as reserved to create fish sanctuaries and also for their preservation. It is also mentioned that the Ministry of Fisheries and Livestock will take the necessary measures with the approval of Ministry of Land and help from district office to establish fish sanctuaries at particular place of the open waterbodies and prohibit fishing at certain period of time for its preservation. However, in the Fisheries policy (section 6.2, NFiPo 1998) it is said that Jalmohals designated as fish sanctuaries will be transferred to the Directorate of Fisheries. These statements are contradictory to each other as it is difficult to comprehend which authority will ultimately bear the sole responsibility of managing the fish sanctuaries.

The statements are given below:

6.4.1 Water Resources

- Natural flow of water into the leased waterbodies should not be restricted.
- Irrigation from waterbodies such as rivers, haor, khal which are usually used for irrigation purpose, should not be constrained. Scope will remain to continue irrigation without disturbing fish production from the leased out closed waterbodies.
- The management of waterbodies more than 20 acre will lie upon the 'District Jalmohol Management Committee' and for the management of waterbodies less than 20 acre the 'Upazila Jalmohol Management Committee' will take the necessary measures.

6.4.2 Environment

In the sides of waterbodies or government owned khas lands environment friendly Koronch garden will be created which will act as safe haven for the fishes. Hunting of birds (including migratory birds) in the reserved waterbodies is prohibited. Necessary measures in this regard will be taken by the local government, local forest department, fisheries cooperative societies, enlisted NGOs, and lease holders.

6.5 National Water Management Plan, 2001

National Water Management Plan is prepared by WARPO under the oversight and guidance of the National Water Resources Council, also in supervision of Ministry of Water Resource of Bangladesh. Drawing upon the formative statements above, the scope of the National Water Management Plan has been determined as follows:

The overall objectives of the NWMP are to contribute in a balanced fashion to the overall national goals of economic development, poverty alleviation, food security, public health and safety, decent standard of living for the people and protection of the natural environment;

The purpose of the NWMP is to operationalise directives given in the National Water Policy, and to do so in accordance with the Government approved Development Strategy;

The NWMP is to be a framework plan to guide (but not prescribe), in an integrated and comprehensive manner, the actions of all concerned with developing and managing water resources and water services;

It is to be a rolling plan to be reviewed and updated every five years, providing a firm plan for the first five years, an indicative plan for the subsequent five years and a perspective plan for the long term (25 years), all set in the context of what may happen at least 50 years ahead;

The Plan has to be realistic about the prospects for institutional and implementation capacity, and should seek to rationalise and strengthen institutional capacity.

6.5.1 Overview of Policy Framework for NWMP

The policy statements above provide an extensive framework for management of the water sector. Assessment of these policies indicates that there are no major contradictions between them. There are however some gaps in terms of water planning. The main policy gap is in land use planning. Principles need to be established that will guide management of the massive urban expansion expected over the next 25 years. Will Bangladesh invest pro-actively in the expansion areas? To what extent will private sector resources be mobilised in that investment? Will there be a policy to attract people to centres other than the major cities? How would that policy be brought about? What roles have economic and regulatory instruments in this? Land use planning needs to take account of the plans and capacities of other sectors. Planners in the energy, water, education, health, communications and other sectors need to be consulted and in turn need to know what principles will guide land use

6.5.2 Strategy for the Water Sector

Strategy defines the broad direction of a plan. Strategy is set within the framework laid down by Policy, which defines the overall goals that are sought. In this case, the National Water Policy also defines in many instances what approach should be adopted in achieving its stated goals. Thus the Development Strategy adopted by Government for the water sector may be seen as an elaboration of Policy, providing increasing definition of the course of action Government has chosen to take. However, the Strategy refrains from being specific on programmes, time lines and resources, these being, inter alia, the job of the NWMP to set out.

6.5.3 Programmes for the Towns and Rural Areas

Eight programmes are suggested in order to achieve the immediate water sector Objectives of Towns and Rural Area development. Since however, water supply and sanitation represent quintessentially demand driven investments, and given also that infrastructure (or provisions for it in the form of land acquisition) must anticipate rather than respond to demand build-up, it is necessary at this point to describe briefly the relationship between capacity and demand that has been assumed during preparation of the cluster. Table 8.3 below expresses assumed the water supply and sanitation demand profiles in terms of population forecasts and service coverage specifications up to 2050. Figure 8.5 which follows is a dimensionless model indicating the way by which capacity should always provided ahead of demand.

6.5.4 Objectives for Disaster Management

Although it is a truism that no country can divorce socio-economic activity from its need for adequate, manageable and timely supplies of freshwater, it is equally true to say that the life and culture of some countries is far more extensively shaped by their hydrology than others. Among such countries, Bangladesh must surely be one of the more extreme examples and this is particularly so with respect to the enormous potential threat to socio-economic activity, and life itself that Bangladesh's vast water resources represent when in spate.

There are three causes of flooding in Bangladesh:

- In-stream flows large enough to cause overtopping;
- Surface run-off resulting from intense precipitation events especially in the north east where they are blown in by fierce Northwesters; and
- Sea level rises due to cyclone and or tidal surges.

While these represent significant and direct individual threats, in combination they become even more so. Large in-stream flows combined with say spring tides and a cyclone event (such as happened as recently as 1998) result in massive loss of life, livelihood, infrastructure and equipment. Equally, the impeded drainage caused by high river water levels greatly exacerbates the harm caused by intense rainfall events. As well as these dangers which are clearly directly related to floods, there are also other indirect threats. These include disrupted communications when highways and railways become inundated; drought and land loss due to increased erosion (but this is addressed in the Main Rivers Cluster). Prevention of flooding is not justified however: the costs would be prohibitive while the actuarial ramifications would remain uncertain. The approach adopted for the NWMP therefore addresses mitigation rather than prevention of flood related disasters. It has four facets:

- improved warning and preparedness systems (the relevant programmes for which are included in the institutional development cluster);
- social measures based on improved or more appropriate dissemination and response procedures (again the relevant programmes for which are included in the institutional development cluster);
- physical and social mitigation measures such as elevated platforms, cyclone shelters, raised highways and the like;
- multiple use of infrastructure, made possible for instance by designing cyclone shelters such that they can be used as schools or other community facilities, or by ensuring the accessibility of raised highway or railway embankments as safe havens for potential flood victims.
- and in full consideration of the proven gender related dimension to flood deaths wherever meaningful, the interventions will include options or facilities for women.

The NWMP was an integrated plan providing the broader framework for managing the water resources of the country. Region specific projects were proposed without linkage with any spatial plan. The plan is presented in three phases: in the short term (2000-2005) it is considered a firm plan of ongoing activities; in the medium term (2006-2010) it is an indicative plan and in the long term (20011-2025) a perspective plan. Implementation of the plan was to be monitored regularly and updated every five years. The updating of the NWMP has started by WARPO but the project monitoring as per the NWMP is not being followed.

6.6 Outline Perspective Plan (OPP), 2010

The objectives of the Perspective Plan in outline for a Transformed Bangladesh by 2021 that are relevant to the BDP2100 are:

- Expansion and diversification of the industrial sector for enlarging the share of the secondary/industrial sector to 35 per cent of GDP and for employment generation.
- Ensure per capita energy consumption rising to 600 kwh.
- Preservation, conservation, and restoration of all the historical monument/mass graves of martyred war veterans.
- Protection and enhancement of the environment, effectively meeting the challenges arising from the intensifying climate change and addressing other environmental degradation issues.

6.6.1 Provision of housing for the poor

The concept of 'an urban village', a place with fixed boundaries, may help to address the challenges of low-income housing. Such a village would have one market, one clinic, one station on the transit, several primary schools and several bathing and washing facilities. A housing policy should be binding on all urban authorities in different parts of the country. Such a national policy should also provide for the conservation and improvement of housing stock in any town or city.

6.6.2 Improving Roadways

- New road construction should be limited, because Bangladesh already has an extensive road network. However, new zila roads will need to be constructed to connect the 16 upazila headquarters.
- National Highways 1 to 8 should receive priority attention to ensure a high level of service, safety and quality. The Dhaka-Chittagong Highway (NH1) is to become a four-lane road. The other seven highways should gradually become four-lane by 2021. These roads can form part of the regional road network, as well as the Trans-Asian Road network facilitating trade between Bangladesh and neighbouring countries.

To ensure balanced development across the country, there should be an adequate number of east-west connections. The 6.15 km long and 22 m wide Padma Bridge will serve southwest part of Bangladesh and improve the connection between Mongla Port and Dhaka. Its completion is scheduled for 2013.

The Outline Perspective Plan (OPP) is formulated by Macro and perspective wing of General Economic Division (GED), Planning Commission. There are several parts of the plan in which the concept of 'an urban village' is one of these. This concept is practically difficult to implement from the economic point of view of Bangladesh. The Plan states that illiteracy will be removed by 2014 or as soon as possible, but now in 2015 there is still a substantial number of people are illiterate and it seems that the illiteracy rate is not going to decrease by the desired rate in near future. Another target of the Plan is to achieve the per capita income of about $1800 by 2021, but the annual growth of income rate is not enough to reach the goal.

6.7 Flood Action Plans (1989-1995)

The FAP studies were conducted by the FPCO during 1989-1995. There were 26 components. The FAP described the baseline situation of the area in respect of water resources, population, poverty, health, education, literacy, agriculture, fisheries etc. It also included projections for the future. The report further discussed the strategy for change, which include the following:

- Protection of urban centres and infrastructure from flood and improvement of the urban environment
- Intensive agriculture for urban consumption
- Enhanced production systems on seasonally flooded areas
- Integrated development of deeply flooded areas
- Biodiversity enhancement and sustainable management
- Improvement of the livability of rural settlements
- Improvement of water transport in the region
- Institutional strengthening and development

The study developed a portfolio of 44 initiatives for the above mentioned strategy. The initiatives included both structural and non-structural measures. The study further detailed the impact of the implementation of the strategy. The FAP Study reports will be reviewed thoroughly to understand the complexities of the issues. It will help in identifying remedial measures as well as formulation of new strategies for development.

The cost for implementation of the FAP was not feasible according to many of the economists. Formal evaluation process was not followed while preparing the plan. Till now, many flood control projects proposed in FAP is still to be implemented. Construction of embankments or polders might reduce the other land use and also have detrimental effects on the environment.

6.8 National Plan for Disaster Management (NPDM), 2007

National Plan for Disaster Management 2008-2015 is an outcome of the national and international commitments of the Government of Bangladesh (GoB) and the Ministry of Food and Disaster Management (MoFDM) for addressing the disaster risks comprehensively. The plan has been developed on the basis of the GoB Vision and MoFDM mission to

reduce the vulnerability of the poor to the effects of natural, environmental and human induced hazards to a manageable and acceptable humanitarian level by a) bringing a paradigm shift in disaster management from conventional response and relief practice to a more comprehensive risk reduction culture and b) strengthening the capacity of the Bangladesh disaster management system in improving the response and recovery management at all levels.

The objectives of this Plan are to:

- Align the strategic direction of disaster management programs with national priorities and international commitments.
- Articulate the vision and goals for disaster management
- Outline the strategic direction and priorities to guide the design and implementation of disaster management policies and programs.
- Create a cohesive and well-coordinated programming framework incorporating government, non-government and private sector.
- Ensure that disaster management has a comprehensive and all-hazards focus comprising disaster risk reduction and emergency response.
- Illustrate to other ministries, NGOs, civil society and the private sector how their work can contribute to the achievements of the strategic goals and government vision on disaster management.

The Disaster Management Vision of the Government of Bangladesh is to reduce the risk of people, especially the poor and the disadvantaged, from the effects of natural, environmental and human induced hazards, to a manageable and acceptable humanitarian level, and to have in place an efficient emergency response system capable of handling large scale disasters. Ministry of Food and Disaster Management prepared the plan.

The main mission of the Government is to bring a paradigm shift in disaster management approach from conventional response and relief to a more comprehensive risk reduction culture and to promote food security as an important factor in ensuring the resilience of the communities to hazards. Again, renaming the name of the Ministry of Relief and Rehabilitation as the Ministry of Food & Disaster Management in May 2004. Now Ministry of Food and Disaster Management is working hard to ensure socioeconomic development of the country through food security, relief and disaster management programmes. The Ministry has taken a number of programmes for,

- overall food management of the country and establishment of dependable national food security,
- implementation of national food policy and strategy with overseeing and monitoring of overall food supply situation of the country,
- monitoring and coordination of all matters relating to procurement, storage and distribution of food grains and ensuring fair price,
- formulation and implementation of policies and planning relating to disaster management, relief and rehabilitation,
- poverty reduction through formulation, implementation and evaluation of programmes like Food for Work, Test Relief, KABITA etc.,
- planning, coordination, monitoring and evaluation of matters relating to relief activities and disaster management,
- co-ordination among the different organizations for pre-disaster, during-disaster and post-disaster activities including preparation of disaster management guidelines,
- provision of assistance to disaster related ministries and organizations in preparing the action plan on matters related to disaster management,
- formulation of policy and its' implementation on matters relating to the preparation, monitoring and evaluation of food assisted projects and programmes,
- coordinating matters relating to the distribution of external food aid and other relief assistance, and (k) other concerned matters relating to food, relief and disaster management.

This is an action plan for managing and reducing disaster risks. Disasters such as the floods and erosion have been mentioned however, floods and riverbank has not been mentioned as a solution to effectively deal with these. The issue of resettlement also has been mentioned briefly without any detail guideline.

6.9 Bangladesh Climate Change Strategy and Action Plan, 2009

The BCCSAP is based on Government's vision as mentioned in the Vision 2021 regarding management of climate change for uninterrupted and sustainable development are to eradicate poverty, increase employment opportunities, ensure food security, provide access to energy & power, and achieve economic and social well-being of all citizens of the country.

The strategies are to:

- Ensure adequate water supplies and improved sanitation
- Plan for and invest in additional water supply and sanitation facilities
- Livelihood protection in ecologically fragile areas
- Address adverse impacts on livelihoods in ecologically vulnerable areas
- Comprehensive and participatory planning and investment for climate resilience against erosion in income, employment and human health in coastal, char, hilly and wetland regions.

The focus of BCCSAP is on medium and long-term goals where it is also important to have some immediate short term objectives to mitigate adverse climatic impacts. It focused on six key areas-food security, social protection and health, comprehensive disaster management, infrastructure, research and knowledge management, mitigation low carbon development and capacity building and institutional strengthening. Therefore, there is scope for including other thematic areas such as social security, environmental sustainability etc. It did not include proposal for making climate resilient housing, roads, health and sanitation facilities. Policy guidelines specifically addressed towards resettlement and migration due to climate change is missing in the BCCSAP.

6.10 Water Body Conservancy Rule

The main issue is addressed is to ensure the presence of adequate water bodies. Urban areas are developed without planning and are encroaching other land uses. To ensure healthy and liveable environments the presence of adequate water bodies is a basic requirement. The water bodies and low lands are however being filled up due to the lack and mismatch of proper policies and regulations. The loss of water bodies can result in water logging, depletion of underground water etc. Next to this the water plays an important role in the beautification of the city and the recreation of city dwellers. The water body conversance rule 2000, is established to protect water bodies from being build.

The urban authorities (like RAJUK CDA KDA RTDA city corporations and Paurashava, district and Upazilla councils can restrict building on wastelands, parks, play area's; you need specific permission before developing those specified open spaces and if you do they can demolish the development without compensation. The rule empowers an urban authority to restrict incompatible use in environmental sensitive areas. The enforcing authorities include development authorities such as: RAJUK, CDA, KDA, RTA and city corporations, Paurashava, district Council and Upazila councils. The owners of the land need permission for development, if they develop without permission the authorities hold the power to demolish any unauthorised development without any compensation. The regulation defines wetland as: the river, canal, pond or water body, or area's indicated as such or as flood zone by a master plan or the area's or any urban local government. And area's that contain flowing rainwater or water.

Water Body Conservancy Rule is particularly developed for urban areas. To save the urban water bodies, this rule is widely practiced all over the country. But, rural water bodies are also being encroached by new constructions. This rule is not well designed to save rural water bodies. The urban authorities (like RAJUK CDA KDA RTDA city corporations and Paurashava, district and Upazilla councils) can restrict building on wetlands, parks, playing areas; but sometimes these

authorities do not work neutrally due to absence of monitoring. So, central monitoring by all of these authorities is a practical requirement, which should have been mentioned in the rule.

7 Links to other Thematic Studies

The links to other themes will be expanded more thoroughly in the integrated thematic analysis. In the following chapter some first important linkages between this thematic study of 'Urbanization and Settlement' and other themes within the Bangladesh Delta plan Baseline study are described.

1. 'Forestry & Biodiversity', 'Fisheries and Livestock', 'Agriculture & Food security' and 'Land resource management'

The main connection is that rapid population growth and with that urbanisation and settlement growth takes up space which is also required for agriculture and forestry and important ecological areas such as the Sundarbans. In case the population expands further this spatial conflict will further increase. A good balance will have to be obtained between urban growth, food security and maintaining forestry and ecological areas.

With regard to the spatial planning process we see that land use regulations on its own are insufficient to protect environmental quality as long as there is no proper implementation and enforcement strategy in place. Preserving open space (e.g. wetlands or large parks) can protect wildlife habitats and thus contribute to local biodiversity and maintaining environmental processes.

In order to address this issue a national strategy and vision with regard to (future) land use is essential. With the formulation of such a vision different aspects should be explored such as; opportunities for multifunctional land use, suitability of land for different functions (such as agriculture or urbanisation) and density studies which reflect upon the area needed to house the Bangladesh population.

On the scale of cities and settlements the potential mixed use of areas should be explored. Biodiversity and agriculture are not simply impossible in close proximity to each other. When cities are designed with room for green, biodiversity and urban agriculture they will potentially more sustainable and livable cities can be developed.

On the small scale of designing streets, waterfronts and buildings many small scale measures can be implemented to increase the biodiversity and amount of green and agriculture in cities. Creating sloped green waterfronts has a positive effect on biodiversity for example.

2. Power energy sector, Public health, water supply and sanitation

The availability of sufficient power and clean water are essential for further growth and development of urban and rural Bangladesh. In many settlements, cities and especially in slums those facilities are not yet provided, leading to public health issues. Also a sewage system and garbage collection would be necessities for clean and more healthy living environment.

Obtaining better water quality will change the experience of water in living environments. As a reference: in the Netherlands we see that were previously polluted open water (despite the advantage for transportation over water and use for agriculture) was mainly conceived as a dangerous health threat. Since the quality of water improved the water became a qualitative, much appreciated element in cities. In The Netherlands a house positioned near water due to this apparitions has a added value of almost 15% compared to houses not positioned along the water. Within the master planning of cities and settlements efforts should be made to include aspects of energy supply, water supply and sanitation in the design.

3. Governance

The multiplicity of service providers is regarded as the principal culprit in the current urban governance system. The multitude of agencies and companies with unclear and often overlapping mandates combined with poor coordination

capacities is at the origin of most current urban problems and the negative perception of government services. Specific attention is needed for the informal (local, bottom-up) governance activities that fill the gap where the official services are unreachable.

Growth of population and management

There is a very strong link between population growth and management and the pressure on cities and settlements to shelter those inhabitants.

4. Economic

There are multiple strong links between Urbanisation and settlement and Economy. More qualitative and attractive living environments are essential to attract employers that are needed to create a more value added economy, to reach middle income status. Additionally the economic geography of the country is very much related to the (job)opportunities, amount of amenities and investments in certain regions, and subsequently to the amount of people drawn to an area. With that the economic geography can guide urban development. More decentralised investments in overall infrastructure, urban centres and rural areas will influence the internal migration in the country and with that mitigate Dhaka's primacy.

Additionally, economic development will influence the quality of life in cities. We see that high density cities in countries with prospering economies succeed in developing high density cities in a more sustainable way, with a better living quality (for instance Shanghai with a central area density 24.700/km2, and peak density of 96.200 km2).

5. Climate Change

Climate change will further challenge the already poor urban living conditions and challenge the sustainability and living quality of the cities further.

6. Coastal development

Within this region many of the urban and settlement issues described in this baseline occur. Especially major interventions such as land reclamation & char development, and the establishment of new harbours can influence the settlement pattern of the complete country. More info on this region and the urbanisation and settlement issues there can be found in section 10.1.

7. Disaster management

There is a strong link between disaster management and urbanisation and settlement. Urban centres are often areas of economic value, generally the economic value to be protected is included in decisions with regard to safety standards. To give an example; the type of flood risk protection can influence occupation patterns; for instance a new dike ring can improve the living conditions of an area and with that attract more inhabitants. This can however lead to a so called 'risk spiral' where the economic value within the protected area increases and with that also the necessary safety standard. The decision for a certain type and scale of flood risk intervention (for instance large dike rings or interventions on building scale) will influence the shape and resiliency of the urban and rural centres.

8. Regional cooperation

In regional cooperation especially infrastructure corridors can have a major impact 1.7.4 Upcoming infrastructure developments.

9. River systems

The rivers are very characterizing for the Bangladesh landscape. Changes with regard to the rivers will potentially change the relation between cities, settlements and the river. We now see that many river flood plains are transformed into building grounds. In case of floods this could decrease the space available for the river water and increase the flood

damage to the occupied areas. Potential canalisation would be a driver for urbanisation and occupation since it provides additional land. In general interventions like canalisation are often reversed later on in time for arguments of aesthetics, (for example in New Orleans and Houston in the USA) or because of hydraulic reasons (the flood risk protection project 'Room for the River' in the Netherlands). When those areas became populated such interventions are often expensive. From a worldwide perspective we see that in many post-industrial cities the river becomes an important structuring and qualitative element. In general we see that harbours start to grow and transfer out of the old city centres, where they are located traditionally. This leaves space within the city for development. If cities are orientated only along one side of the river we often see the city centre extending to the other side of the river. With this 'jump over the river' the river becomes a central element within the city centres with room for development. From this we could expect that the riverfronts of cities will in the future become important public and qualitative elements of the city.

10. Sustainable transport

Transport and networks are important drivers for urban and rural development both on the national and local scale. Sustainable transport should be an inherent element of national, city scale and local spatial planning.

11. Water resources

Water resource management should, just as disaster management, water supply, river management, infrastructure and economic development be an integral part of spatial planning. Both on a national scale as on a local scale there are many links. For instance storm water could be stored to prevent runoff from impervious surfaces such as buildings, parking lots and roads which is a major source of water pollution. By developing catchments and open retention canals and green spaces or impermeable street coverings the permeability of the land will increase, allowing natural infiltration of rain into the ground and which that allowing for the recharge of groundwater supplies.

12. Environmental pollution

The current developments are very polluting. There is no sufficient wastewater treatment with industries, the sewage system still needs to be expanded and the collection of garbage is in most settlements and urban areas not arranged.

8 Characterization of the Urban Context

In this chapter the main characteristics and challenges of the major cities: Dhaka, Chittagong, Khulna, Rajshahi, Sylhet and Barisal are described. This baseline description is first inventory. The Urban area's are in the BDP2100 be defined as a 'hotspot, area'. Information on issues in the major cities will be further explored later on in the project in the 'Urban hotspot report'.

8.1 Dhaka

8.1.1 Physical setting and demography

Dhaka, capital of Bangladesh, is located in central Bangladesh on the eastern banks of the Buriganga River. Dhaka district has an area of 1463.60 sq km, and Dhaka city covers a total area of 360 square kilometers. It is the industrial, commercial and administrative hub of the country. Dhaka currently ranked 11th, is poised to be the sixth largest mega city of the world by 2030 according to UN report (UN, 2014). The Dhaka Statistical Metropolitan Area (SMA) or megacity with a population of 9.67 million, has an area of 1,371 square kilometres which consists of Dhaka City Corporation (including Aminbazaar of Savar thana), Tongi, Gazipur and Savar pourashavas and other adjoining urban areas covering parts of Demra, Gulshan, Lalbag, Mirpur, Sabujbag, Uttara, Gazipur, Savar, Narayanganj and Bandar thanas and the entire thana of Keraniganj (BBS, 1997).

In 1864, the Dhaka Municipality was formed. Through the 'Basic Democracy Order 1957', it became a Municipal Corporation in 1960. The Bangladesh Local Councils and Municipal Committees (Amendment) Order was issued in 1972 which converted the committee into Paurashava. Then, the Paurashava was transformed into Municipal Corporation in

1983 and finally in 1991 it got the status of City Corporation. The city has a population of 89,06,039 of which 55% are male and 45% female. Literacy rate is one of the highest with 74%. Within the city corporation area, there are 92 wards, 2 restricted areas, and 837 mahallas and its adjoining 17 unions as other urban area. (BBS, 2014)

The temperature in Dhaka city varies from minimum of 60c in the winter to 400c in the summer. The average annual temperature is between 250c to 310c. Dhaka has an annual average rainfall of 1700mm to 2200 and most of it occurs during the monsoon from June to September. (Source: BMD)

8.1.2 Social economic

Dhaka's populace has a relatively high literacy rate compared to the other major cities in Bangladesh. It is the country's best-performing city for access to skilled labor, which is an important factor for attracting industries, hence the many garment firms in the city. The city's populace is mostly male, due to the many male migrants that flocked to Dhaka to find work.

The industrial sector in Dhaka is based on manufacturing (33, 12% contribution to Dhaka's gross regional product, or GRP). Most of it can be credited to the garment and leather industries, and the supporting sectors; transportation, distribution, wholesaling and retail trade. Construction is the second largest industry sector, officially contributing only 4,4% to GRP, though when including informal labor the figure will be much higher (BBS, 2007). It has been estimated than 65% of all employment in the city is in the informal sector (Choe, K. and B. Roberts, 2011, p.134). Agriculture contributed the least to Dhaka's economy (about 5.1% of GRP) and its share is falling.

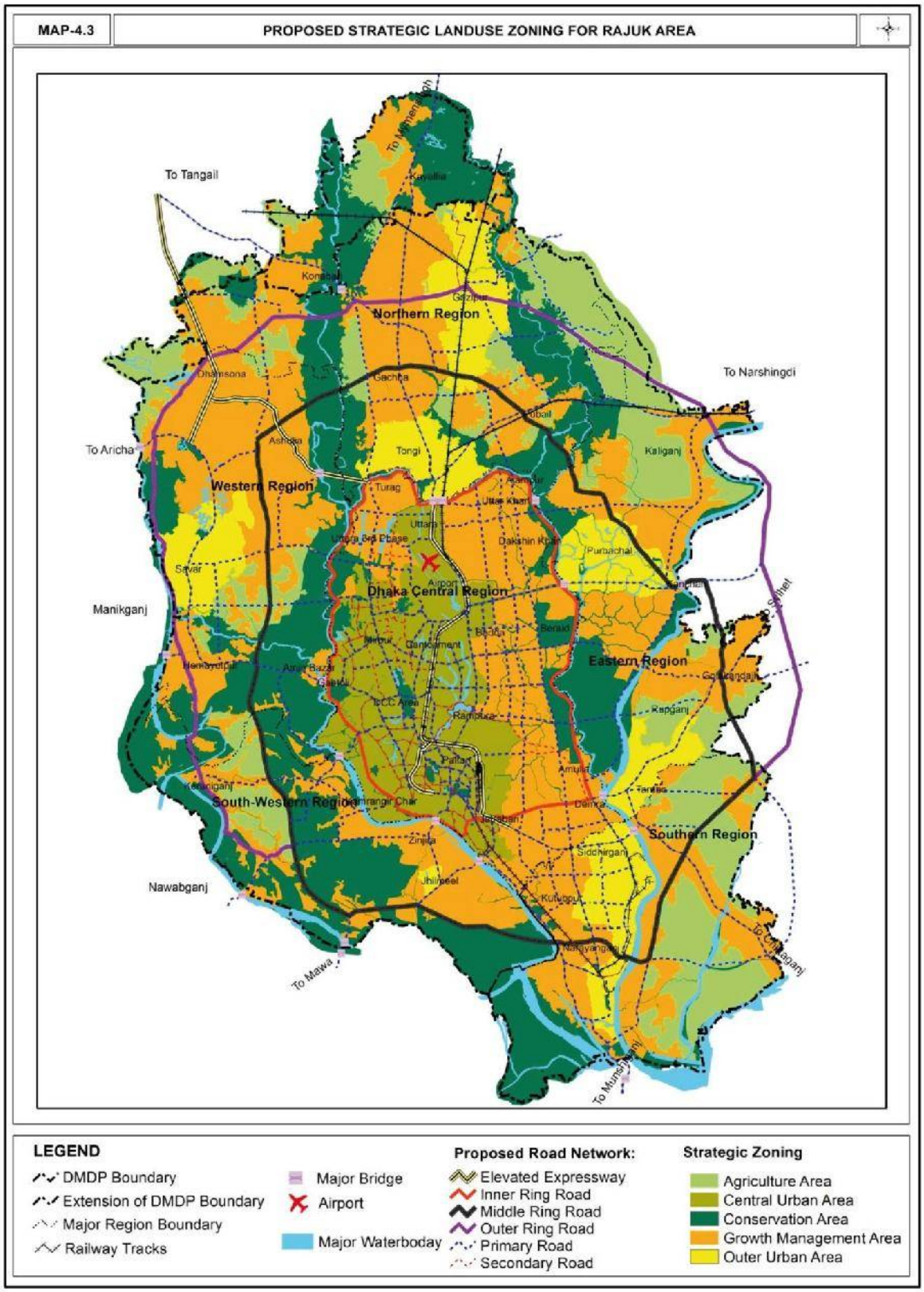


Figure 50 Proposed land use plan for Dhaka 2016-2035

8.1.3 Major issues

Urban areas within Dhaka are expanding through the conversion of vegetation (grass, trees), bare soil, agricultural land (area with crops), waterbodies and wetlands into built-up areas. A land cover change analysis of the Dhaka Metropolitan Area using multidate Landsat images showed that built-up area or urban developing area has expanded from 39% to 47% within a period of 20 yrs from 1989 to 2010 (CEGIS estimate).

1. Population Explosion

The population residing within the Dhaka Metropolitan Area (DMA) is 8,906,039 and the density is 29,392 persons per sq km (BBS 2014). Dhaka City Corporation (DCC) covers an area of 360 sq.km and population of 7 million (BBS 2014). The Detail Area Plan (DAP) or RAJUK area is 1528 sq. km with a population of 14.5 million (BBS 2014).According to BBS census around 30% of the population of Dhaka lives in informal shelters/slums and the total number of slums within the DCC area is 1,925. Although Bangladesh has one of the highest population densities in the world (at 979 persons per sq km), the population density in slums is roughly 200 times greater. Dhaka is poised to be at risk due to climate change induced disaster (Alam and Rabbani, 2007). Dhaka is one of South Asia's fastest growing megacities. Population has grown from 2.2million in 1975 to 15 million in 2010 and is estimated to reach 22 million by 2015. Population growth rate is 2.02%, which is far higher than most other megacities. The rapid urbanization of Dhaka has created vast slums where rural immigrants come to settle. Presently, more than one third of Dhaka lives in slums. Slum dwellers live below the poverty line and have very little capacity to absorb income flow shocks.

2. Flood

During the monsoon, flooding in the city due to river floods and excessive rainfall is a serious issue. Analysis of rainfall pattern of Dhaka city over the period of 1950 to 2010 shows that there is an increasing trend in Dhaka. Different studies stated that this increasing rainfall trend along with the urbanization growth will accentuate the future flooding condition in the urban areas. Major floods in Dhaka occurred in 1954, 1955, 1970, 1974, 1980, 1987, 1988, 1998, 2004, 2007 and 2009 due to the overflow of surrounding rivers and excessive rainfall. Among these, the 1988 and 1998 floods were catastrophic. During the floods of 1988, 1998, 2004, 2007 and 2009, excessive rainfall contributed in urban flooding. Four major floods in recent years (1988, 1998, 2004 and 2007) have debilitated Dhaka. Floods of 1998, 2004 and 2007 were worst in terms of inundation and duration of floodwater in the city fringe areas. Over 50% city population, most of them slum dwellers, were badly affected. People were compelled to live on roof tops during prolonged floods. Communication, livelihood and service facilities were severely affected. In 2007, over 90,000 people in Dhaka city were affected by diarrhoea during the flood. People suffered from lack of food, safe drinking water and health problems. Elderly people, children and women suffered the most. Transportation was affected through the damage of road network.

3. Waterlogging

Dhaka district lies on the lower reaches of the Ganges Delta; Balu, Buriganga, Dhaleswari, Shitolakhya and Turag are the major rivers. Dhaka is exposed to multiple natural hazards including variations in temperature, heat and cold waves, excessive and erratic rainfall, flooding, waterlogging and cyclones due to its geographic location. Of these, urban waterlogging from intense rainfall and riverine flooding has become a recurring phenomenon which adversely affects city life and livelihoods nearly every year. With rapid and indiscriminate urbanization, gradual filling up of low lying flood plains, rivers, canals and other water bodies which used to drain or retain water during rainy season has aggravated the problem of urban waterlogging in recent years.

4. Environmental Pollution

Different types of pollution have become a major environmental concern for Dhaka city. Air pollution is decreased significantly after the introduction of Compressed Natural Gas (CNG) in motorized vehicles. But, sound pollution is severe due to use of hydraulic horn. Odor pollution is created because of open dustbin and overflow of drains. The

situation may further worsen as climate change coupled with non-climatic factors such as increase in population density, poverty, rural-urban migration, illiteracy, unplanned urbanization and lack of public utilities and services such as solid waste management, sewage disposal and wastewater treatment, can increase the vulnerability of the population.

8.1.4 Dhaka Metropolitan Development Structure Plan (1995-2015)

Dhaka Metropolitan Development Structure Plan is developed by Capital Development Authority of Bangladesh (RAJUK). The plan provides a long-term strategy for the 20 years for the development of the greater Dhaka sub-zone with a population target of 15 million. The plan consists of a written report and policy documents with support maps of appropriate scale. It identifies the order of magnitude and direction of anticipated urban growth and defines a broad set of policies considered necessary to achieve overall plan objectives. It considers the micro environmental aspects of Dhaka, both in its existing urban form as well as for future development to keep the city free from all sorts of natural and manmade hazards. The plan recognizes the positive and sustainable role of green belts, preservation of high quality wet and agricultural lands and existing rivers in and around the city limits and their continuous upgrading and evaluation and thus recommends for building a circular waterways round the city. The plan also earmarks a number of retention ponds around the city limits for retaining rain water as well as for maintains an ecological balance too and a healthy environment.

The DMDP was a three tier plan constituting Structure Plan (SP), Urban Area Plan (UAP) and Detail Area Plan (DAP). The DMDP strongly highlighted to follow the Flood Action Plan (FAP). The DAP could not be prepared as the project time ended in due time. This is a major limitation of this project. Lack of DAP coupled with non-compliance of DMDP led to many uncontrolled growth of Dhaka city.

Figure 51 Satellite imagery of Dhaka

8.1.5 Dhaka Metropolitan Development Structure Plan (2015-2035)

The Latest version of the Dhaka Metropolitan Development structure plan has recently become available. It has not yet been described and reviewed for this baseline, but will be taken into consideration in the BDP2100 project.

8.1.6 Dhaka City Detail Area Plan (DAP), 2010

As part of the project 'Preparation of Structure Plan (SP), Urban Area Plan (UAP) and Detailed Area Plan (DAP) - Dhaka Metropolitan Development Plan (DMDP), Rajdhani Unnayan Kartripakkha (RAJUK) prepared the DAP which was gazette in 2010. Assistance was provided by UNDP and UNCHS for the preparation of DMDP. The report sequentially describes the Background, Critical Planning issues which influenced the Plan Preparation process, the Development Plan Proposals, Plan Implementation Procedure and Follow up Actions required for the implementation of the Plan. The extent of RAJUK's jurisdiction is approximately 590 sq. miles comprising 26 Strategic Planning Zones.

The proposed Landuse Zones are: Urban Residential Zone, Rural Settlement Zone, Commercial Zone, Industrial Zone, Mixed use Zone, Flood Flow Zone, etc. This chapter also describes the landuse control procedures.

The Detailed Area Plan (DAP) has given precedence to eliminate water logging and drainage congestion in the Dhaka City. The DAP, however, has overlooked the flood control proposals of both the FAP-8B and DMDP plans. From analysis it is clear that DAP has proposed numbers of development works within retention pond areas of FAP-8B. For example- DAP has proposed 10.40 acre road within Goranchatbari retention pond area. On the other hand 42.93 acre road has been proposed within proposed Kallyanpur retention pond area. Land use proposal and development work of FAP-8B have been deviated by DAP proposal.

8.1.7 Dhaka City Drainage Master Plan

Dhaka City Drainage Master Plan is developed by Institute of Water Modeling (IWM) and Dhaka Water Supply and Sewerage Authority (DWASA) in 2006.

Main Objectives of the Drainage Master Plan are:

- To improve the Drainage situation.
- Collect, review and evaluate previous relevant studies and drainage condition
- Update the collected information
- Recommend various programs for improvement of storm water drainage system of Dhaka

The drainage in Dhaka city is dependent on two aspects:

- Operation of storm-water drainage system including pumps and regulators
- Water levels on the peripheral rivers

Figure 52 Buriganga riverside, Dhaka

The drainage congestion in Dhaka city may occur due to any of the following three reasons

- Flooding due to congestion of storm water or waste water drainage systems inside city
- Encroachment of floodwater from the peripheral rivers to the city area through the drainage routes
- Flooding due to the effect of high water level in the peripheral rivers where drainage is only possible through pumping

Recommendations for the improvement of drainage system in Dhaka:

- After carrying out a comprehensive study on the existing drainage system, its expansion and rehabilitation are necessary.
- Sewer lines should be separated from storm water drainage system.
- Steps have to be taken to prevent disposal of waste into the drainage lines and canals.
- Adequate solid waste disposal system should be made available to the city dwellers.
- Need for improving pumping facilities.
- All flood proofing structures would require proper maintenance and should be manned by adequate personnel for operation during monsoon under definite guidelines.
- All internal drainage and flood control infrastructures should be handed over only to Dhaka WASA for operation and maintenance.
- The city flood and drainage management should collaborate with Bangladesh Water Development Board for weather and flood forecasting system for early warning and preparatory activities.
- RAJUK should ensure that the development of eastern Dhaka is carried out under a Master Plan, whih would integrate land use plan with that of service utilities like, storm-water drainage, water supply and sewerage.
- RAJUK should develop and implement building codes, which would clearly give direction for preserving drainage facilities in city areas, most importantly, in low-lying areas. Natural canals of the eastern part are to be protected from land grabbers and encroachers by the DC office. To ensure that the khash (Government) lands and natural canals are not be given to the private developers on lease. If already given, that has to be cancelled.

- A central high-powered coordination committee should be formed to coordinate activities of all agencies engaged in providing city utility services.
- Create public awareness about the necessity for conservation and protection of the manmade or natural drainage facilities.
- Benchmarks need to be established throughout the city area, so that construction and rehabilitation of drainage facilities could be done against a common reference level.
- Electric pumps with mobile sub-stations should replace all diesel pumps. Standby generators would ensure lesser interruption to pump operations.
- The problem of DND area is complex. The only outlet from the area is the DND drainage channel, which falls into Shitalakhya River at Sarulia. The capacity of the drainage pumps is limited, which needs to be increased. The drainage channel leading to the pump house needs to be protected from encroachment. Two additional pumping stations, one at Adamjinagar and the other at Pagla, are recommended. The drainage channels needs to be re-excavated to increase their conveyance capacity.

8.2 Chittagong

8.2.1 Physical setting and demography

Chittagong, the port city and the second largest metropolis in Bangladesh is considered to be the commercial capital of the country. The city is bounded by hills and forests to the north, the Halda river valley to the northeast, the Bay of Bengal to the west and the Karnaphuli River to the southeast. Initially, in 1984, the Chittagong Municipality was established. The municipality was renamed as Chittagong Paurashava according to Bangladesh Local Councils and Municipal Committees (Amendment) Order 1972. Then it received the status of a city corporation in July 1990.

The Chittagong City Corporation covers an area of 155.40 square kilometres with a population of 2581643 (1360125 males and 1221518 females) including 41 wards and 238 mahallas (BBS 2014). Chittagong is situated about 15 km upstream of the river mouth at the confluence of the Karnaphuli River and the Bay of Bengal. The water that used to store in the low lying areas now gathers in the urban builtup areas. (IDS, 2007) Annually on an average 3,000 mm of rainfall is observed, of which the major amount of about 2,400 mm occurs during the monsoon. (Source: BMD) The temperature is between 80c to 340c (CCC website).

The city corporation area include 18% built-up area, 13.46% agricultural land, 16.38% rivers and waterbodies, 12.42% settlement area with homestead vegetation, 10.43% forests, 3.26% industrial area, 12% open space (including parks and playgrounds), 2.08% barren land and 0.84% slum area. It also has transportation infrastructure where 3.72% is roadways, 0.27% is railways and 0.79% is port. (CEGIS estimate, 2015)

8.2.2 Pattern of settlement and type of structure

More than fifty percent of the city corporation area is already developed of which 18% is built-up area, 12.42% is settlement area with homestead vegetation, 3.26% is industrial area, 12% is open space (including parks and playgrounds), 2.08% is barren land and 0.79% is port. Chittagong port, the largest and one of the major sea ports of the country is located near the Karnaphuli river estuary. The port enables import and export of industrial goods, raw materials, jute, rice, tea, oil, sea food etc. The developed area also includes transportation network where 3.72% is roadways and 0.27% is railways. Slum (0.84%) is found in a very small portion in some parts of the city. (CEGIS estimate, 2015)

Agricultural land covers 13.46% area. Vegetation is visible within the settlement as homestead vegetation and also in the forests (10.43%). Water bodies such as rivers, canals and ponds constitute 16.38% area. (CEGIS estimate, 2015)

The settlements have grown linearly along the Karnaphuli River and radially from the port towards the southwest direction of the sea. Industrial development has taken place near the port and also inside the city as per the policy directives of the structure plan. The city authority's intention was to keep the investments within the city.

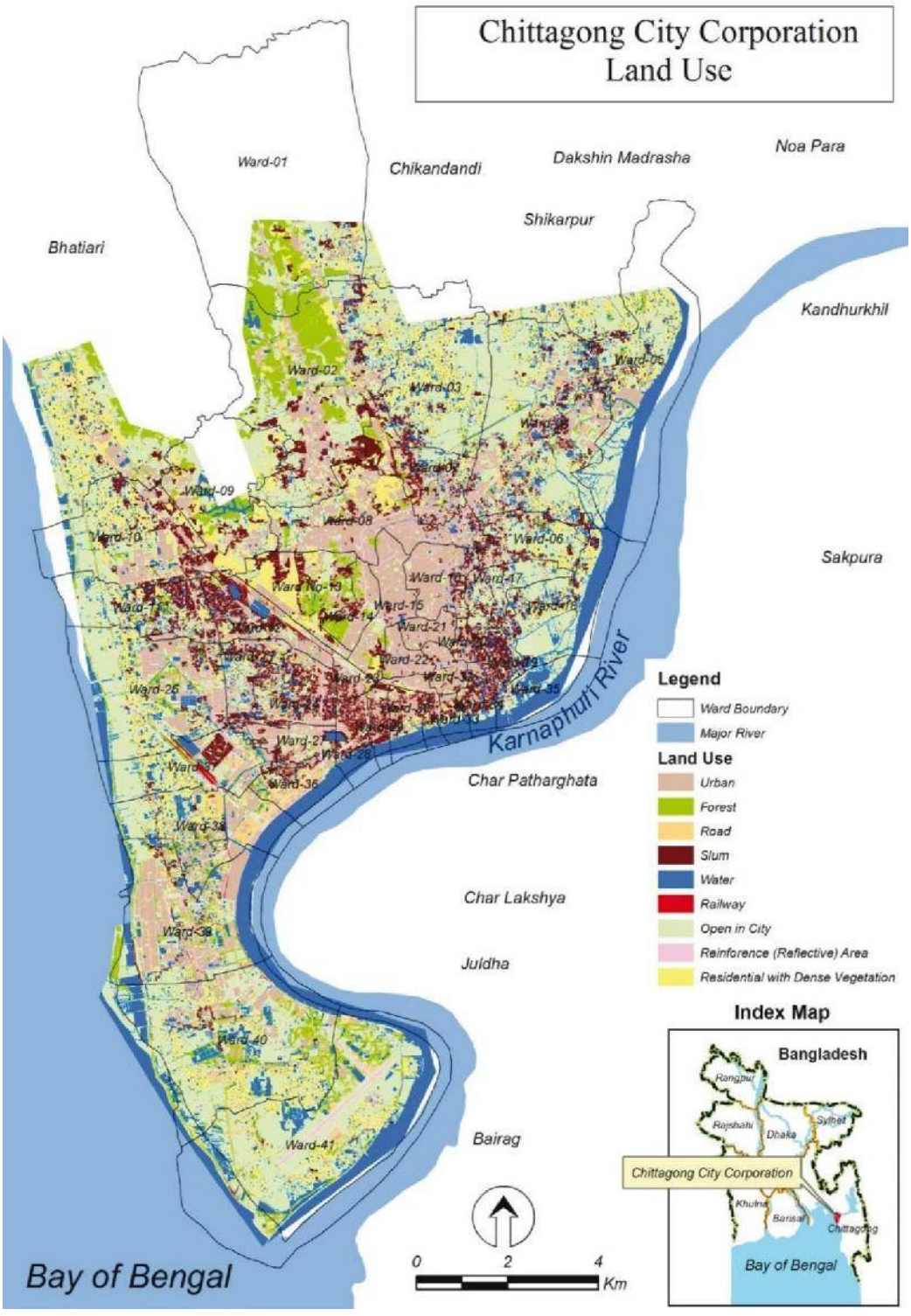


Figure 53 Chittagong land use map

8.2.3 Socio economic setting

Chittagong houses Bangladesh's largest sea port which plays a vital role in connecting the country to the global market. The city is a popular spot for foreign investments, and in order to meet the growing demand for Export Processing

Zones, new industrial plots are under development. Nevertheless, the Chittagong port is one of the most inefficient ports in Asia. The largest oil refinery in Bangladesh is located here as well, which supplies around 40% of the country's current petroleum products.

The textile industry is major source of employment with 42,7 % of the total jobs (24,4 % manufacturing and 18, 3 % wholesale retail and trade), followed by the transportation industry at 18, 2 %. Almost a quarter (23%) of the jobs are temporary and informal. In Chittagong it's harder to find skilled laborers.

The employment rate within the City Corporation remains much higher (45%) compared to the rural settlements around the city (20, 7 %).

8.2.4 Major issues

The major issues and challenges for the urban areas are: increasing demand of housing, traffic congestion, establishment of small and cottage industries, tourism industries etc. Hazard related problems include cyclone and tidal surges, floods flooding (flash flooding), waterlogging, storm surges, salt water intrusion, sedimentation, landslides and environmental pollution.

1. **Housing, Industrialization and Migration**

The city corporation has 556391 numbers of households. The population growth in the last decade has been estimated at about 2.8% which is much higher compared to the national population growth of about 1.34% and national urban population growth rate of 1.38% (BBS, 2014). In search of job opportunities the rural people are moving to the big cities. The people in Chittagong are involved in business, commerce and port activities, service, fishing, agriculture etc. This city includes around 40 percent heavy industrial activities of Bangladesh which include dockyard, steel mill, cement clinker factory, cable manufacturing, oil refinery, ship breaking etc. The light and medium scale industrial activities are located along the Chittagong Export Processing Zone (CEPZ). These industries are attracting people from surrounding villages to the city. For instance, development of garments industry has attracted a huge number of rural populations, especially female workers. The rural to urban migration and increasing population to a great extent is creating mass demand of housing stock.

2. Traffic congestion

The increasing traffic and low carrying capacity of the roads, creates traffic congestion in the roads. Other reasons for congestion are on-street parking, road and footpath occupied by hawkers, movement of slow vehicles in highways, mixed modes of transport, plying of non-motorized vehicles and three-wheeler vehicles, lack of awareness of drivers, inadequate traffic police etc. Construction of underpass or overpass can be the solution to traffic congestion.

3. Flood and erosion

Seasonal flood becomes a major problem for Chittagong city dwellers. Almost in every monsoon the city is facing pluvial or fluvial flood due to heavy rainfall, cyclones and storm surges. The flood of 1998 and 2004 was devastating for the city. Water level was highest in 2004 and remained stagnant for longest time in 1998 (around 3 months). The city corporation is also affected by river bank erosion. Only 20 sq km area is erosion prone.

Figure 54 Satellite imagery of Chittagong

4. Cyclone and storm surge

Being a city in a coastal region, Chittagong is vulnerable to frequent cyclone. Normally, 3 to 7 cyclones hit the Bangladesh coast each decade. About 53% of the total world deaths in Bangladesh are accounted to tropical cyclones. For example-the cyclone that hit Bangladesh especially Chittagong in 1991 had a maximum wind speed of 150km/h. Cyclone 'Sidr', another devastating cyclone, made landfall on southern Bangladesh on November 15, 2007, causing over 2,000 deaths and severe damages. Again, due to cyclone 'Aila' on May, 2009, more than 6,600 people were injured and 3.3 million people were affected.

Storm surge is induced by cyclones. In 1991, the maximum storm surge height reached about 5 to 8 m. 150,000 people died and 70,000 numbers of cattle was lost. The damage loss of property was estimated at about Tk 60 billion (Wikipedia, 2010). Around 1150 sqkm area is at risk of storm surge of more than one metre and above.

5. Land Slides

As Chittagong city is a hilly area, land slide of hills is very common. Chittagong Hill Tracts which covers 10% of land area supporting about 1 % of its population. It receives rainfall of the order of 3000mm annually. So, for the heavy rainfall, landslide occurs frequently all over the year. On 24 June 2000, eight people were killed and hundreds of shanties were wiped away when rain triggered landslides hit the area around the southern part of Chittagong on the Bay of Bengal. The landslide disaster of 11 June 2007 resulted in death of 91 persons of which 59 were children. The rain was so prolonged that mudslides buried houses at the foothills near the Chittagong Cantonment. The worst hit place was Lebubagan area. A major landslide killed 14 people in Chittagong area in the morning of 18 August 2008.

6. Pollution

Sound, air and odor pollution is a common problem for Chittagong city. Increasing population is responsible for these environmental problems. Excessive number of traffic is causing sound pollution. Some heavy vehicle uses hydraulic horn in the city, which is a severe crime. Then, air is polluted by the exhaust gases from vehicles. Chittagong is considered as the trade city of Bangladesh, so a large number of industries emitting a huge amount of gases, which are polluting the air of the city. Lastly, unplanned sewerage system, open drains, dustbins, road side gutter causing water and odor pollution.

8.2.5 Chittagong Master Plan

Chittagong Master Plan is developed by Chittagong Development Authority (CDA). Chittagong Development Authority (CDA) is the statutory planning and development authority for the Chittagong Metropolitan Area (CMA), was created in 1959 under the provision of the CDA Ordinance 1959, established by Bangladesh Government in order to ensure the planned and systematic growth of the city. The Plan was prepared with UNDP & UNCHS financial and technical assistance in the year 1995, though it was approved by Govt. in the year 1999 and it replaced the 1961 Master Plan.

The components are:

- Structure Plan (1995-2015)
- Urban Development Plan (1995-2005)
- Detailed Area Plan (Up to 2015)
- Long Term Development Strategy for Traffic and Transportation for Chittagong (1995-2015)
- Storm Water and Drainage Master Plan (1995-2015)

1. **Structure Plan (1995-2015)**

The major features of the structure plan are:

- Strategic Plan for the CDA controlled area of 1152 sq- km.
- Indication for infilling of vacant land

- Guideline for the management of the regional growth
- A total of 76 Strategies and guidelines in the following sectors: Population, Economy, Spatial Development Strategy, Housing, Community Facility, Transport, Infrastructure Services etc.

2. Urban Development Plan (1995-2005)

Major features:

- Concentrated only on the urbanized area of 259 sq-km.
- Land use Zoning
- Guideline for Development Control, Development Promotion and Guided Development.

Figure 55 Chittagong Kahl

Figure 56 Chittagong seaside

3. Detailed Area Plan

Major features:

- Pro-People Planning (participative planning)
- Encourage the development and expansion of CMMP Area
- Creation of a GIS Database for the study area
- Study each particular area in greater details
- Formulations of Development Proposals for Roads, Drain, Utility Facilities etc.
- Identification & Reservation of Open Spaces, Water bodies, Hills
- Prepare detail guideline for land use, Land use Control and management

4. Long Term Development Strategy for Traffic and Transportation for Chittagong (1995-2015)

The transportation component of Chittagong Metropolitan Master Plan contains a present situation report, an immediate action plan and a long term development strategy for traffic and transportation. Under long term Development Strategy an extensive development strategy has been undertaken for future transport planning purpose in Chittagong. CDA is working as per the principal recommendation of the strategy, which includes:

- Establishment of Roads hierarchically in the city
- Highway improvement
- Provision of Railway over bridge at several sites
- Improvement of Road and Transport Services
- Industrial Strengthening
- Improvements of other modes, namely waterways, aviation and railways.

5. Storm Water and Drainage Master Plan

The objectives of the storm water drainage and flood control component laid down by UNCHS are:

- Preparation of a comprehensive storm water drainage and flood control Master Plan for the metropolitan area within the Chittagong Development Authority (CDA) administrative boundary including the land area on the left bank of Karnaphuli River.
- Identification of a first phase project package to a technical standard and a degree of a detail suitable for appraisal and subsequent funding by an international funding agency
- Formulation of recommendations aimed at strengthening the present technical, managerial and administrative capabilities with respect to responsibility for design, implementation and operation and maintenance of storm water drainage and flood control facilities.

A master plan for the first time was undertaken in 1964, but there was no drainage plan at that time. CDA with the financial assistance of the World Bank (WB) undertook the master plan for the city for the second time in 1995 through the finding of UNDP. The implementation period for the 20-year master plan was fixed from 1995 to 2015. Though the CDA started to implement the transportation plan, the full implementation of the drainage plan is still to be done. The Chittagong City Corporation (CCC) undertook projects to re-excavate existing and new canals. However, the silt still remains in the canals due to non-implementation of the plan.

8.3 Khulna

8.3.1 Physical setting and demography

Khulna is the 2nd port city of Bangladesh. By size of population, Khulna is ranked third. The Municipality of Khulna was established in 1884. It was changed to municipal committee through the Municipal Administration Ordinance of 1960. The municipal committee of Khulna was replaced by a paurashava in 1972 according to the Bangladesh Local Councils

and Municipal Committees (Amendment) Order, 1972. The Khulna City Corporation in place of the committee was created in 1992 in accordance to the Bangladesh Local Council and Municipal Committee (desolation and administration arrangement) order 1972. This City Corporation is ranked third in size in the country. It has 31 wards and 200 mahallas over an area of 50.61 sq.km. Including Gilatola Cantt. The total population of the city corporation is 664728 of which 346069 are male and 318659 are female. The literacy rate of the city corporation is 73.6%. The entire city area is under the city corporation. (BBS, 2014)

The temperature ranges between 12.50c to 35.50c and the annual average rainfall is 1605 mm (KCC website). The land use pattern of Khulna has been substantially influenced by the flow of the Rupsha and Bhairab rivers. As a deltaic plain the land is flat and poorly drained. The whole metropolitan area is approximately 2.5m above the mean sea level (ADB, 2010). Downstream of Khulna City, the Rupsha River meets the Kazibancha-Pussur River that travels more than 100km and then falls into the Bay of Bengal. Tidal flow from the Bay has daily, seasonal and annual variation. The effect of this tidal flow is observed throughout the system.

The City Corporation and its adjacent areas encompass many large scale industries most of which were constructed during 1950-70, such as Khulna Hardboard Mills Ltd, Khulna Textile Mills Ltd, Khulna Power Station, jute mills, Khulna shipyard Ltd etc.

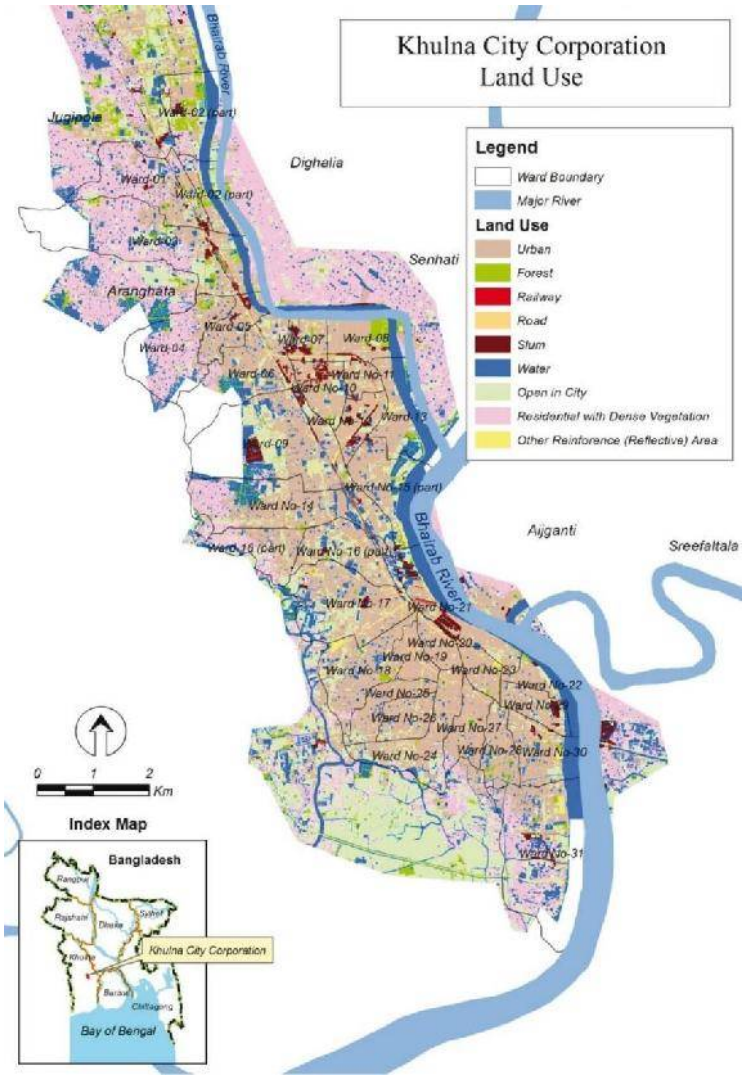


Figure 57 Khulna land use map

8.3.2 Socio economic

Khulna established itself as a major agriculturally developed area that is producing agricultural goods which are exported through its own port. The jute mills industry is one of the main industries in the region (World Bank, 2000).

8.3.3 Pattern of settlement and type of structure

More than fifty percent of the city corporation area is already developed of which 18% is built-up area, 12.42% is settlement area with homestead vegetation, 3.26% is industrial area, 12% is open space (including parks and playgrounds), 2.08% is barren land and 0.79% is port. Chittagong port, the largest and one of the major sea ports of the country is located near the Karnaphuli river estuary. The port enables import and export of industrial goods, raw materials, jute, rice, tea, oil, sea food etc. The developed area also includes transportation network where 3.72% is roadways and 0.27% is railways. Slum (0.84%) is found in a very small portion in some parts of the city. (CEGIS estimate, 2015)

Agricultural land covers 13.46% area. Vegetation is visible within the settlement as homestead vegetation and also in the forests (10.43%). Water bodies such as rivers, canals and ponds constitute 16.38% area. (CEGIS estimate, 2015) The city expanded through the increase of trade activities along the Rupsha and Bhairab rivers. Thus a linear development trend is visible along the Rupsha River and Bhairab River in Khulna city. Mayur River is located on the western part of the city. A nucleated growth is also observed in the area where the central business district is located. Due to unavailability of buildable land in the western side, the growth is limited mainly in the north-south direction.

8.3.4 Major issues

Khulna city, because of its geographic location is highly vulnerable to climate change. The city experiences recurrent urban flooding problems during the rainy season. The situation could be further worsened by increased rainfall and sea level rise.

1. Urbanization and migration

Urbanization is increasing thereby creating demands for housing and other infrastructures. The continuous urbanization has already made Khulna the third-largest city in the southwest part of the country. Khulna comprises of 46% built-up area, 15% industrial area, 5% commercial area and the rest is occupied by transport infrastructure, official buildings, community and defence, facility parks and water bodies (Aqua-Sheltech, 2002 as cited in ADB 2010). More recent analysis of quick bird image revealed that the Khulna City Corporation area includes 52% built-up (40% without and 12% settlements with homestead vegetation), 4.7% industry, 8.5% open space, 5% transportation network (road 4.16% and railway 0.62%) and 1.87% slum areas (CEGIS estimate). So, there is already an increase of 8% built-up area within the last ten years.

Natural hazards, poverty and better job opportunities makes people to migrate from the vulnerable coastal areas towards the cities like Khulna. If the impacts of climate change persist then, the number of migrated population will also increase. The urban poor end up in slums or squatter settlements. According to a study conducted by CUS, the 520 number of slums was identified in the KCC area constituting 20% of KCC's total population in 2005. So the slum population was 189,000 living in 37,826 households. Even outside the slums, some areas were located where the urban poor continue to live. (CUS, 2006)

Figure 58 Satellite imagery of Khulna

2. Water supply

The main source of drinking water is tubewell. However, there is lack of water supply to meet the increasing demand. Due to unavailability of any alternatives people depend on saline water for drinking and catch diseases like hypertension, pre-eclampsia, eclampsia, pre-mature separation of placenta, kidney disease, hair loss, etc. waterborne diseases. Other diseases such as diarrhoea, cholera and skin and eye diseases result due to the occurrence of floods and waterlogging.

3. Sewerage

In the city does there is no sewer network. Hanging latrines are used by 5% households and 3% of households have no latrines (Murtaza, 2001). There are concentrations of hanging latrines in some areas of the city. Use of unhygienic latrines pollutes the environment. About 88% of generated sewage and 64% solid wastes from residential building are directly discharged into the surface drain, 21% into mud hole and 15% carried by KCC van (Islam et al. 2010). Slums have only simple pit latrines instead of septic tanks. Slum discharges 76% sewage and 60% solid wastes into the drains (Islam et al. 2010).

4. Drainage problems

Most of the households (51%) are connected with open drains, 25% have connections to unpaved drains and 15% have no outlet connections at all (Murtaza, 2001). This results into public nuisance and a dirty and unpleasant environment.

5. Environmental Pollution

The accumulation and dumping of solid waste, sewer overflow, and stagnant water in open drains, slaughter houses and decomposition of wastes in derelict ponds are the major sources of environmental pollution in the city. People living near the industries and roads experience noise pollutions. Households affected by noise pollution are: 20% by the hydraulic horn of vehicles, 18% by industries and factories, 15% by loud speakers and 11% by workshops of various categories (Murtaza, 2001).

Similar to noise, the households (84%) are also disturbed with bad odor (Murtaza, 2001). According to 34% of the total households the reason is unclean open drains, followed by poorly managed decomposed wastes of nearby dustbins and mixing of sewage with water (Murtaza, 2001).

6. Salinity Intrusion

Currently 2151 sq.km area is under 1ppt salinity line. In the year 2007, the highest level of salinity in 32 years was recorded. The salinity intrusion from the Bay of Bengal to the river system is expected to increase due to sea level rise and prolonged dry weather. Tidal water surge and reduction of sweet water flow due to the Ganges barrage are some of the reasons of salinity intrusion. Shrimp farming also causes intrusion of saline water inside the agricultural land. However, this practice is limited outside the city boundaries in the rural areas. Agricultural productivity is hampered due to salinization. There are negative impacts on the water resources and the water and drainage infrastructure of the city and its surrounding areas due to increasing salinity intrusion.

7. Flood

Khulna city is highly vulnerable to normal flood and flash flood. The vulnerable low-elevated coastal zone about 40% of the country is facing the consequences of inadequate maintenance of existing embankments and other environment protection measures, and rapid unplanned urbanization and industrialization. Climate change induced frequent and severe floods, cyclones, storms, tidal surges, SLR, salt water intrusion, river and coastal erosions force many rural people to migrate to the coastal cities.

8. Cyclone and storm surge

Cyclone Sidr (2008) and Cyclone Aila (2009) are two of the devastating cyclones that caused huge damage in the coastal areas. Around 3,447 no. of people died and 650,000 people lost their houses in cyclone Sidr. During the last decade in Khulna, 83.3% households have been destroyed by cyclones and 43% households migrated temporarily. (ADB, 2010)

Cyclone associated storm surge also cause damages. According to CEGIS estimate more than 50% area of the Khulna district falls under the 1m high storm surge risk area.

9. Water Logging

Khulna city used have its own natural drainage system to drain out the excess water. Over the years, these drainage channels have been filled up as part of expansion of urban areas. Dense areas and inadequate drainage causes waterlogging or rainfall flooding in some parts of the city during extreme rainfall events. In Khulna city, 38% of households regularly experience short-term water-logging (Murtaza, 2001). Recurrent water logging is a serious headache for the city dwellers which have damaging impact on the infrastructures. 14% households are temporarily displaced in during waterlogging situations.

10. Climate change

The metropolitan area is only 2.5m above mean sea level making it vulnerable to sea level rise induced hazards (ADB, 2010). Climate change is expected to increase the intensity of cyclones, resulting in the penetration of storm surges further inland, causing higher damages. Intensified storm surges due to SLR and ice melting will create more damaging flood conditions and inundations of the coastal cities (Dasgupta et al., 2009). Chittagong and Khulna are estimated as highly affected population among the 25 cities with the largest population exposures (60% and 51% respectively). Their results indicate large effects in the coastal cities and the exposure of coastal urban population in the 21st century.

8.3.5 Khulna City Master Plan

Khulna Master Plan (2001-2020) is the main product of Khulna Development Authority (KDA) , which was created as semi-autonomous body on 21 January 1961 by the then East Pakistan Govt. by an ordinance called 'The Khulna Development Authority Ordinance, 1961. It was established for planned development and expansion of Khulna City and its suburb areas.

Major objectives of the authority:

- To reduce the challenge of "urbanization of poverty".
- To ensure a comprehensive Master Plan
- To provide safe drinking water, clean air, shelter or housing, employment and health care
- To reduce the urban agglomerations and environmental degradation.
- Urban Planning
- City Development
- Development Control

Major planning instruments:

- Strategic Plan
- Structure Plan
- Master Plan
- Detailed Area Plan

Key Issues:

- Development of Strategic Infrastructure
- Creation of Employment Opportunities

- Densification of Existing Urban Areas
- Lateral Physical Growth for a Compact Shape
- Poverty Alleviation and Promotion of Spatial Equity
- Regional Integration
- Rural-Urban Linkages
- Provision of Public Utilities and Services
- Growth Management

1. Strategic Plan

The Strategic Plan is a development strategy consisting of a comprehensive package of physical, economic, social and environmental policies regarding urban development for the next 20 years. Among others, the most important policy areas are the growth of population, the future extension, shape, size of the city, employment and investment, land, infrastructure, transport, housing and social services. This plan formulated development policies in the light of national perspective plan to develop the area in a coordinated manner.

The important policies assigned in the plan are the development of strategic infrastructure, creation of employment opportunities, revitalization of stagnant economy, densification of existing urban areas, lateral physical growth, poverty alleviation and promotion of spatial equity, regional integration, rural urban linkages, provision of public utilities and services etc. The spatial strategies and policies have been shown on a map of 1:50,000 scale. The total area of the plan is 451 sq. km.

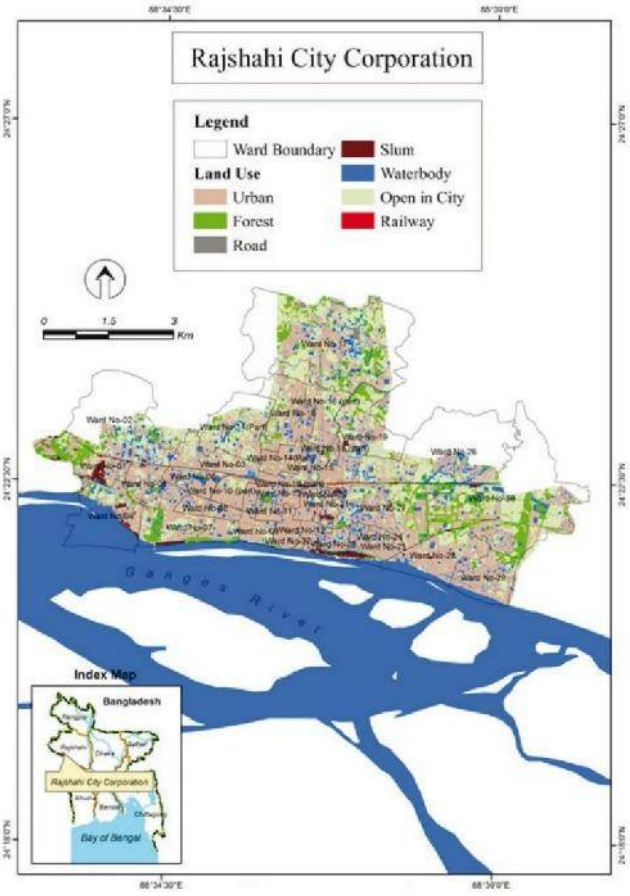


Figure 59 Rajshahi land use map

2. Structure Plan

The Urban Structure Plan is defined as the structure of the area. It provides long term strategy over a period of 20 years time for the development of greater Khulna and a portion of Jessore sub-region with a population target of 3.19 million. It analyzed the trends in spatial growth, population growth and its spatial impact. It formulated sectoral policies and justification and also provided implementation guidelines. This plan consists of a written report and policy documents with supporting maps of 1:10,000 scale. In the map the Structure Plan area has been divided into broad zones of different land uses and the principal structural elements of the city. The plan covers an area of 451 sq. km.

3. Master Plan

The area development plan or local area plan named as Khulna Master Plan covers the whole Khulna City Corporation area and the surrounding growth potential areas of the next ten years (2001-2010). This plan covers an area of 231.7 sq. km. including 45.65 sq. km. of Khulna City Corporation area, Noapara Municipal area, almost entire area of Phultala, Dighalia and Rupsa upazilas and part of Batiaghata, Dumuria and Fakirhat upazilas which is roughly little over half of the Structure Plan area. This plan provides an interim mid-term strategy for the next 10 years. This plan consists of a written report and maps of 1:3960 scale. This plan is the main basis for reaching the desired land development options through area specific policies such as upgrading, redevelopment or new development and action plans. It provides a basis for land use regulations and development control as well as a vehicle for bringing detailed planning issues before the public.

4. Detailed Area Plan

Detailed Area Plans are micro level plans with scale of 1:792. These plans have been prepared for a Comprehensive treatment of an area, which has been selected for intensive change over a shorter period of time, say for 2 to 5 years. Structure Plan has identified 14 urban ecological zones, each of these zones can be a unit of detailed area plan. Otherwise these zones may be divided into more smaller area in respect of the homogeneous characteristics of the zones. In the Master Plan package three Detailed Area Plans (DAP) were prepared as priority basis. These are the East Mujgunni Residential Area Improvement plan, Slum and Squatters Resettlement Area at Rupsh, and the Area Plan at Central Khulna Railway Land.

Khulna Master Plan (2001-2020) has been prepared by the Khulna Development Authority (KDA). The main objective of the Master Plan is to reduce the Challenge of "urbanization of poverty", which is not practically possible. Another lacking of the Master Plan is the absence of Urban Area Plan, Drainage Master Plan and Transportation Plan for Khulna City. Besides, the area development plan or local area plan is formulated only for next ten years, which is already not valid now.

8.4 Rajshahi

8.4.1 Physical setting and demography

Rajshahi is a divisional as well as a district town. Rajshahi City Corporation is the fifth largest city corporation of Bangladesh in respect of population. Initially, Rajshahi Municipality was established in 1876 as Rampur Boalia Municipality with 7 wards and only a population of 10,000. The municipality was transformed into a fully functional municipal corporation on the 13th of August 1987. The municipal corporation area extended from Horgram bazaar in thewest to Rajshahi University of Engineering and Technology in the east covering 6.64 square miles containing a population of 56,883. Later, the municipal corporation of Rajshahi was upgraded to a City Corporation in 1991. It has an area of 97.18 sq.km (87.06 sq km excluding the water areas). It consists of 30 wards and 283 mahallas including Boalia Cantt. The total population of the city corporation is 448087 of which 52% are males and 48% are females. The literacy rate of the city is 74%.

The city is located in the bank of the Padma River and surrounded by Pabna District in the north. The city has a tropical climate with the average temperature of the city being 23.8oC (1991-1996) and the yearly average rainfall of 1447.6 mm (1996-2001). (RDA vol. I 2004, p.16)

Analysis of quickbird image shows that within the city corporation area there are 54% urban or builtup area, 12% waterbodies, vegetation 11.24% and 3.6% road. The slums cover only 1.27% area. The urban area extends beyond the city corporation areas. The urban area has increased from an area of 18.5% in 1970 to 54% by 2010. (CEGIS estimate, 2015)

8.4.2 Socio economic

Rajshahi's industrial sector is dominated by rice and oil mills (19%), hand loom (36%) and the food industry (43%), famous for its mangoes (Source BBS, 2005) . The agriculture is playing a vital role in the economy of the region (Clemett et al. 2006).

8.4.3 Pattern of settlement and type of structure

Rajshahi city is part of the Barind region and so crops such as rice, wheat, potatoes and lentils are grown here. Therefore, 22.41% of land is involved in agricultural activity. This type of land is also suitable for the growth of tropical fruits such as Mangos, Lichies, Watermelons etc. A distinctive pattern of Mango orchard (9.35%) is found within the city. In the city the total vegetation is 11.24% with 10.14% high density (including Mango garden) and 1.09% low density vegetation area. Urban developed land is 54%. The city has 12% waterbodies where 4.3% is river/canal, 7.17% is pond and 0.36% is ditch. Except the famous Silk industry, industrial development has not taken place in this region due to lack of private and public initiatives. Roads and railways serve a total of 3.57% area where road cover 3.44% area.

The built-up area is mostly concentrated on the bank of the River Ganges. Agricultural land or fruit gardens developed along the northern periphery of the city.

Figure 60 Satellite imagery of Rajshahi

8.4.4 Major issues

Bangladesh is a disaster prone country in the world. More or less almost every district of this country is affected by the disasters. Rajshahi district is one of the most vulnerable and risk prone district to disaster and climate change. A number of natural disasters such as flood, river erosion, water logging, drought, cyclone, excessive heat, rain and cold hits this district with an increased frequency and intensity compared to previous years.

1. **Drought**

Rajshahi is the most drought prone area of Bangladesh. Due to excessive heat and lack of rainfall on this area (around 40° C), maximum rivers and farmlands are dried during summer. It causes serious damage to the crop of farmers. During drought condition, water is rarely available to the general people for their drinking and daily uses. Sometimes, severe lack of food exists due to drought.

2. Ground Water Pollution

For domestic and irrigation purposes people are dependent on the ground water. Availability of drinking water is affected by the increased demand of irrigation water. The quality of the ground water is poor due to pollution and high concentrations of iron, manganese and arsenic. In the RCC area, iron content ranges from range 0.4-3.5 mg/l exceeding the national drinking water standards of 0.3-1.0 mg/l (RDA vol-I 2004, p. 29; GoB 1997). The level of manganese range from 0.1-1.52 mg/l exceeding the drinking water standard of 0.1 mg l-1 (RDA vol-I 2004, p. 29; GoB 1997). Due to the high level of arsenic content in the groundwater, the use of tube-well water is reducing with increase of piped water supply. The current water demand is 160000 m^3 per day.

3. Sanitation

Access to sanitation facilities are better in the urban area (50% coverage) compared to the rural areas. The surface water drainage network carries surface runoff, sewage as well as solid wastes into the river system as there is no sewerage system in the city.

4. Waste Management

32% of the total industries are located in the Rajshahi City Corporation (RCC). The wastewater generated from these industries hampers agricultural production.

5. Health Issues

The condition of health facilities is relatively good which includes Rajshahi Medical College Hospital (with 550 beds), three specialized hospitals (including a 150 bed TB hospital and a 20 bed infectious diseases hospital). But, with the growing number of population, these hospital wouldn't be enough for the people of Rajshahi. So, additional hospitals are a necessity.

8.4.5 Rajshahi Metropolitan Development Plan (RMDP)

The main goal of Rajshahi Development Authority is city planning and also to ensure planned growth and development of the city. Just after establishment, in 1978 the Authority has started to prepare its first Master Plan for 20 years. The Master plan was finalized and was started to implement from 1984 for the area of 177 sq.km. The main components of RMDP are a Master Plan, Urban Area Plan, Detailed Area Plan, Strategic Plan, Structure Plan

1. **Urban Area Plan**

Urban Area Plan is formulated to serve as a guide to development together with the control of land use of the RDA administrative area. This plan is more elaborate than the Structure Plan and contains a land use zoning map in the background of cadastral (Mouza) map apart from sectoral development proposal.

The major features of the Urban Area Plan are as follows,

- It provide primary and secondary road network;
- It will keep provision for other major physical infrastructure, like, drainage & Water supply network and flood control infrastructure at intermediate level;
- It will show central and regional open space recreation areas;
- Major social service, like education and health facilities will be indicated;
- It will give other future proposals in the form of land use including major housing, commercial and industrial proposal;
- It will provide important utility installations;
- It will indicate detailed land use of Urban Area Plan coverage;
- Sites of committed and on going major public and private sector projects;
- It will divide Urban Area Plan area into large number of Strategic Planning Zone (SPZ) where Detailed Area Plans will be prepared.

2. Detailed Area Plan (DAP)

Detailed Area Plan (DAP) is a micro level plan, prepare under the policy framework of upper level plans, combined with detailed design and other detailed elements to render it is an implemental project. DAP can be prepared for any site meant for residential, commercial, industrial, or recreational or open space or any other kind of development. DAPs include, apart from public sector initiated site and services plans and spatial development plans, the participatory land readjustment plans, guided land development plans and infrastructure lead development plans and area improvement plans. The DAPs consists of design and other implementation details. The DAPs have been formulated for execution in a period of 3-5 years.

3. Strategic Plan

Strategic Plan indicate the magnitude and direction of future growth of Rajshahi and sets forth recommendation for spatial and sectoral policies. The duration of the plan shall be of 20 years. It means during the period the plan will remain as legally valid document that will continue to serve as a guide for development during next 20 years

4. Structure Plan

Structure Plan will not attempt to specify plot to plot land use or local or access roads and detailed services and facilities. Instead Structure Plan will identify areas where growth is likely to take place and that need preparation of Urban Area Plan and Detailed Area Plans.

Rajhshahi Development Authority (RDA) is responsible for the Master Plan of Rajshahi Division and the metropolitan city, which was first initiated in 1977 and implemented in 1984. Then in 2004 the master plan is reviewed for next twenty years (2004-2024). The main weakness of the master plan is the absence of Drainage Master Plan for Rajshahi Metropolitan City. Besides, there is no Transportation Plan for Rajshahi Metropolitan.

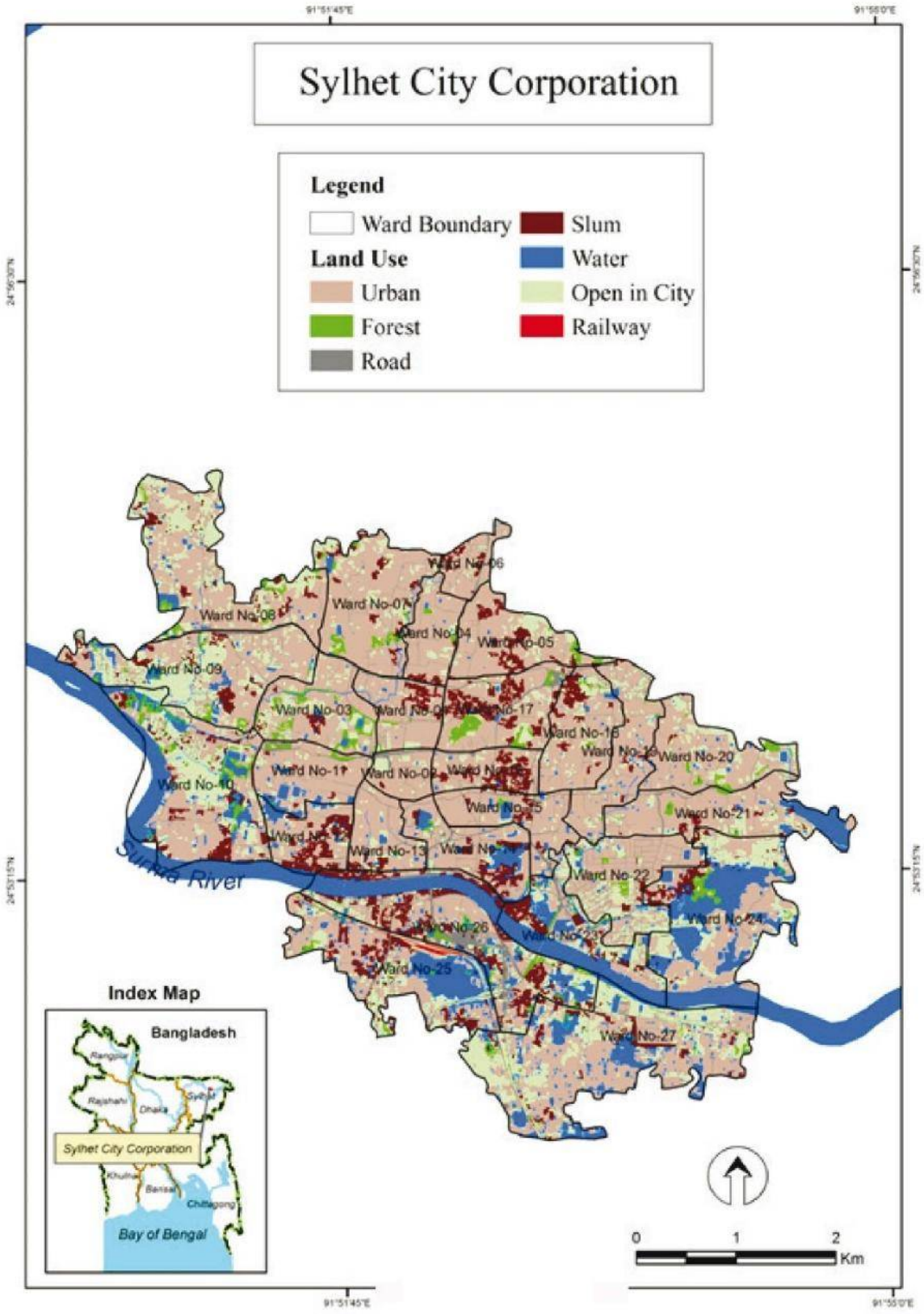


Figure 61 Sylhet land use map

8.5 Sylhet

8.5.1 Physical setting and demography

Sylhet is a major city of the north-eastern part Bangladesh. It is located on the bank of river Surma and the district consists of 12 upazilas and 5 pourashavas and 101 unions with the city as Municipality. Sylhet is one of the oldest and largest city in Bangladesh having a vast historical and cultural background and diversified inhabitants of Garo, Khasia, Monipuri and Hazong. The district is surrounded by the Jaintia, Khasia and Tripura hills. The city is has a high population density with population of 500,000. Sylhet region is well known for its tea gardens and tropical forests.

The Sylhet Municipality was formed in 1885 and then in 2001 it became a City Corporation. Population wise, it is the fourth largest city corporation of Bangladesh. The total population of the city is 5,31,663 of which 54% male and 46% are female. The literacy rate of the city is 67.4% which is lowest among the big cities. The city includes Sylhet City Corporation with 27 wards and 236 mahallas, other urban area (adjoining three 3 mauzas) and Sylhet Cantonment. Total urban area is 41.85 sq.km. of which 26.50 sq.km. is under city corporation.

Historically, the city is the result of conquests and throughout the years has inherited different types of cultures. The mausoleum of the great saint Hazrat Shah Jalal (who brought Islam to Bengal during the 14th century) is located inside the city. It is also a holy place where more than 360 "Olee (spiritual leader)" lying in peace. So, the city is also known as the city of saints. Sylhet also played a major role in the Bangladesh Liberation War during the 1970s.

It is a resourceful area in the country having oil, gas, natural stone quarries and tea estates. Agriculture is practiced in the fertile lands by the river Surma, Koshiara, Sari, and Piain.

8.5.2 Socio economic

Sylhet's economy thrives on received remittances from abroad, especially from the UK and US. The availability of capital brings economic opportunities, hence it is the most economic diversified city in Bangladesh. The dominant sectors in Sylhet are processing (Tea Processing and Food Processing), manufacturing and service/trade, construction and transport.

8.5.3 Pattern of settlement and type of structure

More than 85% area is already developed. It includes 17% open space or bare land, 13% water bodies, transportation network (5% road and 0.14 railways). Within the built-up area, 21% area is occupied by settlements with homestead vegetation. Slums are scattered all over the city covering 8% area. Forest land is spread only 2.45% of the total area.

Sylhet city has developed as a compact township in the form of cluster along the Surma River due to land scarcity. The city is located in between hills, tea gardens, rain forests etc. As the Haor region is affected by flooding and Afal (wave erosion), therefore settlements are protected by submersible embankments.

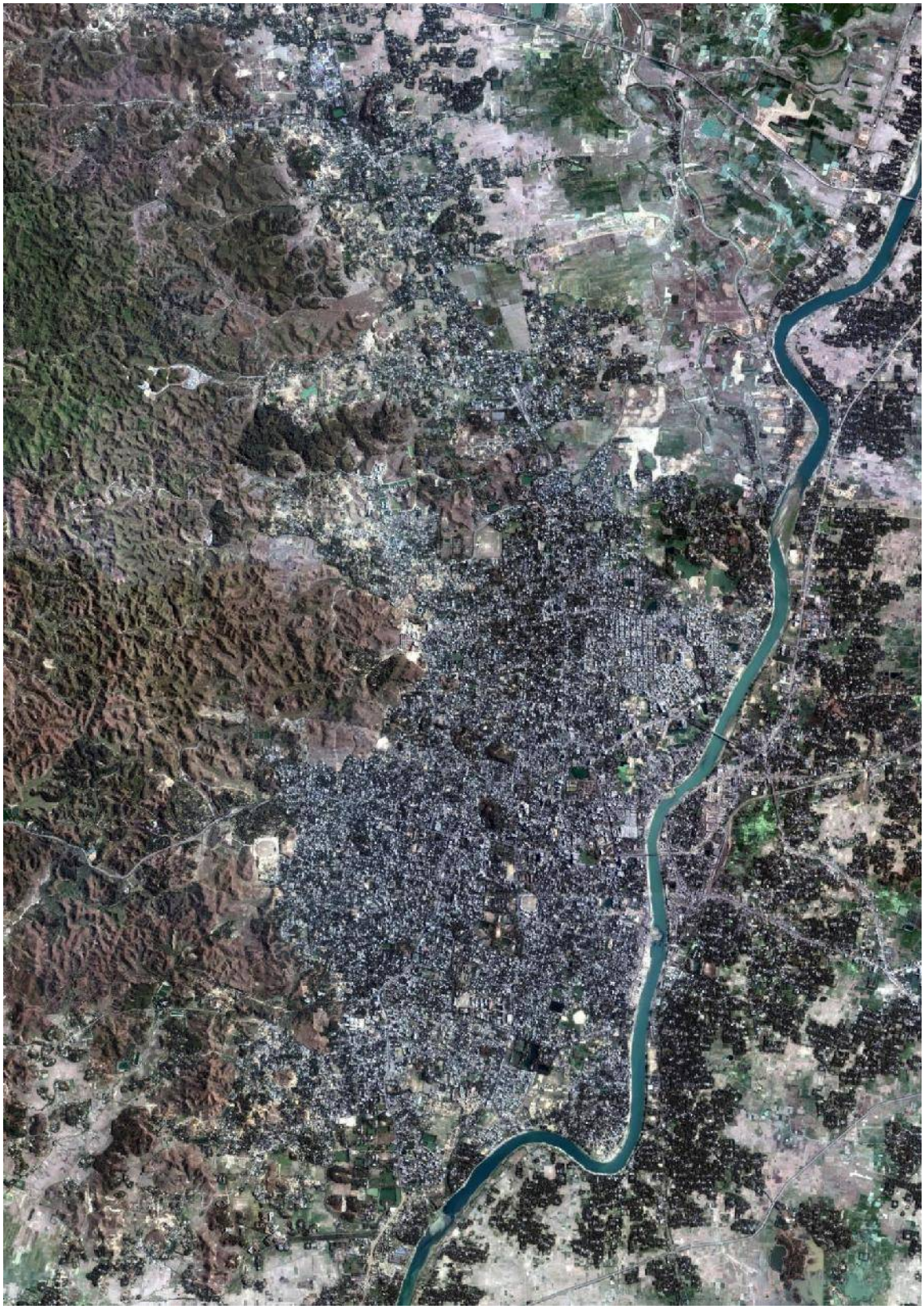


Figure 62 Satellite imagery of Sylhet

8.5.4 Major issues

Sylhet has a predominantly hot and humid summer and a relatively cool winter with annual average temperatures ranging from 7 °C to 23 °C. The city is within the monsoon climatic zone and receives one of the highest rainfalls i.e. 3,334 mm of the country. Most of the rain (80%) falls between May and September. (Source: BMD)

With a complex geomorphology, Sylhet district is the combination of high hilly areas such as Khasi and Jaintia hills and small hillocks along the border, and low floodplain areas also known as Haors. Some parts of the region have limestone deposits which indicates that during the Oligo-Miocene period, the whole area was under the ocean. Flood, Flash flood, excessive cold and rain, river bank erosion are the main natural calamity of Sylhet region.

1. **Flood**

Sylhet city is more vulnerable to flash flood than normal flood. Heavy rainfall from hills is responsible for flash flood. Normal flood occurs rarely in the city, because Sylhet is the highland of the country. Now-a-days, pluvial flood is not occurring in the city, just because of good drainage system. Sometimes, fluvial flood happens because of overflow of Surma river and monsoon rainfall.

2. Earthquake

Sylhet is also vulnerable to different hazards like earthquake. It has been already marked under the most risked zone. Considering recent records, earthquake has become a large threat for the people of Sylhet city. Three major earthquakes with a magnitude of minimum of 7.5 have been reported during the last century. The last earthquake hit in 1918. Increasing population and gradually developing unplanned urbanization is increasing the vulnerability even further. According to experts, even a medium scale earthquake can bring a devastating impact on the lives and assets of the people in this area.

3. Land Slides

Sylhet consists of some hill tracks of the country, which often causes land slide through heavy rainfall. On 4 July 2009, a landslide occurred near Habiganj town, 250km north east of Dhaka and there are numerous such examples. Several incidences of land-sliding occurred in 2008.

4. Noise Pollution

It is a human health hazard when it the noise level exceeds 60 decibel. People feel disturbed by noise from construction activities, aircrafts, the hydraulic horn of vehicles, industries and factories, loud speakers and workshops of various categories. In Sylhet city, a huge fleet of motorized vehicles such as bus, minibus, truck, car, jeep, microbus, three wheeler and motor cycle emit toxic substances such as carbon monoxide, oxide of nitrogen, oxide of sulfur, hydrocarbons and their derivatives, lead, and particulate matter. Together they cause serious irritation and infection of eye, nose, throat and lungs.

5. Housing Problems

Housing is one of the basic human needs like food and clothing. It provides shelter, safety, and sense of belonging to a person (Ahsan & Islam, 1999). Due to increase of population in Sylhet city, direct pressure is visible on the housing sector. The housing situation is unsatisfactory in the city. Urbanization, particularly rapid urbanization within a situation of weak economic condition, creates extreme pressure on housing and urban services like education, health, transportation, water, sanitation, electricity, fuel, garbage clearance, recreation etc. More than 85% area is urban builtup area which includes 17% open space or bareland, 13% water bodies, transportation network (5% road and 0.14 railways), 21% settlements with homestead vegetation. Slums are scattered all over the city covering 8% area. Forest land is spread only on 2.45% area. (CEGIS estimate, 2015)

8.5.5 Sylhet Master Plan

Sylhet obtained the status of Divisional Town in 2002 as a result of increased population pressure, economic growth due to foreign remittance supply and spatial development. The urban area has already extended 85km beyond the city's limit. As such the previous structure plan prepared in 1987 became outdated and need arose for a new master plan to manage the uncontrolled growth and also to improve the basic services as per the rising population's demand. So, with the urge to ensure planned development an initiative was undertaken by UDD in 2006 to prepare the Master Plan. The preparation of the Plan through government's funding started in 2006 and finished in 2008.

The Master Plan includes three components- Structure Plan, Urban Area Plan and Detailed Area Plan. Structure Plan covers an area of 85.18 sq. km or 21,039 acres including the City Corporation (26.5 sq. km.) and other potential urban areas (58.68 sq.km.) within its vicinity. The topography varies from 5.000 m MSL to +68.125 m MSL with the highest land level being in the hilly areas and tea gardens.

The Structure Plan (SP) is provides a long term strategy till the year 2030 for the development of city and its environs. Strategies are formulated for 12 Strategic Planning Zones (six zones within the city corporation and six outside the city). The Urban Area Plan is for a period of 10 years (2010-2020). It covers the city corporation and some areas within the extended area (40.96 sq.km.).

The Detail Area Plan (DAP) of Sylhet was prepared with intention of being implemented within a period of 3-5 years. Detailed Area Plan consist of public sector initiated site and services plans and special development plans, the participatory land readjustment plans, guided land development plans and infrastructure led development plans and area improvement proposals. Initially, these plans are targeted towards the detailed development of some priority areas.

Sylhet City Master Plan is developed by Sylhet Development Authority (SDA). The Master Plan package consists of three levels and types in a hierarchical order. These are: the Structure Plan (SP) or general development plan; the Urban Area Plan and the Detailed Area Plan (DAP). So, clearly there is no Drainage Master Plan and Transportation Plan for Sylhet City, which are the major lacking of the Master Plan. The Urban Area Plan is formulated only for ten years (2010-2020), which is not sufficient. In the Detailed Area Plan, development proposal of the planning package is absent.

8.6 Barisal

8.6.1 Physical setting and demography

Barisal district is criss-crossed by plenty of rivers that earned her the nickname 'Dhan-Nodi-Khal, Ei tine Barisal' which means rice, river and canal built Barisal. Barisal was formerly a district called Bakerganj. The town lies in the Ganges (Padma) River delta on an offshoot of the Arial Khan River (Kirtonkhola). The main river is Kirtankhola. Growth of the city is visible in Koladoma Chahuta mauza in the north and in the south direction crossing the Kirtonkhola River towards Dapdopia mauza. The city is part of the south central coastal zone of Bangladesh.

Barisal has annual average temperature ranging from 12.1°C to 35.1°C. The amount of annual rainfall is 1955 mm (Barisal District website). Barisal is an old port city of the Kirtankhola River. Barisal city, the divisional headquarter of the Barisal Division. Municipality was formed in 1876 and it was turned into Barisal City Corporation in 2000. It is bounded by Kaunia and airport thanas on the north, Bandar thana and Nalchity and Bakerganj upazilas on the south, Kaunia and Bandar thana on the east, Airport and Kotwali Model thanas and Nalchity upazila on the west. The total population of the city is 339308 of which 52% are males and 48% are females. The literacy rate of Barisal is 75%, the highest among the cities. The City Corporation includes 30 wards and 225 mahallas and adjoining 3 mauzas as other urban area. The city corporation cover 58.05 sq.km. out of a total urban area of 69.19 sq.km. (BBS, 2014)

The city is linked by steamer with Dhaka (117 km north) and with Chittagong to the southeast. These river networks are used to gain access to the surrounding coastal districts, and the Chittagong and Mongla ports. Due to its location and

easy access to both riverine and marine navigation channels, it has become a trans-shipment centre for rice, hides, and pulses. Bakery, textile, pharmaceutical products are output of a few industrial installation.

8.6.2 Socio Economic

The economic activity of this region is concentrated in agriculture (50% of it involved cereal production), Fisheries, labor wages and foreign remittances. 40 % of the regional GDP comes from agriculture where 80% of the population is employed in the sector. About 15% to 20 % of the population absolutely depends on fishing and fall under the extreme poor category (RED, 2009).

8.6.3 Pattern of settlement and type of structure

Barisal City Corporation is also located in the southern delta of the country like the Khulna city corporation. Agriculture is dominantly seen in 29% area. Developed area covers 61% area including settlement with homestead vegetation 36.63%, other built-up area 16.27%, road 1.67% area and slum only 0.62% area. Approximately, 10% of the total city area is under the coverage of water bodies. Forest area is small with an extent of 0.43% area.

The city has extended along the Kirtonkhola River in a linear manner in the north-south direction. Wholesale business of fish and agro-based products is located here. Agricultural land has also grown alongside the built-up area. The core settlement is densely populated and situated around the central business district.

8.6.4 Major issues

The city is located within 100km from the Bay of Bengal. Barisal is one the coastal cities affected with frequent flooding, cyclones, storm surges and droughts. As such the city is vulnerable to natural hazards along with other problems such as drainage congestion, solid waste management, siltation, health problems etc. The occurrence of natural hazards destroys the structures, infrastructures thereby disrupting city life. Socially and economy wise the city is in a better condition than the rural areas of the entire district with low risk of social vulnerability.

1. **Housing**

The urban area is expanding through the filling up of waterbodies and open spaces. Spontaneous development is occurring without any provision of infrastructures. Areas allocated in the Master Plan have been occupied by public agencies. The huge population growth is expected to create housing demand of 1,74,915 households by the year 2030. Although the city is surrounded by beautiful natural setting and heritage sites, still there is scope to develop it as a tourism place.

According to the interpretation of high resolution image, Agriculture is dominantly seen in 29% area. Developed area covers 61% area including settlement with homestead vegetation 36.63%, other built-up area 16.27%, road 1.67% area and slum 0.62% area. Approximately, 10% of the total city area is under the coverage of water bodies. Forest area is small with an extent of 0.43% area. (CEGIS estimate 2015)

2. Water supply and sanitation

Most of the households have tubewell connections. Groundwater alone is not sufficient to meet ever increasing demand for potable water since the rate of groundwater recharge is much lower than the rate of its extraction, which results in lowering of water table. Besides, recently arsenic has been detected in groundwater at some locations within study area, although within tolerable limits. The existing water supply system has got a very poor scenario in terms of demand and supply. Surface water treatment is needed to fulfill the demand. There is a shortage in supply of 38.9 Million Liters per Day (MLD) with network coverage of only 20 wards out of 30 wards in the City Corporation Area.

The city has high coverage (75%) of sanitary facilities (with water seal and no water seal). The whole area still needs to be covered. However, the wastewater needs to be properly treated before being discharged into the waterbodies.

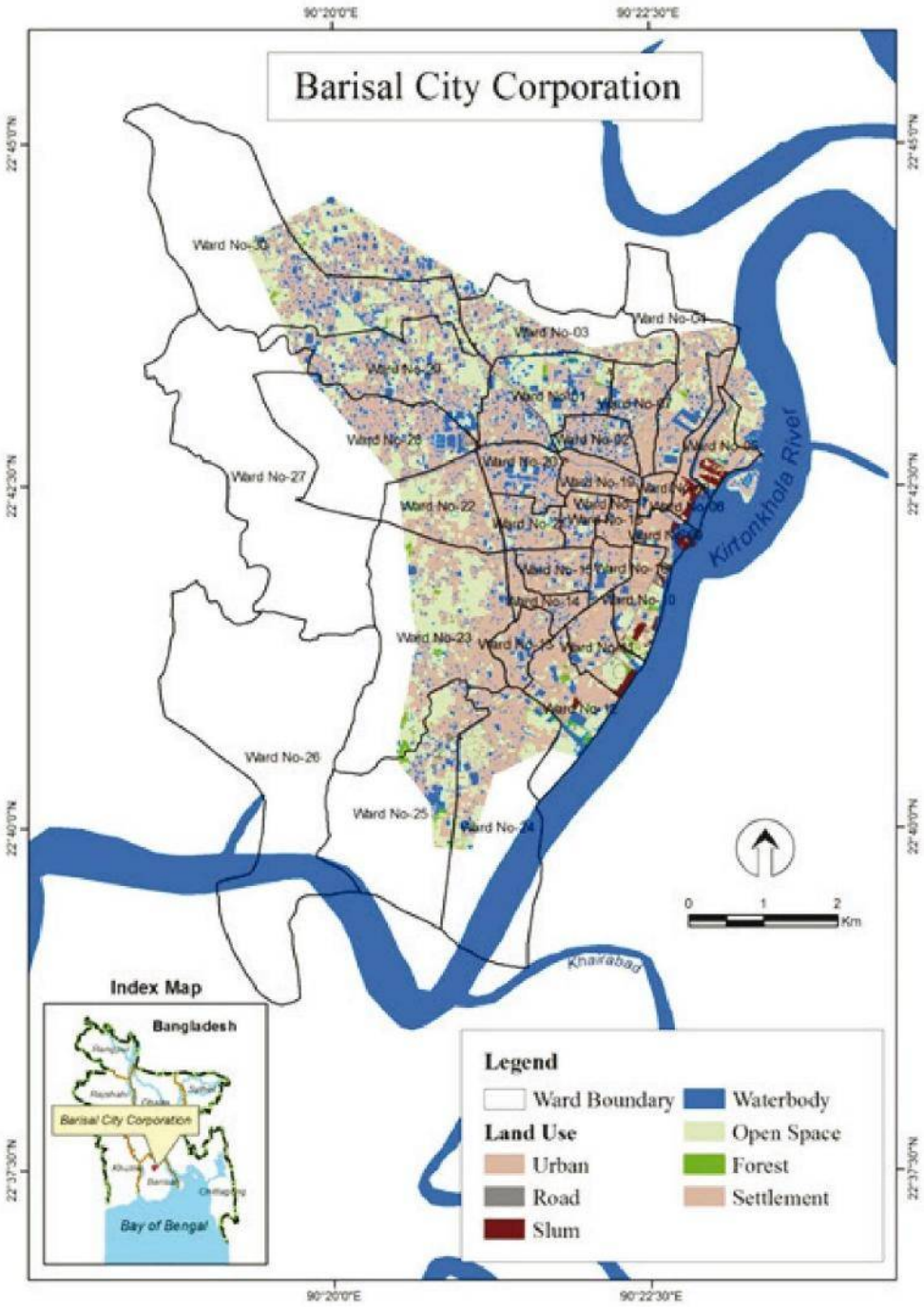


Figure 63 Barisal land use map

3. Transportation

The divisional town of Barisal hasn't yet reached a stage of congestion and breakdown yet. But with the visions of the plan in mind of making it a bustling economic centre alive with new ideas and activities, it'd not be farfetched to say that this would be a highly likely consequence once the development policies start materializing. More economic activity directly implies to more need to travel.

4. Flooding and drainage congestion

Siltation is occurring in the river and khals. This along with unplanned development of industries, residential building and markets on both side of natural channel (from DC launch ghat to Battala) is reducing the normal flow. Construction of bridges across natural channel obstructs the natural flow thereby causing drainage congestion on the upstream. In some places of the channel, cultivation is carried out resulting into blockage. Filling up of waterbodies specially ponds for residential or industrial purposes is continuously going on. This way, flow of rain water is hindered and also the migration of fish species is hampered. The waterbodies and canals are contaminated by the indiscriminate dumping of solid wastes and sewage. These also pollute the water of the channel which is harmful to both human and fishes.

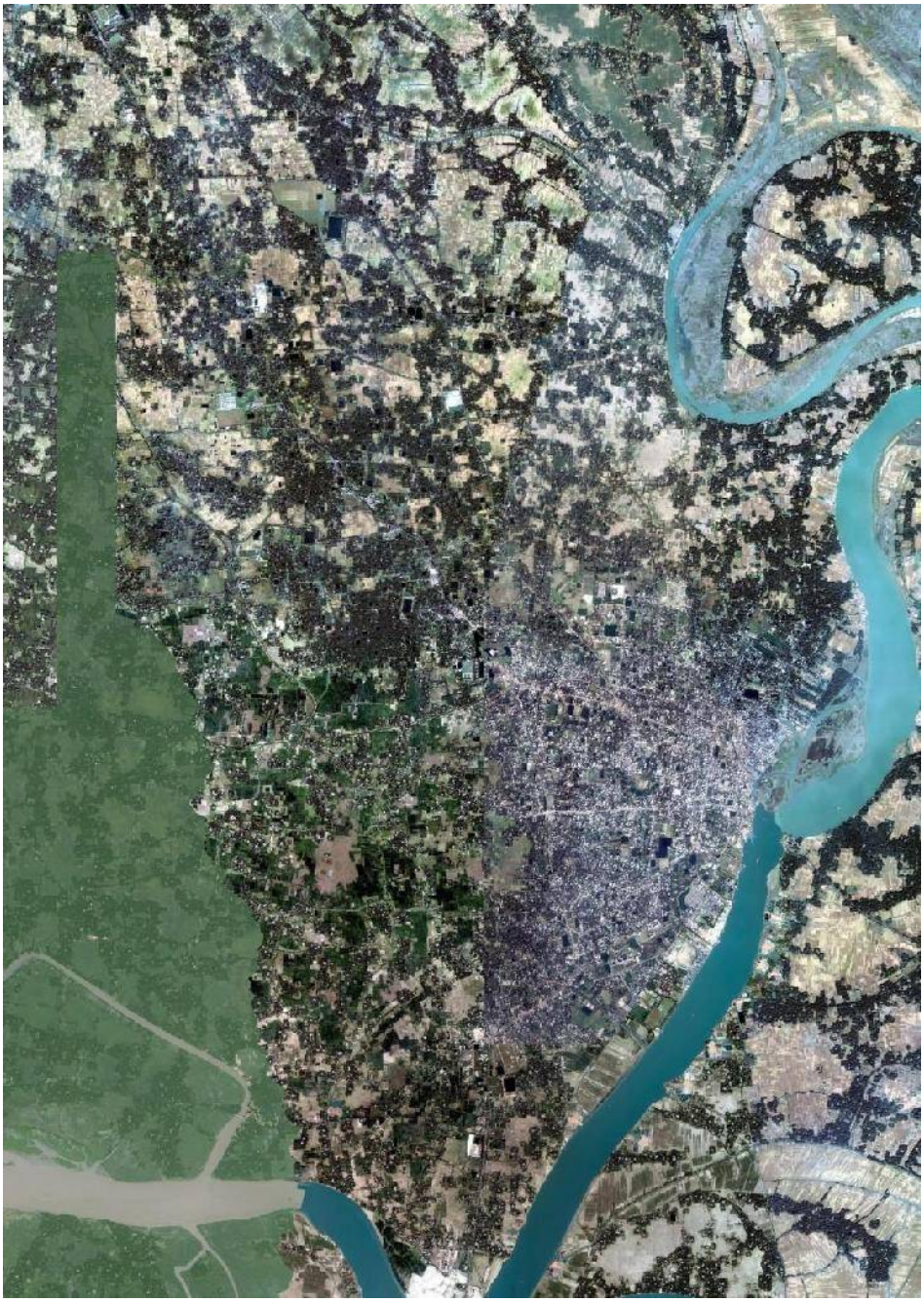


Figure 64 Satellite imagery of Barisal

9 Characterization of Hotspots/regions

These Hotspots are prototypical areas where similar characteristics and problems converge (such as flood vulnerabilities, water shortages, siltation constraints, etc.). The Hotspots are:

a) Coastal Zone
b) Haor and Flash Flood Areas
c) River Systems and Estuaries
d) Barind and Drought Prone Areas
e) Chittagong Hill Tracts
f) Urban Areas (the characterization of the major cities are described in chapter 9)

9.1 Coastal Zone

Coastal zone refers to the area where the land and sea meets. Bangladesh has a 710 km long coastline. About 62% of land having an elevation less than 3m and 86% less than 5m. Under the Integrated Coastal Zone Management Project (ICZMP), 19 districts have been identified as the coastal districts. These districts have been further divided into exposed (8 districts) and interior (11 districts) zones regarding distance from the coast or the estuaries. Delineation of the coastal zone was done based on three distinctive features which are: tidal fluctuations; salinity condition in both surface and ground water; and risks of cyclone and storm surge.

The coastal zone extends over 47150 sq km area and has a population of 3,85,17,698 (BBS 2011). The zone is characterized by vast network of rivers and channels, enormous discharge of water with huge amount of sediments, many islands, the Swatch of No Ground, shallow northern Bay of Bengal, strong tidal influence and wind actions, tropical cyclones and storm surges. The coastal zone is comprised of 10 agro-ecological zones. The distribution of land type in the zone are highland (15%), medium highland (67%), medium low land (14%) and low land (4%). (Islam, 2004)

The coastal region is vulnerable to hazards such as flood, riverbank erosion, salinity intrusion, drought, cyclones and storm surge. Inundation due to flooding and storm surge differs based on the land elevation and surface form. In the last 200 years more than 70 cyclones have hit the coast damaging life and properties. Erosion is visible only in the estuaries where new land is also formed due to the accretion process. Salinity ingress is another major problem for the coastal zone which leads to change in biodiversity, agricultural practices, forest species change and most importantly contaminating the drinking water. There are some areas that have very little rainfall termed as 'Rainfall stressed areas". This low amount of rainfall along with salinity intrusion reduces the freshwater flow endangering the sustenance of ecosystem.

9.2 Haor and Flash Flood Areas

Characterized by unique physical and hydrological settings, Haor region is one of the main economic zone of the country. Haors are bowl-shaped depressions of considerable aerial extent lying between natural levees of the rivers or high lands. In most cases, haors have been formed as a result of peripheral faulting leading to the depression of the haor area. In the wet seasons, the haors are full of water, but during the dry seasons, these are dried up except for the beels. Haors are located in the north-eastern region of Bangladesh covering about 859,000 ha or 8590 sq km of area and accommodating about 19.37 million people. There are about 373 haors and wetlands dispersed in the districts of Sunamganj, Sylhet, Maulvibazaar, Habiganj, Netrakona, Kishoreganj and Brahmanbaria. Almost all land above the maximum flood level is under permanent cultivation and human settlement. The total settlement area is 303120 ha or 3031 sq km and the number of houses are 3244380 respectively. The percentage of the settlement area is 12% of the total area. The average rainfall annually ranges from 2200 mm along the western boundary to 5800 mm in its north east corner and is as high as 12000 mm in the headwaters of some catchments extending to India. (HMP, 2012)

The settlements have high population density because of the surrounding huge watery areas and severe shortage of habitable highland. The space is inadequate for locating social services and facilities like educational facilities, health facilities, markets & growth centres, food godown/cold storage, religious institutions, graveyards/cremation grounds, sport facilities etc. Agriculture and fisheries, key source of economic development of haor region is lagging behind due to constraints such as scarcity of land, lack of marketing facilities, inadequate purchasing power, unsteady maintenance of food stock etc. Despite the fertility of land, the forest, agricultural, fisheries production is gradually decreasing due to the lack of proper preservation. Although the government collects rice every year from the farmers but the farmers never get the actual price. Due to the over production in some years the farmers have to sell the yielded crops in a cheap rate. The people living in the haor and adjoining haor areas are the most affected population due to flash flood and most of them live below poverty level.

9.2.1 Haor Master Plan, 2012

The Haor Master Plan developed a comprehensive Master Plan to preserve, protect and restore the eco-system as well as protect the people of this area from natural disasters and improve the livelihood of poor people. The Bangladesh Haor and Wetland Development Board (BHWDB) engaged the Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources (MoWR) for preparing the Plan.

This Master Plan is a framework plan for developing the haor region through optimal utilisation of natural and human resources for the next 20 years (up to 2031). The Plan has been formulated following the principles of the IWRM. This is a definite framework plan for the integrated development of haor areas thereby ensuring preservation of haors, wetlands and their ecology. It will be implemented on the short, medium and long term basis with provision for updating and incorporating rationale change in demand and land use. Policies, strategies and plans relevant to the haors have been extensively reviewed to identify the targeted goal and priorities and to establish linkage with the Plan. The Master Plan has been prepared to translate the directives of the national policies, strategies and plans. The Plan provides the future development options based on analysis of the problems, issues, opportunities, strengths and risks of each sector. It has been formulated in an integrated manner envisioning mainly flood management, environmental sustainability, production of crop, fisheries and livestock, expansion of education, settlement and health facilities, road communication, navigation, water supply & sanitation, industry, afforestation, tourism, use of mineral resources and generation of power and energy.

The principles followed for developing the Master Plan strategy are:

- Compliance with respective development policies, strategies and plans
- Consideration of the national vision, goal, objectives and strategies
- Recognition of the recommendations and suggestions based on public participation and consultation process
- Pursing the integrated policy directives of the government for sustainable development of the areas
- Maximisation of resource utilisation with minimum degradation of the haor and wetlands and eco-system

Based on the above principles, the strategies have been formulated under the umbrella of six broad thematic areas, which are:

1. Improved water and disaster management
2. Agricultural development for food security
3. Biodiversity enhancement and wetland management
4. Social safety net and improved standard of living
5. Improved physical infrastructure, and
6. Enterprise and technology development

1. Housing and settlement

- ensure development of housing for the poor and needy as well as for the majority of the rural population.
- community participation for development of housing and ensuring a healthy livable environment.
- The concept of eco-villages has been introduced for the expansion of planned infrastructure on a priority basis in the newly developed settlement platform and for reducing housing density in the existing settlement area.

2. Social Service and Facilities

- Ensuring balanced distribution of resources among people and marketing of products through construction of rural markets and growth centres in all the unions;
- Ensuring supply of food grain during emergency periods as well as surplus food grain to other areas in need through construction of food godowns and cold storage at union level and near each growth centre or rural markets and construction;
- Creating a congenial and secular atmosphere and providing options for practising religion through construction of mosques, temples and churches as needed and awareness generation among spiritual leaders;
- Construction of graveyards/crematoriums etc.;
- Making provision for sports through construction or expansion of one large playground for each upazila and each secondary school and adequate sports equipment at schools; and
- Ensuring safety and security of people through establishment of police stations and out posts and improve the law and order situation in all the villages.

This plan is only applicable for the north-eastern haor regions of the country. It is a framework plan lacking any local or regional level physical plans for future. Implementation of the plan has been suggested in concurrence of sixth five year and perspective plan of the government of Bangladesh. Strategies for specific thematic areas are included. A list of projects worth 3383796 lakh taka, have been proposed for three phases: short (2012-2017), medium (2017-22) and long term (2022-2032), which seems too costly for implementation.

9.3 Mighty rivers

Bangladesh consists mainly of riverine and deltaic deposits of three large and extremely dynamic rivers entering the country: the Brahmaputra, Ganges, Upper Meghna and finally all together Lower Meghna rivers. More than 200 rivers flowing through this country and among them 57 rivers are transboundary, shared with India and Myanmar. The river systems mainly cover about 7% of the total surface of the country. The average flood discharges of these rivers (individually) are within the range of 14,000 m3/s to 100,000 m3/s. Every year these rivers system are carrying one trillion cubic meter of water with more than one billion ton of sediment from ninety-two percent catchment area beyond the Bangladesh border to the Bay of Bengal. The major rivers of Bangladesh are morphologically very active and thus influence the hydrological and morphological characteristics of other rivers significantly.

The hydrological characteristics of the Ganges-Brahmaputra-Meghna basin is influenced by the climate changed induced situations like temperature rise which affect the timing and snow melting in upper Himalayan reaches. This change tends to raise the average water level of lower riparian rivers and causes serious flooding. Bangladesh is the country to discharge about 90% of the water from GBM river system with only 7% area of total GBM catchment. Eventually problems concerning drainage congestion are exacerbated due to increased volumes of water coming through cross boundary river system (SNC, 2011).

Another problem which is occurred due to altercated hydrological situations is riverbank erosion. The major river systems change the dynamic pattern and about 0.1 million people of this country become homeless every year due to river erosion. It not only cause displacement of people, but also occur huge financial loss. The two major rivers, the Jamuna and the Padma are considered as alternatives for the river bank erosion situation. Remote sensing data for the period 1973 to 2004 were analyzed. It has been found that riverbank erosion in Jamuna before 1995 was much higher

than the present rate, which is about 2500 ha per year whereas, in Padma, is about 1500 ha per year. From present studies, it has been found that in 2008, erosion along the bank of the Jamuna River was 530 ha, about 85 ha of which is settlement. Erosion along the bank of Ganges was around 880 ha, 75 ha of which is settlement. For Padma, 535 ha of river bank were eroded and 100 ha of which were settlements (SNC, 2011).

9.4 Barind and Drought Prone Areas

Barind Tract is located in the centre and western part of Rajshahi division. in the northwestern part of the country, covering a total area of approximately 7,770 km^2 of mostly old alluvium. The greater part of the tract is almost plain and is crisscrossed by only a few minor rivers. This tract is considered an ecologically fragile ecosystem with extremely low vegetation cover. This region includes the districts of Bogra, Rajshahi, Naogaon, Nawabganj and Natore.

The weather is drier during monsoon and summer and winter is more cold than an average temperature. Rainfall is less than the other parts of the country in the Barind region. The trace is undulated and most of the land of this area covered is with mango orchard and rice cultivation. Though this zone was rich with faunal diversity in the past, it has now noticeably reduced mostly due to various pressures like expansion of human habitat, agricultural extension, unwise use of agrochemicals and illegal hunting. In the past, this zone had rich faunal diversity which has been reduced due to various unregulated anthropogenic pressures.

9.5 Chittagong Hill Tracts

The Chittagong Hill Tracts (CHT) differs in almost every aspect from the rest of Bangladesh. It is geographically part of the Hindu-Kush-Himalaya (HKH) region. CHT borders India's Northeastern region, sharing boundaries with the state of Tripura to the north and northwest and Mizoram to the east. To the south and southeast lies the Arakan province of Myanmar. Three districts namely Rangamati, Khagrachari and Bandarban are called the Chittagong Hill Tracts. The CHT has an area of 13295 sq. km covering 10% of the total country. But most of the areas are dense forest covering 47% of the total forestland of the country (BBS, 2001). Because of this mountainous geography and dense forest the population density in the region is very low. People living in the region 50 years ago were mainly comprised of several indigenous and tribal groups, collectively known as Paharis in Bangla term. Currently, the population is 16 million. So, from a density of 10 person/sq km in 1901, the population density has increased to 120 person/sq km in 2011 (BBS, 2011).

The CHT has a tropical monsoon climate. A decrease in rainfall (max 8mm over 2 decades), was found for the period 1901-2002. The total area of the Chittagong Hill Tracts (CHT) is about 13,344 sq km according to the BBS 2011. The land comprises 38% forest area, 36% fallow land, 20% agricultural land and 6% non-agricultural land. The major parts of the agricultural land of the CHT are used for jhum-annual crop cultivation (39%), 30% for perennial crops, 13% for double crops, 9% for annual crops, 6% for single crops and 3% for triple crops. Traditionally, the Jhum farming practice involves the rotational slash and burn system. Jhum system is one of causes for land and forest degradation.

The rocky soil makes the land infertile and uncultivable. Forest conversion, population increase and the creation of the Kaptai lake that inundated good agricultural land, have led to environmental change, resulting in forest decline, soil degradation, biodiversity loss and production loss. Monoculture plantation of timber, cutting of hills, felling of forest erodes the soil thereby destroying the biodiversity. 74% people have no access to safe water which combined with the lack of knowledge on water hygiene leads to water borne diseases. Another area of conflict is land ownership which is directly linked with agricultural production and associated environmental issues.

5. Critical Issues for the CHT area:

The CHT had been a low dense area due to its hilly topography, economic condition, religious backgrounds and social customs with only 10 people per sq km in 1901 which has increased 12 times to 120 people per sq km in 2011. The three districts of Bandarban, Khagrachhari and Rangamati consists a population of 24%, 38% and 37% respectively out of the total CHT population (BBS, 2011). 52% of the total population is of ethnic community including 12 tribes, namely, the Chakma, the Marma, the Tripur, the Tanchangya, the Khiyang, the Chak, the Murong, the pankhu, the bawm, the Khumi, the Lushai and the Usui.

The CHT experienced steady growth of tribal population during the British rule till 1951. After 1951, under the Pakistan regime, major influx of Bengali settlers attributed to government policies accelerated the population growth. The construction of the Kaptai Hydro-Electric Power Dam from 1952-62, had a huge impact on the CHT people's lives as thousands of tribal population was displaced.

Land is the very basis of life for the CHT peoples, whose main source of sustenance is agriculture. The tribal people had the sole ownership of land according to the Manual Law of 1900. This policy was changed significantly in 1962, giving land ownership rights to the Bengali settlers also and thereby raising ethnic conflicts with the tribal people for many years. Land grabbing has occurred in a number of ways:

1) Construction/expansion of military facilities
2) Construction/expansion of settlements
3) Expulsion in the name of protecting forests or the environment
4) Leases of land by the local administration
5) Attacks (refer to chapter on human rights violations)
6) Expulsion through false cases, harassment and other tactics

Land grabbing of patterns 1) and 2) was mostly led by the military, that of patterns 3)and 4) was by the Forest Department or local administration, and that of patterns 5) and 6) was by Bengali settlers (often with the direct or indirect support of the military).

A Peace Accord was signed by the Government on December 2, 1997 to create a healthy and peaceful living environment. Even after the peace accord, military rule continues for practical purposes in the Chittagong Hill Tracts (CHT). In practice, the military remains above the law and constitution; soldiers and settlers involved in human rights abuses against the CHT people remain largely immune to prosecution. This is the factor contributing most to human rights violations in the region. Despite the peace accord, attacks by settlers continue to be perpetrated, often in a planned manner, through cunning manipulation of the discontent of land-hungry settlers by the military and other power brokers.

10 BDP 2100 Knowledge Gaps Urbanisation and Settlement

In this part the main knowledge gaps in urbanization and settlement in relation to the Delta plan are described. Many other knowledge gaps exist that are less urgent for the Delta plan.

1. Good national, regional and settlement base maps

A national base-map on which the relation between urban and rural centres, road and water infrastructure and land use can been seen clearly, is lacking. This map could show and clarify differences in land use and urbanisation patterns of different regions, and with that providing more inside in the logic ad characteristics of different area's.

Figure 65 Example of national spatial map of the Netherlands, including different time frames

Source: NAI Hybrid landscapes- Nederland 1860-2010

When a series of maps can be constructed showing the countries spatial development over time, this could further increase and improve the understanding of the spatial composition and relations of the country. The same applies to maps of urban areas and settlements, good base maps including data such as urban morphology (logic of building and building blocs in relation to each other, streets and open spaces), infrastructure and traffic conditions, facilities, functions, green structures and water bodies, sewage and drainage networks are essential for planning. Those maps could be an valuable base for analyses of urban planning principles and with that for regional, national, urban and settlement planning.

2. Regional composition

A good understanding and description of regional dynamics and the relation between urban and rural linkage and development are lacking

3. Knowledge of growth patterns and drivers of settlements

Thorough analyses of the settlement patters and especially insights in changes and drivers of the patterns over time is lacking. Especially to be able to see how for instance the growth of Dhaka, the making of coastal polders and levees, and the establishment of the Upazilla Governance structure have influenced spatial patterns in the past.

This knowledge could be used to:

- Abstract tools for guiding urbanisation and settlements in the future.
- Input for urban modelling in order to better model future urban development.

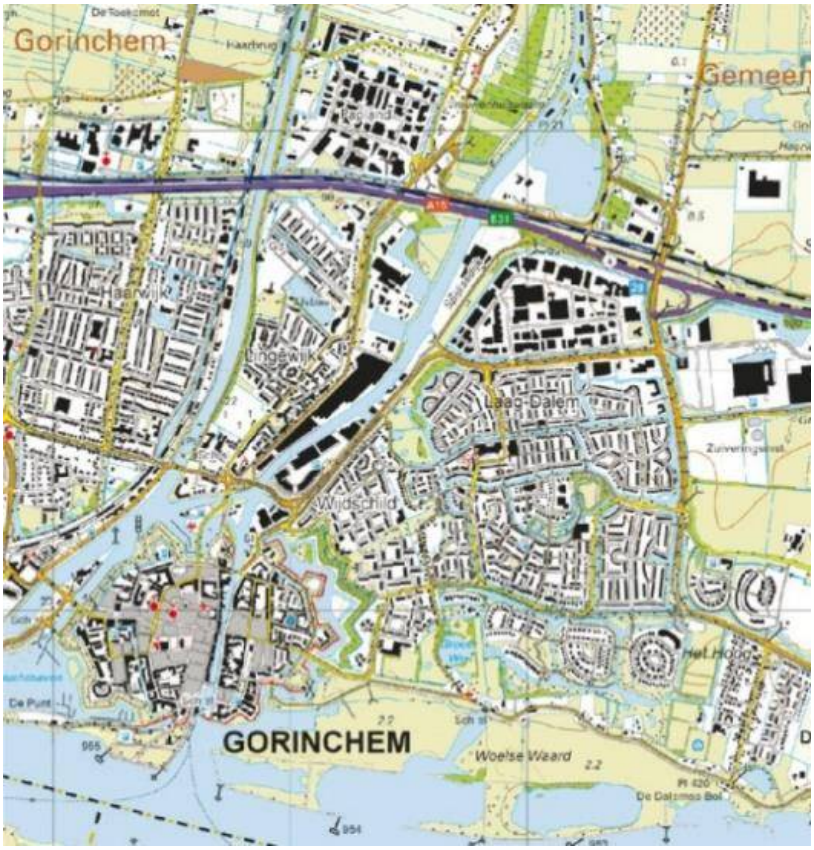


Figure 66 Example of an urban area map of a Netherlands town, including the display of building blocks/ urban morphology.

Source: Topografische dienst

4. Accurate infrastructural network model

In the current infrastructure space syntac models (see page xx) models constructed by the authors the quality, capacity and congestion of the roads are not included in the network analyses. A model that would include such data and extends to the local scale could be a valuable base for drafting a national infrastructure investment plan. Especially since network integration (especially access to Daka and markets) is closely linked to poverty, using this model the impact of new road connections or improvement to overall network integration could be estimated.

SPATIAL PLANNING KNOWLEDGE GAPS / ADDITIONAL INTEGRAL STUDIES PROPOSED FOR BANGLADESH