Bangladesh Delta Plan 2100

Bangladesh in the 21st Century

(Abridged Version)

The Best Gift for the Future Generations by the Present Generation

General Economics Division (GED)
Bangladesh Planning Commission
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The Bangladesh Delta Plan (BDP) 2100 is the plan moving Bangladesh forward for the next 100 years. We have formulated BDP 2100 in the way we want to build Bangladesh.

-SHEIKH HASINA

Bangladesh Delta Plan 2100: Bangladesh in the 21st Century

A. Overview

The development activities have gained tremendous momentum in the last decade by the dynamic leadership of the Honourable Prime Minister Sheikh Hasina. The indicators of an exceptionally strong development record have inspired the country to aim even higher. The country now aspires to reach the upper middle income status by 2030. Sound and effective development policies and advantage of the hugely abundant supply of labour, a very fertile land, plenty of water and monsoon rains have laid the foundation of this achievement in the recent past. The Bangladesh Delta, the largest dynamic delta of the world, along with a large and growing population base, presented many advantages that the people and policy makers converted into opportunities to secure the above development gains. Yet, the same delta and high population density presents many development challenges. With a population of about 160 million crammed into 1,47,570 km^2 including rivers, Bangladesh having at about 1,200 people per square kilometer is one of the most densely populated countries in the world. Owing to the deltaic formation of the country, the configuration of the rivers and climate change, Bangladesh has been ranked as the 6th most vulnerable country in the world in terms of risks from natural hazards. Tidal surge, salinity, flooding, river erosion and cyclones are regular features of the country. These features pose a continuous challenge to food security for the country and livelihood for a large part of the rural population. These delta-related challenges are just one source of challenge. The country faces other challenges from growing urbanization, declining land availability, infrastructure shortages, energy supply constraints and dearth in labour skills. The interface of these multiple challenges with limited public resources and a constrained public sector capacity define the policy and institutional challenges of lower middle income Bangladesh. Even so, past track record gives confidence that with strong determination and effort, the country has the capability to overcome these challenges.

In view of the long term challenges presented by climate change and natural hazards, the Government has formulated a long term Bangladesh Delta Plan 2100 (BDP 2100). The BDP 2100 seeks to integrate the medium to long term aspirations of Bangladesh to achieve upper middle income (UMIC) status and eliminate extreme poverty by 2030 and being a prosperous country beyond 2041 with the longer term challenge of sustainable management of water, ecology, environment and land resources in the context of their interaction with natural disasters and climate change. The BDP 2100 looks primarily at the delta agenda up to 2050 but also recognizes that the decisions taken today have implications up to 2050 and beyond. In this regard, it sets up a long term vision for the evolution of the Bangladesh Delta by the end of the 21st century, but defines short and medium term goals as steps to reach that vision. These goals, associated strategies, policies, institutions and

investments are moving targets and adaptive in nature. They are adaptive to changing natural events in order to respond appropriately and stay on the course to the path of the long term vision. In view of the best practice of Dutch Delta management, the Government has taken technical assistance from the Government of Netherlands to help Bangladesh develop this BDP 2100. The General Economics Division (GED) of the Planning Commission of the Government of Bangladesh has formulated the BDP 2100, with support from Dutch and national experts.

B. Need for an Integrated and Holistic Plan (BDP 2100) for Water Resources Management

A number of sectoral initiatives and plans for water and agricultural development sectors have been adopted in Bangladesh since 1960. Furthermore, national-level strategic plans such as the Five Year Plans and Perspective Plan have been formulated by the Government. More recently, the 17 Sustainable Development Goals (SDGs) with 169 targets are new global agenda and Bangladesh is highly committed to meeting these goals. However, the challenge lies in integrating these sectoral, national and global targets and plans into long term coherent strategies taking climate change and future demands into account, as well as in effective implementation of the needed interventions in a well-coordinated manner, following a no regret approach.

Typically, the sectoral plans tend to be short term oriented and independently pursued by the formulating ministries or departments. Whereas, goals and targets are at the national level and climate change and natural disaster risks present major downside challenges and risks that require long term strategies and multi-sectoral coordinated policy management under uncertainty. For example, the national challenge to maintain food security in the face of increasing population and decreasing agricultural land as well as the threat posed by climate change requires coordinated policy actions involving ministries for agriculture, environment, forests and climate change, land, fisheries and livestock, water resources, LGRD&C, shipping, food, disaster management and relief, finance and planning. Similarly, to meet the higher water demand for achieving a greater standard of living and to protect the ever increasing level of investment in housing and industry from disasters, Bangladesh needs a long term vision, planning and implementation involving all government ministries and agencies that contribute to this objective.

Due to the large uncertainties with respect to climate change and socio-economic development, planning is being enriched with adaptive strategy making in several deltas in the world. Rather than providing linear recipes, robust and flexible strategies and measures have been taken, with strong institutions and a good knowledge base that allows policy makers and stakeholders to anticipate and decide on the most appropriate investments. Learning from these international experiences, BDP 2100 has been developed

in light of the many possible future paths that are possible, and is designed to

be changed over time as new information becomes available or policy priorities change. So, instead of only focusing on short term 'trial and error' actions and projects, the idea is to keep the long term vision in mind while prioritizing short term 'no regret' actions.

C. Analytical Framework OF BDP 2100

The Bangladesh Delta is variously defined in the literature. This report uses the most expansive definition of the delta that basically encompasses almost all districts of Bangladesh because they face numerous weather and climate change risks related to their location either around the sea, around major rivers or in water scarce zones. Only six districts are relatively less hazard prone owing to their location away from sea and active rivers. The BDP 2100 is essentially an adaptive techno-economic plan involving the interaction of water, land use, ecosystem and climate change with development outcomes. Hence, hydrology plays a major role in delineating the planning regions for the preparation of the BDP 2100. Using the eight hydrological zones as the starting point, the focus has been sharpened on the magnitude of the natural hazard vulnerabilities facing each of the hydrological regions. This has led to a modified grouping of districts and areas facing similar risks of natural hazards and climate change. These groups are called "Hotspots" that simply define a broad grouping of districts and areas facing similar natural hazard and climate change risks. The aggregate hotspot grouping provides a convenient tool to summarize certain broad socio-economic characteristics and common risk profiles. They are only a first step of analysis. The risk profile and magnitude of vulnerabilities facing a district within and between hotspot districts vary considerably. In some cases, a further disaggregation to the district and upazilla level may be necessary to understand in detail the risk profiles. Accordingly, a risk profile at the district level, and where necessary at the upazilla level, was also developed in formulating the BDP 2100.

The Six Hotspots and number of districts covered are summarized below. Because of geographical overlap, some districts may fall in more than one Hotspot.

1. Coastal Zone (27,738 sq. km);
2. Barind and Drought Prone Areas (22,848 sq. km);
3. Haor and Flash Flood Areas (16,574 sq. km);
4. Chattogram Hill Tracts (13,295 sq. km);
5. River System and Estuaries (35,204 sq. km); and
6. Urban Areas (19,823 sq. km).

Table: Mapping of Districts to Hotspot Areas

Hotspots	No. of Districts	Name of District
Coastal Zone	19	Bagerhat, Barguna, Barishal, Bhola, Chandpur, Chattogram, Cox's Bazar, Feni, Gopalganj, Jashore, Jhalkati, Khulna, Lakshmipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira, Shariatpur.
Barind and Drought Prone Areas	18	Bogura, Chuadanga, Dinajpur, Gaibandha, Joypurhat, Kushtia, Meherpur, Naogaon, Natore, Nawabganj, Nilphamari, Pabna, Panchagarh, Rajshahi, Rangpur, Satkhira, Sirajganj, Thakurgaon
Haor and Flash Flood Areas	7	Brahmanbaria, Habiganj, Kishoreganj, Moulvibazar, Netrokona, Sunamganj, Sylhet
Chattogram Hill Tracts	3	Bandarban, Khagrachhari, Rangamati
River Systems & Estuaries	29	Barguna, Barishal, Bhola, Bogura, Chandpur, Cumilla, Faridpur, Feni, Gaibandha, Gopalganj, Jamalpur, Kurigram, Lakshmipur, Lalmonirhat, Madaripur, Manikganj, Munshiganj, Narayanganj, Natore, Chapai Nawabganj, Noakhali, Pabna, Potuakhali, Rajshahi, Rajbari, Shariatpur, Sirajganj, Tangail, Khulna
Urban Areas	7	Barishal, Chattogram, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet
Relatively Less Hazard Prone (RLHP) Areas	6	Gazipur, Jhenaidah, Magura, Mymensingh, Nilphamari, Sherpur

Source: BDP 2100 Analysis, GED, 2015 and ICZM Policy, 2005

D. Delta Opportunities

The delta opportunities are many. The soil and water combination of Bangladesh makes it a highly fertile land with multiple cropping opportunities. Bangladesh has wisely combined this natural advantage with seed-fertilizer-irrigation technology to intensify land cultivation and expand food production, primarily rice. Consequently, rice production has surged from 12 million tonnes in 1973 to 36.3 million tonnes in 2018. Along with a very successful population control policy, Bangladesh has now met food self-sufficiency requirements with prospects for rice exports. This amazing achievement, despite the multiple risks posed by the delta and climate change, is a testimony to the resilience of the Bangladeshi society.

The plentiful of rivers, fresh wetlands, and lakes provide ample scope for fisheries resources. Apart from that marine fishing has now become a major source of fisheries resources. More recently, Bangladesh has been increasingly exploiting the open access to the Bay of Bengal. Owing to the growing importance of fisheries, the structure of agriculture is slowly changing as the share of crop sub sector is falling and that of fisheries increasing. Consequently, the value-added and employment shares of fisheries are increasing.

The plentiful of rivers in Bangladesh provide another large comparative advantage. Almost all districts are connected with each other and with the growth centers of Dhaka, Chattogram and Khulna through river ways. The inland waterways provide an environment friendly and low-cost transport option for both passengers and cargo for the country as a whole but especially for the rural poor. Inland water transport is also a major source of rural employment. More focus on river transport can provide a huge development opportunity to lower the cost of transportation, reduce environmental degradation, conserve budgetary resources and add to employment prospects for the poor.

The open access to sea is a huge advantage to Bangladesh. In addition to the port facilities that could serve the needs of the growing internal trade and commerce needs of Bangladesh, with proper investments Bangladesh can become a regional hub for international sea transportation. Examples of dynamic port cities like Rotterdam, Singapore and Hong Kong show how proper planning and investments can dramatically convert this natural advantage to a huge development gain for Bangladesh. Increasingly, the open access to sea is becoming a major opportunity in another way. The rapidly growing demand for energy in Bangladesh owing to increasing GDP growth led by the expansion of manufacturing sector is facing a challenge of primary energy shortage. The rapid depletion of natural gas has led to a search for other primary fuels. This search has led to a strategy of procuring clean imported coal, LNG and LPG. All these primary energies require port facilities to handle these bulky cargoes. Bangladesh is slowly capitalizing this open access to sea by establishing new ports, in addition to Chattogram and Mongla ports. The ongoing Payra port construction in Patuakhali is an example of this. The open access to sea also opens up enormous prospects for developing the blue economy of Bangladesh. Marine fishing is already emerging as a major source of domestic food, exports, income and employment. There is a growing demand for coastal tourism and alternative options to the traditional Cox's Bazar coastal resorts. An example is the Kuakata coastal tourism in Patuakhali district.

E. Delta Challenges

1) Climate Change

Temperature Rise: In the Fifth Assessment Report of the International Panel for Climate Change (IPCC), the globally averaged combined land and ocean surface temperature data show a warming of 0.85 (0.65 to 1.06) °C, over the period 1880 to 2012. The total increase between the average of the 1850–1900 period and the 2003-2012 period is 0.78 (0.72 to 0.85) °C. For the longest period when calculation of regional trends is sufficiently complete (1901 to 2012), almost the entire globe has experienced surface warming. In addition to robust multi-decadal warming, global mean surface temperature exhibits substantial decadal and inter-annual variability. The pattern of rising global temperatures is expected to continue in the future. Projections show that for 2046-2065, mean temperature rise ranges from 1.0 to 1.4°C, whereas it ranges from 1.0 to 3.7°C for the period 2081-2100.

Bangladesh has also experienced considerable rise in temperature. While there is debate about the magnitude of future increase, there is consensus that global warming will increase and so will be the case for Bangladesh. In this Report two scenarios are considered: Business As Usual scenario (BAU) and Extreme scenario (EXT). The BAU considers the moderate climate change scenario with sustained global and national efforts to reduce Green House Gas (GHG) emissions. The EXT considers the extreme climate change scenario with limited global and national efforts to reduce the GHG emissions and fossil fuel based economic development. Projections show that temperature

will rise in all regions in Bangladesh in future similar to the global trend. The magnitude ranges from 1.4 to 1.9°C for BAU and around 2°C for EXT by 2050. Further rise in temperature is expected in the latter half of the century, especially in the EXT scenario.

Rainfall: The rainfall pattern in Bangladesh is going to be more variable and erratic in future. There is an indication that pre-monsoon and monsoon rainfall will increase under BAU scenario. On an annual basis, the rainfall is expected to increase in most regions during 2030. But, during 2050, southern parts of the country along with the eastern hills might get reductions in rainfall. Under the EXT scenario, as temperature rise will be higher, more erratic behaviour of rainfall along with variation in amounts is projected.

Floods: Flood is a recurrent phenomenon of Bangladesh. Three mighty rivers the Ganges, the Brahmaputra and the Meghna meet together in Bangladesh forming the largest delta of the world. As a consequence, most of the country consists of huge flood plain and delta of which, around 70% of the total area is less than one meter above sea level and 10% of the land area is made up of lakes and rivers. Bangladesh experiences heavy monsoon rains, especially over the highlands along with frequent tropical storms in coastal region. All of these events trigger frequent flood occurrence in Bangladesh. On average, an estimated 20-25% of the country becomes inundated due to river spilling and drainage congestion. Extreme situation arises when the three major rivers (the Ganges, the Brahmaputra, and the Meghna) reach their flood peak at a similar time. In general, 55-60% of the country is inundated during extreme flood events. Recent evidence reveals that the magnitude and frequency of mega floods is increasing as a consequence of climate change. Other human causes like construction of dam in upper riparian countries, unplanned urbanization in illegally encroached floodplains, lack of combination of structural and non-structural measures, etc. are aggravating the situation. Research suggests that the flood extent will be increased for all areas of the country by mid-century (2050) based on the EXT scenario. Both banks of the Brahmaputra-Jamuna Rivers will be worst affected in this scenario. On average, 3-9% additional area will be inundated from the base (1978-2007) on the left side of the Jamuna River. On the other hand, some portion of the Barind region adjacent to right bank of Jamuna river will be more inundated (around 30%) from the base by 2050 due to flooding in the EXT scenario.

Droughts: The droughts occurring in Bangladesh are not meteorological droughts but agricultural droughts, which could be also termed as severe moisture stress. In the drought prone agro-ecological regions of Bangladesh, period of dry days range between 32-48 days, starting from 24 March to 21 May. During this period the temperature also rises more than 40°C for 5 to 15 days within the same agro-ecological regions. In addition, some soils have low moisture holding capacities, which show different degrees of doughtiness. The government's intervention to attack drought with the Barind Region Irrigation Project has changed the profile of the Barind region with a rapid

transformation of the area into an agrarian green field with a diversified agriculture based on rice, fruits and vegetables. This has contributed substantially to lowering poverty in the North-West part of Bangladesh. Yet, the drought risk has been shifted forward as surface water reduction from diversion of river water upstream in India and inadequate rainfall in the dry season continues to lower the water table. So, climate change that lowers rainfall further in the dry season could hurt agriculture in the Barind Tract.

River Erosion: The morphology of the country's rivers is highly dynamic and river bank erosion is also a regular phenomenon, particularly along the banks of the main rivers. The present rate of the Jamuna bank erosion is about 1,770 ha per year while bank erosion by Padma River is about 1298 ha per year. Lower Meghna erodes at a rate of 2,900 ha per year. A major reason for the erosion is that the discharge in the rivers is increasing. Flow records over 50 years long for the station Bahadurabad (Brahmaputra/ Jamuna rivers) show that peak discharge is increasing and is peaking earlier. The average timing of the peak was in the middle of August but is now in the first week of August. At Bhairab Bazar (Meghna), peak discharge is decreasing and its occurrence is delayed slightly. The time of peak has moved to the last week of September from mid-July in the late 1970s. At Hardinge Bridge station on the Ganges, peak discharge is increasing but the time of peak is advancing. The date is advancing by about one day in a decade. The rising peak discharges of the Ganges and the Brahmaputra mean increasing probability of future river erosion. One consolation is that if the present trend of advancing of the peak prevails, the chances of coincidence of the Ganges and the Brahmaputra peaks will be less, reducing the probability of catastrophic and long duration floods. Along with erosion, there is also some land accretion from river movements and associated transport of sediments. During 1973-2015, a total of 52,313 ha land has been accreted. On balance land accretion is significantly lower than land erosion for all three major rivers, although net erosion is the largest for the Brahmaputra/Jamuna River. Changes in the river flow and sediment transport due to multi-faceted impacts of climate change are expected to increase the dynamics of these rivers even more.

Sea Level Rise (SLR) and Salinity Intrusion: Sea level rise and consequently, salinity intrusion are the most prominent issues now in Bangladesh delta for its complex geographical position. IPCC (2013) predicts sea level rise from 0.2 meter to 1 meter for low to high emission scenarios in 2100 for the Bay of Bengal. Analyses indicate that under EXT scenario flooding extent will increase up to 6% and 8% from base (2005) in central part of Coastal Zone by 2050 and 2100 respectively, which is highest among other parts of the Coastal Zone. The west portion of the Coastal Zone will face 5% and 6% more coastal flooding than base by 2050 and 2100 respectively. No significant changes have been found in eastern portion of the Coastal Zone.

The rising sea level impedes fresh water availability in coastal area, expediting intrusion of salinity front. Both surface water and soil salinity along the coast

may be increased with the rising sea level. Projections suggest that in base (2005) condition about 10% area is under 1 ppt salinity and 16% under 5 ppt salinity; these areas will increase up to 17.5% (1 ppt) and 24% (5 ppt) by 2050 in the EXT scenario.

Cyclones and Storm Surges: Low lying areas of coastal region are highly vulnerable to cyclones, which pose serious threat to lives and properties of the region. Nearly every year, cyclones hit the country's coastal region and a severe cyclone strikes the country every three years, on average. Intensity of cyclonic storm surges as well as depth and extent of storm surge induced coastal inundation are likely to increase in changing climate through rising sea surface temperature (SST) and sea level. The IPCC further reports that future cyclonic storm surges and related coastal floods in Bangladesh will likely become more severe as future tropical cyclones increase in intensity. In the EXT scenario, the areas vulnerable to inundation depths of more than 1 meter and 3 meters, respectively would be 14% and 69% higher than the current baseline scenario. A 10-year-return period cyclone in extreme scenario will be more intense by 2050 and cover 43% of the vulnerable area, 17% more than the current coverage.

2) Upstream Development Activities in the Upstream

Being highly dependent upon developments at upstream, the diversion, use or storage of flows from the trans-boundary rivers is of major importance to Bangladesh. Impacts on dry and monsoon season flows, salinization, siltation of rivers and sediment deposition in the Meghna estuary are the most important factors. These, in turn, have a direct impact on the ability of the (coastal) floodplains to keep up with sea level rise in the Meghna estuary. The Ganges River has been found to be the most negatively impacted river among the major rivers followed by the Brahmaputra and to a much lesser extent the Meghna River. The most impacted regional rivers are: The Dudhkumar, Dharla, Teesta and Mahananda Rivers.

3) Water Quality

Water quality worsens severely in 32 rivers (based on available data); are considered at risk of severe environmental degradation. Industrialization, including mechanization of the agriculture sector, urbanization and salinization, are expected to lead to further deterioration of surface water quality in the country. There are at least three types of direct negative impacts of water pollution: i) increasing health problems of the rural and urban population; ii) loss of agricultural and industrial productivity due to pollution and salt water intrusion; and iii) environmental degradation, leading to a degradation of the environmental services offered. Key issues in groundwater quality include arsenic in groundwater and salinization. Pollution from industrial and domestic sources also constitutes a clear risk. About 12.6% of supply water contains arsenic.

4) Waterlogging

Waterlogging in urban and rural areas pose a serious development challenge. These are caused by a number of factors, including unplanned and ineffective drainage infrastructure, encroachment on wetlands in urban and rural areas and the hampering of tidal flows in the coastal area, especially in the southwest (Satkhira, Jashore Khulna and Bagerhat) and south east (Noakhali, Feni) coastal zones.

Adverse Impacts of Climate Change

The climate change factors working through the geography of the Bangladesh Delta can have vast adverse effects on the country's development. The climate factors work through a large number of sectors that add up to substantial losses economy wide. The most vulnerable sector is agriculture. High temperature reduces yields of high-yielding varieties of Aus, Aman, and Boro rice. Climate change, especially in temperature, humidity, and radiation, increases the incidence of insect pests, diseases, and microorganisms. Simulation studies predict about 17% decline in overall rice production and as high as 61% decline in wheat production compared with the baseline situation. By 2050, this could lead to a reduction in 4.5 million tonnes of rice output at the 2002 level of production. Agriculture will also suffer from increase in soil salinity. The salinity effects are already severe as indicated by very low yields in the salinity prone areas, especially Patuakhali where the average rice yield is 40% lower than the national average and more than 50% lower than in Naogaon. Under a moderate climate change scenario, the crop loss due to salinity intrusion could be about 0.2 million tonnes per year. Simulations show that under the BAU scenario, due to the reduction in yield, annual paddy production would fall by 1.60% in 2050 and 5.1% in 2100. Agriculture will suffer additionally from the higher incidence of flooding caused by climate change, including from inundation caused by sea level rise. The other highly vulnerable sectors are forestry and ecosystems. Many of the anticipated adverse effects of climate change, such as sea level rise, higher temperatures, and an increase in cyclone intensity, will damage the forest resources of the country, put pressure on many climate-sensitive species, and cause increased erosion and deterioration of soil quality in many uplands forested areas. The world's largest mangrove forest, the Sundarbans, is extremely vulnerable to climate change. Sea level rise will increase saltwater intrusion and negatively affect the forest and its diverse ecosystem.

Additional adverse effects will happen in loss of land and physical assets from inundation. At a one meter SLR, a significant part of dryland in Bangladesh will be permanently inundated; the fall in production in all sectors in the economy due to the land quantity shock would lead to a fall in real GDP. Under the BAU scenario, real GDP would fall by 0.73% per year in 2030 and by up to 0.93% per year in 2100. Climate change and the resultant floods and cyclones will have a significant impact on infrastructure in Bangladesh. Estimates suggest that the capital stock in the construction sector would be depleted by 0.05% annually. Additional losses will happen to the road infrastructure. Health

hazards will also intensify due to climate change. Water-borne diseases, such as diarrhoea and dysentery, and vector-borne diseases, such as malaria and dengue, are climate sensitive. Projections show growing morbidity could occur from dengue and malaria.

At the macro-level, the combined effects of climate change could range from a loss of 1.1% of GDP per year in a moderate climate change environment to 2.0% of GDP per year in an extreme climate environment. The projections made for BDP 2100 using a moderate climate change environment shows a loss of about 1.1% of GDP per year between 2017-2041 based on the government's target of achieving 9% annual average target. This is a huge negative impact and provides the basis for developing and implementing the Bangladesh Delta Plan. Indeed, if the Delta Plan is implemented along with suggested investment programmes, the Policy Scenario shows that the average growth rate can accelerate to 8.8% of GDP, which yields an average annual GDP gap of 1.9% between the BAU and the Policy Scenario. The value of the Delta Plan for Bangladesh is indeed very high.

In terms of loss of human welfare, district and sub-district level analysis shows that there is a strong positive correlation between incidence of poverty and the intensity of natural hazards. Some 70% of the 16 districts ranked as most exposed to natural disasters (intense risk category with ranking of 1) also show poverty rates that are higher than the national average using the upper poverty line for 2010. There is a similar high positive correlation between high-risk districts (risk ranking of 2) and poverty. Some 67% of these districts have poverty rates that are higher than the national average and 13% have poverty rates same as the national average. At the national level, of the 15 most poverty-stricken districts, almost 90% of the districts belong to natural hazard risk categories 1 or 2. Regarding per capita income, some 80% of the most-intense hazard-prone districts (risk ratings of 1) had per capita income below the national average. The corresponding percentages were: 67% for districts in risk category 2 and 100% for risk category 3.

F. Salient Features of BDP 2100

BDP 2100 is envisioned as a long term integrated and holistic plan that takes a long term view on water resource management, climate change and environmental challenges with a view to supporting long term development of Bangladesh. The opportunities, risks and vulnerabilities emerging from the interface of water, climate change and environmental issues are long term in nature. The strategies, policies and programs must also be formulated with a long term perspective. Yet there are immediate and medium term challenges that must be addressed now or in the near future. The associated short to medium term strategies, policies and programs will have implications for long term developments. As a result, long term planning is complicated by considerable uncertainties. Water, climate change and environment are heavily influenced by the behaviour of nature that is not often predictable.

How should policies, programs and investments be formulated in the short to medium term to be consistent with the long term outcomes that are inherently uncertain? This is a major strategy challenge for the BDP 2100, which has been addressed by setting a clear vision and specific goals.
The BDP 2100 approach is to first develop a broad based long term vision and also the mission about the likely changes of the Bangladesh Delta by the end of the 21st Century. Thus, an integrated, comprehensive and long term Delta Vision as well as Mission has been stated as:

Vision: *"Achieving safe, climate resilient and prosperous delta"*

Mission:
"Ensure 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 through robust, adaptive and integrated strategies, and equitable water governance".
This long term vision needs has been translated into specific goals or targets for its implementation. This is done by combining long term development outcomes in terms of economic growth and poverty reduction in the Perspective of 2041 with targets for reducing long term vulnerability from water and climate change related hazards plus targets for environmental conservation.

BDP 2100 approach to long term goals: The BDP 2100 proposes 3 higher level national goals and 6 BDP 2100 specific goals that contribute to achieving these higher level goals.

Higher Level Goals

Goal 1: Eliminate extreme poverty by 2030;

Goal 2: Achieve upper middle income status by 2030; and

Goal 3: Being a Prosperous Country beyond 2041.

BDP 2100 Specific Goals

Goal 1: Ensure safety from floods and climate change related disasters;

Goal 2: Enhance water security and efficiency of water usages;

Goal 3: Ensure sustainable and integrated river systems and estuaries management;

Goal 4: Conserve and preserve wetlands and ecosystems and promote their wise use;

Goal 5: Develop effective institutions and equitable governance for in-country and trans-boundary water resources management; and

Goal 6: Achieve optimal and integrated use of land and water resources.

BDP 2100 approach to managing uncertainties and linking short to medium term to long term outcomes: Given the inherent uncertainties of the long term behaviour of the natural forces that influence water, climate change and environmental outturns, it is essential to adopt a flexible and adaptive approach to converting the long term Delta Vision to medium term strategies for moving towards this vision. BDP 2100 uses the best available information and develops short to medium term strategies and policy options under different assumptions about the external outcomes. The scenarios and strategies need to be updated as new information is available on a 5-year cycle. This adaptive approach to delta planning including selection of investment projects provides the link between the short to medium term development targets and investment programmes with the long term goals of sustained development based on climate sensitive management.

G. Strategies for BDP 2100

Water remains an indispensable resource and is used for both production sectors, such as, agriculture, industry, commercial, forestry, fisheries, etc., and for human consumption, such as drinking, cooking and hygiene. The nation-wide demand for water is growing over time, which is being intensified by several socio-technical drivers such as, high demographic growth, rapid and unplanned urbanization, high sectoral demand (such as agriculture, fisheries, transportation and industries), climate change, etc. On the other hand, the essentiality of water for the rich but vulnerable ecosystem of the country and the variability of water availability in dry and wet season complicates water resources management in Bangladesh. Additionally, the management of water resources is complicated by the fact that the flow generated in the 93% catchment of the Ganges- the Brahmaputra- the Meghna originates outside the border of Bangladesh before draining out to the Bay of Bengal. The country is frequently hit by natural disasters such as, flood, river bank erosion, cyclone in the wet season; and drought in dry season. Furthermore, the country encounters problems like water logging, salinity intrusion, arsenic contamination navigation problems, etc. Most importantly, the country confronts with growing uncertainties in receiving equitable water share from its upper riparian countries. Therefore, it is of high importance for the country to manage this critical natural resource in an integrated and holistic strategic manner.

The BDP 2100 therefore comes up with an adaptive, holistic and long term integrated plan to steer the opportunities and vulnerabilities created by the interface of water, climate change, natural disasters, environment, ecological balance, agriculture, land use and inland water management for national development. The sustainable use of water resources and prevention of water-related natural disasters provides the backbone to the Delta Plan. The strategies for managing water resources in wet and dry seasons that have been formulated are flexible in respect of measures and actions with its timeframe and uncertainties. The strategies are adaptive in the sense of periodic review and update in Five Year Planning cycle on the basis of situation and development needs. These are 'no regret' measures in terms of

effectiveness and maximum benefit and offers integrated implementation with innovation, advanced information technology and strengthened institutional capacity.

The water challenges and proposed strategies in BDP 2100 are built around addressing the fundamental problem of flooding that is a nation-wide challenge and addressing hotspot specific challenges of water shortage in drought-prone Barind Region; river erosion problems of the river and estuary region; coastal inundation and salinity problems of the Coastal region; flash-flooding and wetland management issues of the Haor region; water shortage, sanitation and drainage problems of the urban region; and the water shortage problem of the CHT region.

Strategy at National Level

Flood Risk (FR) Management Strategies

Flood risk management strategies have been developed based on 3 principles as follows:

- Strategies conducive to economic development without degrading the environment;
- Developing Climate change resilient Bangladesh through optimal use of natural resources; and
- Climate resilient development through participatory process.

Strategy FR 1: Protecting Economic Strongholds and Critical Infrastructure

Supporting economic development implies that those areas that are essential for the economic growth of Bangladesh require a high flood protection standard. This is required to attract the investments that allow the economy to grow. Typical measures that can provide this level of protection include embankments, barriers, erosion control (e.g. by integrating the measures proposed by this BDP 2100 and the FRERMIP[1] project), and efficient drainage systems. Most of these measures are already in place, albeit at a basic level. In addition, adapted flood proof building is needed for key facilities such as hospitals, power stations, industrial plants and major communication networks between these facilities. Flood control measures will need to ensure that projects do not create inundation problems elsewhere by creating room for rivers that allow them to follow their natural courses and find their pathways to the sea. Sub-strategies include:

- Sub-strategy FR 1.1: Protection by development and improvements of embankments, barriers and water control structures (incl. ring dikes) foreconomic priority zones & and major urban centres;
- Sub-strategy FR 1.2: Construct adaptive and flood-storm-surge resilient building;
- Sub-strategy FR 1.3: Adopt spatial planning and flood hazard zoning based on intensity of flood;

- Sub-strategy FR 1.4: Improvement of Flood Early Warning System services (both basin and hotspot wise); and
- Sub-strategy FR 1.5: Improvement of Drainage .

Strategy FR 2: Equipping the Flood Management and Drainage (FMD) Schemes for the Future

Creating a climate proof Bangladesh implies that the measures are designed to meet current physical and socio-economic conditions, as well as future developments. The country has invested heavily in FCD development over the past 60 years[2], FCD schemes are in urgent need of maintenance and, in selected areas, remodelling to equip them for the future. Future designs need to take into account projections of climate and hydrological change, sea level rise, as well changed land use and, infrastructure and urbanization. Considering present climate change projections, up to 2030, the rapidly changing socio economic conditions are more important. Beyond 2030, however, and depending on which scenario actually unfolds, climate change may have a notable impact. How the future unfolds is inherently uncertain and investing in measures that could be rapidly outdated due to changing conditions needs to be avoided. At the same time, over-dimensioning of structures- which later turn out to be unnecessary lead to a waste of scarce resources. Flexible measures that are efficient under a range of boundary conditions are therefore most attractive. These are no-regret measures. This is where the Delta scenarios including climate change, sea level rise and socio-economic development, come into play to assess the robustness of different strategies and measures. At the same time constraints inflicted by development activities of upstream countries will have to be recognized along with the issues and challenges of land accretion and land losses from river course changes. Sub-strategies include:

- Sub-strategy FR 2.1: Management of 'submerged char' before taking any initiative for flood management and river flow management;
- Sub-strategy FR 2.2: Drainage improvement inside FMDI schemes;
- Sub-strategy FR 2.3: Restoration of water bodies and connectivity among and between FMDI schemes;
- Sub-strategy FR 2.4: Restoration, redesign and modification of embankments and structures (where necessary); and
- Sub-strategy FR 2.5: River management, excavation and smart dredging preceded by appropriate feasibility study.

Strategy FR 3: Safeguarding Livelihoods of Vulnerable Communities

In addition to protecting economic strongholds, there is an obligation to provide safety and to support economic resilience of vulnerable regions and

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1 *Flood and Riverbank Erosion Risk Management Investment Program (ADB funded)*

2 *The BDP 2100 Baseline Study on "Water Resources" and "Sixty Years of Water Resource Development in Bangladesh".*

communities in the country. This is in line with the principle of 'leaving no-one behind'. This type of 'protection' is not aimed at avoiding floods and creating a flood free Bangladesh for all. Given the current level of economic development, this is not feasible within the coming decades. Considering the extreme natural and socio-economic boundary conditions and inability to ensure adequate O&M of flood protection infrastructure in remote and poor areas, it is not a desirable goal in the medium term. 'Leaving no one behind' merely means: i) mitigating the most undesired effects of large and extreme floods; and ii) enabling those who are affected by floods to recover quickly in the aftermath of the flood events. Sub-strategies include:

- Sub-strategy FR 3.1: Management of rivers and embankments with provision of fastest drainage of water during monsoon and flood;
- Sub-strategy FR 3.2: Improved river management and better O&M of FMD schemes;
- Sub-strategy FR 3.3: Extension and improvement of multipurpose cyclone shelters and its services along with emergency services;
- Sub-strategy FR 3.4: Development of flood proof water supply and improved drainage system;
- Sub-strategy FR 3.5: Flood and storm surge proofing of housing and other critical infrastructure supported by quick emergency services;
- Sub-strategy FR 3.6: Social safety net and enhancement of rapid response recovery packages;
- Sub-strategy FR 3.7: River management as well as improved flood management, drainage, O&M and flow management; and
- Sub-strategy FR 3.8: Protection of Chars and its population along with alternative livelihood arrangements.

Fresh Water (FW) Strategies

Strategy FW 1: Ensure Water Availability by Balancing Supply and Demand for Sustainable and Inclusive Growth

The freshwater strategy is aimed to ensure water availability by balancing supply and demand for sustainable and inclusive growth. The cross-boundary issues become important here. Sub-strategies include:

- Sub-strategy FW 1.1: Ensure optimum water resource management in the country following basin wide management along with construction of necessary embankments;
- Sub-strategy FW 1.2: New irrigation schemes for the major rivers of the country;
- Sub-strategy FW 1.3: Excavation of local water reservoirs (canals, ponds and baors) for restoration of water and rain water harvesting;
- Sub-strategy FW 1.4: Construction of Rubber dam preceded by appropriate

feasibility study;

- Sub-strategy FW 1.5: Enhancement of freshwater flows in urban and regional rivers;
- Sub-strategy FW 1.6: restoration of natural reservoir and water bodies along with their biodiversity conservation;
- Sub-strategy FW 1.7: Preserving ground water level by restriction on excessive extraction of ground water; and
- Sub-strategy FW 1.8: Increase the fresh water flow in urban and rural rivers and control of river pollution .

Construction of the Padma Barrage with proper feasibility has been suggested as a major activity under this strategy. Optimum uses of water of the Padma during dry season would be possible after construction of this barrage. This will ensure availability of water for irrigation in coastal zone and Barind and Drought prone areas in one hand and increase the flow of fresh water in the rivers of these areas in other hand. Overall, the production of agriculture and fisheries will substantially increase and salinity will be decreased in this area. Moreover, emphasis has been given on the conservation of natural water bodies, excavation and re-excavation of ponds and canals, rain water harvesting and re-establishing connectivity of canals with rives as effective means of increasing the availability of fresh water during dry season.

Strategy FW 2: Maintaining Water Quality for Health, Livelihoods and Ecosystems

This strategy is based on the second objective "water quality" of the freshwater strategy. Water quality is a growing concern for the country, with many rivers and wetlands at serious environmental risk. To ensure healthy lives, livelihood and ecosystem of Bangladesh, the quality of water needs to maintain according to rules and regulation. Sub-strategy includes:

- Sub-strategy FW 2.1: Appropriate waste management and reduction of pollution in urban and rural areas;
- Sub-strategy FW 2.2: Monitoring and control of pollution; and
- Sub-strategy FW 2.3: Action research for improved ecosystem services.

Hotspot Specific Strategies

1) Coastal Zone

The Coastal Zone of Bangladesh will remain hazardous for coastal floods in the foreseeable future. Cyclones and accompanying storm-surges will continue to develop in the Bay of Bengal, as well as high river discharges and monsoon precipitation will continuously put an enormous pressure on the drainage capacity of the Coastal Delta. Besides, possible future changes in discharge regimes or sea level rise, the Coastal Zone will be under increasing pressure of socio-economic change, with economic development and

demographic changes as main drivers. Strategies include:

- Combating storm surge and salinity intrusion through effective management of existing polders;
- Increase drainage capacity and reduce flood risks;
- Balancing water supply and demand for sustainable growth;
- Reclaim New Land in the Coastal Zone;
- Sundarbans Conservation; and
- Restoration of dead/low flowing rivers and basin wide management of cross boundary rivers for increasing supply of fresh water.

Tidal River Management (TRM)

TRM is an effective strategy for reducing water-logging, increasing river navigability and reclaiming land. In BDP 2100, it has been recommended to gain efficiency in TRM as well as its expansion to address these problems of coastal zone.

2) Barind and Drought Prone Areas

The Barind and Drought prone areas Hotspot was selected as representative for the drought – or freshwater availability - issue in the country. To support the Delta goals in the Barind and Drought Prone (DP) areas Hotspot and enhance on-going development activities, strategies include:

- Balancing supply and demand for sustainable and inclusive growth ;
- Management of cross-boundary water issues including river basin developments;
- Minimising losses due to floods and drainage congestion;
- Ensuring water supply and sanitation; and
- Encouraging excavation of ponds and digging well to retain rain water.

3) Haor and Flash Flood Areas

The haor basin has been identified as one of the food insecure regions of the country with both opportunities and constraints for the inhabitants. Due to longer period of annual flooding a single crop (rice) can be grown resulting in food insecurity. Strategies include:

- Protect agriculture and vulnerable communities from floods;
- Achieving fresh water security;
- Management of River and water resources;
- Sustainable management of haor ecosystem and biodiversity; and
- Integrated land and water resources management.

4) Chattogram Hill Tracts

In the hotspot 'Chattogram Hill tracts', both the hills and related coastal plains are considered, as problems experienced in the hills, like landslides, are related to coastal plain problems like sedimentation and recurrent dredging. Importantly, while for the larger rivers in Bangladesh much of the catchment is outside the country, in the Eastern Hill area most of the catchments of the important rivers is within the country's borders, offering excellent conditions for integrated river basin management and opportunities to address problems holistically. Strategies include:

- Protect economic zones and towns from floods and storm surges;
- Ensure water security and sustainable sanitation;
- Ensure integrated river management;
- Maintain ecological balance and values (assets); and
- Develop multi-purpose resources management system for sustainable growth .

5) River Systems and Estuaries

The Major Rivers of Bangladesh are the backbone of the delta system and therefore play a central role in the BDP 2100. A long term strategy for these rivers therefore has national importance. Many of the water-related challenges in Bangladesh are related to the dynamic mighty rivers. Strategies include:

- Provide adequate room for the river and infrastructure to reduce flood risk;
- Improvement of the conveyance capacity as well as stabilize the rivers;
- Provide fresh water of sufficient quantity and quality;
- Maintain ecological balance and values (assets) of the rivers;
- Allow safe and reliable waterway transport in the river system;
- Developing strategy for sediment management including a strong capital dredging and maintenance programme;
- Strengthening river and estuaries management in the newly accredited lands;
- Necessary arrangements for capital and maintenance dredging in important rivers such as the Padma, Meghna, Jamuna, Brahmaputra, Dharala, Arial Khan, Kushiyara, Gorai, Monu, etc;
- Appropriate and effective measures for salinity management for the rivers in the southern zone during dry season; and
- Formulating policy/guidelines for proper management of 'Balu Mohal', dredged materials/soils.

6) Urban Areas

The country's current urban centres will continue their growth in the coming decades under the influence of rural-urban migration and by 2045 the majority of the population will live in cities. Although the focus is on the water-related issues in this strategy, it is important to consider the wider context and challenges that face urban areas now and in the future. More general urban planning issues, such as uncontrolled urban growth and haphazard development have a close connection to water-related issues, like flood risk management. Underlying issues include high population density and various socio-economic and political factors that are responsible for the currently challenged state of urban service delivery. The impact and effectiveness of the strategies in dealing with water-related and more general urbanization issues have been considered. Strategies include:

- Increase drainage capacity and reduce flood risk and waterlogging at in urban areas;
- Enhance water security and water use efficiency in the urban areas;
- Regulate and monitor river and other water body pollution from industries and human sources;
- Conserve and preserve urban wetlands and ecosystems and promote their wise-use;
- Develop effective urban institutions and governance;
- Integrated and sustainable use of urban land and water resources;
- Improved urban services: water supply, sanitation, wastewater and solid waste management. Place special emphasis on management of disposal of medical, electronic and other hazardous waste/materials; and
- Control and monitoring of water pollution caused by industry and other sources.

Strategies for Cross-Cutting Issues

1) Sustainable Land Use and Spatial Planning

Planning, managing and developing strategies for land resources are integral parts of BDP 2100. Land use strategy encompasses natural areas for agriculture, forests and watercourses as well as areas for urban and industrial needs. The utilization of land includes both for agricultural and non-agricultural land use, for which making spatial planning an integral part of land use management will be important. Strategies include:

- Develop effective policy guidelines and rules for the Balu Mahal and sediment management;
- Preserve/conserve agricultural land from floods or erosion to sustain food grain production;
- Prevention of salinity intrusion and desertification;

- Management of newly accreted land in the Meghna Estuary;
- Sustainable coastal land management for enhancing agriculture and non-agriculture land;
- Development of Digital Land Resource Management System;
- Reviewing and updating/enactment of Laws/Regulations relating to Alluvion and Diluvion to improve efficiency of land administration of accreting and reclaimed land;
- Formulation of necessary laws and acts to form Land Zoning;
- Increase climate change adaptation capacity for land management;
- Spatial land use planning for urbanization;
- Optimization of Land Use;
- Formulation of Spatial Planning and Land Resource Management Act;
- Enhance afforestation and plantation in the coastal zone for stabilizing land;
- Restoration and protection of soil health, erosion and land loss; and
- Integrated management of coastal water infrastructures to protect land .

2) Agriculture, Food Security, Nutrition and Livelihoods

Agriculture is likely to bear the main brunt of output losses due to climate change impacts and natural disasters. By 2100, climate change could impose costs on the Bangladesh economy that could be significantly higher than the estimated global average loss. Strategies include:

- Increasing resilience of agricultural production systems;
- Diversification in agricultural output and livelihoods;
- Lower emissions (GHGs) from agricultural land;
- Encourage establishing commercial farms;
- Introduction of Aquaponics farming system to culture fish and plants together;
- Using Nanotechnology in agriculture for processing, distribution and packaging;
- Introduce precision agriculture model ;
- Encouraging solar power in irrigation;
- Improved farm practices and technologies for mediating negative impacts of Climate Change;
- Preservation of ecosystems for plant, wild animals, fishes, birds, etc. and encourage fruit tree plantation;
- Improve Wetland Management in Haor Areas for development of fisheries;
- Maintaining biodiversity to ensure long term fish availability;
- Sustainable marine fisheries resources management ; and
- Production of climate resilient Livestock;

3) Transboundary Water Management

Being within the central position of the Ganges- the Brahmaputra- the Meghna basins and the recipient of substantial amount of trans-transboundary flows from several neighbouring countries, cooperation regarding water resources management with India, Nepal, Bhutan, Myanmar and China is essential for Bangladesh to foster further development. Closer cooperation has to be ensured with neighbouring countries in view of the general understanding that joint cooperation outweighs individual development. Strategies include:

- Development of action plan keeping the water usage of upstream countries in consideration;
- Selection of prospective sites for the construction of embankments considering the water flow from upstream and with understanding and cooperation from upstream countries;
- Multi-track water diplomacy to prevent or peacefully resolve conflicts;
- Continuing efforts for signing of Treaty regarding the sharing of water for the Teesta and all other transboundary rivers;
- Demand based common river basin management schemes have to be initiated;
- Third party involvement (multilateral or bilateral development partner or country) to resolve transboundary water related issues; and
- Improved basin-wide flood forecasting .

4) Dynamizing Inland Water Transport System

Bangladesh is crisscrossed by a network of about 24,000 km. of rivers, streams and canals, constituting 7% of the country's surface. Being a land of rivers it always enjoyed the natural advantage of inland navigation. Strategies for inland waterway sector include:

- Regular dredging activities for maintaining flow and transport in the rivers;
- Develop reliable water system conditions for long term sustainable IWT through the capital and maintenance dredging of the rivers Padma, Meghna, Jamuna, Brahmaputra, Dharla, Arial khan, Kushiyara, Gorai, and Manu;
- Regular dredging should also be considered for Ghashiakhali and other channels in the Sundarbans;
- Ensure efficient and equitable use of sand through the regular shifting of the 'Balu-mahal' (sand quarry). The local administration should take necessary steps accordingly. Specific guidelines should be developed for the management of soil/sediment resultant from dredging ;
- BIWTA to cooperate and coordinate with BWDB to provide optimal levels of surface water for navigation;

- Develop the navigation network according to the societal and economic demands;
- Develop, maintain & operate inland river ports, landing ferry ghats and terminal facilities in ports or ghats;
- Contribute to dealing with trans-boundary water aspects by ;developing mutual understanding and cooperation;
- Development of riverine and maritime ports ; and
- Initiatives for activating transboundary waterways .

5) Advancing the Blue Economy

With the settlement of maritime border disputes with neighbouring states Myanmar and India in 2014, the Government of Bangladesh embarked on to unlock the potentials. The blue economy is now considered as a new 'development space' in Bangladesh. Shipping, coastal shipping, sea ports, ship building and recycling, marine fisheries, sea salt, coastal tourism, ocean energy, land reclamation, maritime surveillance, human resources development and governance have been identified as key priority sectors. A total of sixteen different approaches have been proposed. Out of those regional partnerships in developing the blue economy is ranked high on that agenda. Moreover, different MoUs have also been signed with India. Strategies for Blue Economy include:

- Quick completion of multidimensional survey of marine resources;
- Increase the number of sea going vessels and modernization and capacity building of the sea ports;
- Increase both shallow and deep sea fishing;
- Introduction of eco-tourism and private sector initiatives in sea cruise; and
- Keeping the coasts and sea port pollution free.

6) Renewable Energy

Bangladesh is expected to have enormous potentiality in renewable energy development: Solar, Wind Energy, Biomass and Hydropower. Strategies include:

- Develop long term renewable energy policy as well as strategies and formulate a master plan for at least 50 years to harness the potential of renewable energy resources in the country involving public and private sector investments ;
- Promote research on the development of technology in the field of renewable energy in universities and research institutions as well as build capacity for its application;

- Enhance Green Growth through research and development of renewable technologies including clean development mechanism (CDM);
- Devise innovative financing packages for grant funding and low interest financing to address affordability for both grid and off-grid renewable energy projects; and
- Target for at least 30% energy production from renewable sources by 2041 in the context of being a prosperous country .

7) Earthquakes

Bangladesh and the north eastern part of India states have long been one of the seismically active regions of the world, and have experienced numerous large earthquakes during the past 200 years. Strategies include:

- Strengthen earthquake management and enhance the capacity to cope with earthquakes ;
- Design earthquake-proof structures including barrages, regulators, sluices, embankments, cross-dams, roads, bridges, buildings in conformity with the Bangladesh National Building codes or any other approved standards ;
- Formulate a proper land use plan for building construction in municipal areas ; and
- Conduct a detailed study on identification of faults and epicentres .

H. Macroeconomic Scenarios

The macroeconomic framework for BDP 2100 is the first attempt to quantify economic impacts of climate change by linking the real side (i.e. economic variables) to the environment or climate change parameters. The policy scenarios are built around three endogenous variables: economic growth, employment and poverty; two exogenous variables: natural hazards and climate change; and a large number of policy variables including: population and labor force, investment (public, private and total); sectoral investments including investments needed to offset the various climate change risks; macroeconomic policies; transboundary water dialogues; and institutional reforms and good governance. The scenarios are interactive in the sense that they allow for the interaction of endogenous variables with exogenous and policy variables. As a result, the model helps answer the all important policy question: what happens if the BDP 2100 is not adopted?

In order to illustrate the role of BDP 2100 and its contribution to the long term development of Bangladesh, two scenarios based on selected policy options

are considered.

- The First Option refers to the Business As Usual Policy Option (BAU). This is essentially a representation of the government's Vision 2021, Perspective Plan and the Seventh Five Year Plan. But importantly it directly incorporates the adverse effects of the climate change and natural hazards to show how these adverse effects will change the outcomes with respect to growth, employment and poverty without the adoption of the BDP 2100. All policies are in place except the implementation of the Delta Plan. This is the business as usual policy environment of the present times where a coordinated effort to manage the delta risks and hazards does not exist.
- The Second Option is the Delta Plan (DP) Policy Option, which is the combination of the BAU with the adoption of the BDP 2100. Thus, this scenario incorporates the adoption of strong climate change and other delta related adaptation measures to achieve higher and sustainable growth trajectories in the face of the various weather-related natural hazards and risks.

The results are very striking. Under the BAU Policy Option, the GDP growth rate starts falling over time as the adverse effects of climate change and natural hazards gain momentum. The efficiency of capital falls. Outmigration to cities from vulnerable districts increases, adding to the urbanization pressures. Agriculture productivity falls. Land degradation and lower land productivity reduce land availability and increase land prices. Availability of urban land falls in relation to demand as growing urbanization from outmigration creates additional pressure on urban land. Cost of urban production increases as flooding and drainage problems damage urban properties and enterprises and create infrastructure problems. Urban water shortages, water quality and sanitation risks add to health costs and reduce quality of life. The net effect is an annual average GDP loss of about 1.1% between FY2017-41 as compared with the government's target to achieve and maintain 9% average GDP growth until FY2041. Most importantly, in this scenario Bangladesh is unable to reach upper middle income status and eliminate extreme poverty by 2030.

In contrast to the BAU option, under the DP Policy Option that incorporates the adoption of the BDP 2100 the negative effects of climate change and natural hazards are considerably reduced. This allows the Bangladesh economy to avoid a disruption of the growth effort and secure an average GDP growth rate of about 9%. Based on higher GDP growth rate including the avoidance of loss of agricltural income and rural livelihoods, Bangladesh secures the development objectives of eliminating extreme poverty and reaching upper middle income status by 2030.

Under the BAU option, the inclusion of environmental risks and subsequent loss in income causes substantial losses compared to the baseline. GDP

growth goes on a downward slide, falling from around 7.2% in FY2017 to only 5.6% by FY2041. Owing to loss of capital stock and outputs in climate sensitive sectors, per capita nominal income would reach only US$ 10,540 in FY 2041, which would be US$ 3,837 lower than the DP scenario of US$ 14,377. On average, there is a loss of 1.3% of real GDP per year in this scenario over the government's target of achieving 9% GDP growth rate, which adds up to a cumulative loss of US$ 741 billion of income by FY 2041. This lower GDP growth and income levels have significant welfare consequences in terms of employment and poverty outcomes. Importantly, Bangladesh misses out on both UMIC and poverty targets in the BAU but achieves them in the DP Policy Option. The importance of adopting the BDP 2100 is obvious.

I. Investment Cost of the BDP 2100 and Financing Options

Need for Investment

The macroeconomic and sectoral costs of not implementing BDP 2100 can be substantial. At the macroeconomic level, under moderate climate change conditions, the costs can be as large as 1.3% lower rate of growth of GDP per year through the loss of physical assets and economic activities. Others costs will be in terms of health risks and loss of bio-diversity. The costs would be commensurately higher under a worst-case climate change environment. The implementation of BDP 2100 involves sectoral strategies for water, environment, land, agriculture (forestry, livestock and fisheries) as well as new policies, institutional reforms and investments. These Delta policies, investments and institutional reforms in the delta related sectors are additional to the investments, macroeconomic policies and economy wide governance changes associated with the government's Seventh Five Year Plan and their intensification in the context of the government's pursuit of an 8% growth strategy.

The implementation of the BDP 2100 involves total spending on delta-related interventions, through new projects and maintenance of new and old projects, in an amount of about 2.5% of GDP per annum. This compares with an annual spending of a mere 0.8% of GDP presently. In current prices and using the prevailing GDP, total required spending on BDP 2100 related projects would need to grow from the pre-BDP 2100 spending levels of about US$ 1.8 billion in FY2016 to about US$ 3.5 billion in FY2017 and will increase to US$ 29.6 billion by FY2031.

The BDP 2100 envisages that out of the total required 2.5% of GDP, some 0.5% of GDP could be funded by the private sector under various initiatives discussed below and about 2% of GDP would need to be executed through the public sector. Out of this 2% of GDP financed from the budget, about 0.5% of GDP would need to be spent on O&M activities and the remaining 1.5% of GDP should come under the BDP 2100 IP. It may be noted that at present O&M is very much neglected and the actual amount may not even be more than 0.1% of GDP. The practice of not maintaining delta related investment has led to rapid deterioration in the efficiency of water infrastructure and leading to

complete rebuilding of the same at much higher costs.

Investment Priorities

The list of investment priorities identified in the BDP 2100 is extensive. Additionally, implementation capacity constraints will limit the ability to design, prepare and implement large projects. So, priorities will have to be set. It is important to note that BDP 2100 projects are not just physical investments. There is major research, knowledge and institutional gaps that will require complementary capacity building investments.

Much of the public funding of BDP 2100 will need go to flood protection, river erosion control, river management including river training and navigability, urban and rural water supply and waste management, and urban flood control and drainage. These are highly capital intensive investments. Investments in flood control, river erosion, river management including dredging, training and navigability are amongst the highest priority investments in today's Bangladesh and will likely absorb 35% of total Delta investments. Secondly, the back-log of investments in urban water supply, sanitation, waste management and drainage in major cities coupled with rapidly growing concentration of population and economic density in these areas suggest that this category will absorb at least 25% of all delta investments. Thirdly, the lack of water and sanitation services in small towns and rural areas suggest that the need to achieve the government's targets for safe water supply and sanitation for these areas will call for massive investments in these services. This category may absorb as much as 20% of total BDP 2100 investment up to FY2031.

BDP 2100 Investment Plan (IP)

The Investment Plan consists of a total of 80 projects: 65 are physical projects, and 15 are institutional and knowledge development projects at the first phase up to 2030. Its total capital investment cost is BDT 2,978 billion (US$37 billion). All projects can be started within the next eight years, though given the scale and programmatic nature of some investments, construction in some cases will extend over decades.

Development of the Investment Plan followed a rigorous, consultative, and inclusive process, using the principles of ADM. As part of the BDP 2100 formulation process, the General Economics Division (GED) of the Planning Commission requested more than 20 agencies involved in work in the Delta to submit their priority investment projects. This generated 133 candidate projects with total capital costs of BDT 3,753 billion (US$47 billion). The candidate projects were screened, grouped, then sequenced following an ADM methodology. Candidate projects were included in the Investment GEDif their expected benefits exceed expected costs; if they contribute to at least one of the six BDP 2100 goals; and if they are compatible with the ADM approach. Of the 133 candidate projects, 80 met these criteria.

Public Sector Financing Options

As noted, presently the government spends about 0.8% of GDP on BDP 2100

related programmes, whereas the needs are estimated at around 2% of GDP. Finding an additional 1.2% of GDP for public financing of the BDP 2100 will not be easy. Even with optimistic assumptions about domestic resource mobilization incorporated in the Seventh Five Year Plan and the BDP 2100 macroeconomic framework, some creative efforts will be needed. The public funding of the IP is a part of the overall public investment programme for the national development strategy discussed in detail under various Scenarios. The IP is associated with the BDP 2100 Scenarios. The strategy for public funding is some combination of tax financing, application of cost recovery based on beneficiary pays principle and mobilizing foreign funding including tapping into the global Green Climate Fund (GCF) initiative. The fiscal policy strategy of the BDP 2100 also outlines the strategy for fiscal deficit and associated domestic and external borrowing strategies that are consistent with internal and external stability. International best practices in Delta management shows the strong role of the application of the beneficiary pays principle in financing water related investments.

For example, in the Dutch Delta much of the funding of flood control, irrigation, water supply, sanitation and waste management investments is financed through the application of the beneficiary pays principle. The O&M is fully funded through cost recovery and water management is heavily decentralized. Some 80% of water spending including 100% of O&M is done by lower levels of government. The bulk of this spending is done by the local water management bodies that are managed and run as private cooperative enterprises with 100% application of the beneficiary pays principle, with some degree of cross-subsidies to the recognized poorer communities.

There is ample scope for application of the beneficiary pays principle in Bangladesh Delta management. In Bangladesh, O&M funding of urban water and sanitation is prevalent in significant ways. But full cost recovery of O&M is not prevalent. Moreover, the cost recovery of O&M of waste management is negligible. By default, there is no cost recovery of capital cost of urban water supply, sanitation and waste management. Regarding flood control and irrigation, there is no cost recovery of either capital cost or O&M. This is to some extent due to the absence of local water management bodies. Once these institutions are created under the proposed Delta Act, the application of beneficiary pays principle will become a reality. Regarding urban water and sanitation, the institutions and regulations are in place. They need to be applied more rigorously. A time bound policy should be adopted whereby all public urban water and sanitation services must be required to gradually recover 100% of the O&M cost. Over time, consideration may be given to recovering capital costs, starting with the relatively well-off service areas of the 4 WASAs (Dhaka, Chattogram, Khulna and Rajshahi). Regarding solid waste, cost recovery can happen through an annual service charge linked with the setting up of a modern property tax system. The GCF, which was established with the objective to mobilize climate finance to support scaled-up mitigation and adaptation action in developing countries, would be an important source of funding projects of BDP 2100.

Bangladesh has had significant success in using its public sector intermediaries to incentivize the private sector, particularly in the renewable energy industry. As such, it is well placed to tap this important source of grant funding to scale up delta investments. While a lot more needs to be done to ensure private enterprises fulfil their crucial role in the fight against climate change, if Bangladesh can pursue her case effectively, there is bright possibility that Bangladesh may receive fund as large as US$ 2 billion per year from the GCF.

Private Sector Financing Options

Effective engagement of the private sector will generate sizable resources. The BDP 2100 projections suggest that on an average Bangladesh should be able to mobilize at least 0.5% GDP per year from private sector to finance projects of water resource management and related infrastructure. International experience shows that the prospects for attracting private investments in water treatment, water supply and sewage treatment are excellent. Another prospective area is irrigation. A third area is dredging. There is strong private sector interest in undertaking dredging contracts. The cost of dredging may be significantly offset by the sale proceeds from sand, making dredging costs quite low. However, there are a number of important technical factors and risk sharing issues that need careful management. Bangladesh can learn from international best practices in developing the proper contracting arrangements for dredging. A fourth area for PPP is land reclamation. Combining land reclamation with dredging of rivers in a PPP concession framework would be attractive for the private sector. Finally, PPP initiative is also possible in establishing river port infrastructure for IWT.

J. Governance and Institutions

Sound implementation of public policies and programmes depends upon the prevailing governance environment and underlying institutional arrangements. These requirements gain added significance when policies and programmes are cross-sectoral in nature and involve multiple line agencies. The BDP 2100 agenda is essentially cross-sectoral and implementation arrangements involve multiple line ministries, local government institutions, communities and private sector. Clarity of role, interdependence of actions and a coordinated approach are essential requirements of the institutional set up for BDP 2100 implementation. The stakes are large and so are the resource requirements. Yet, resources are limited and there are competing demands. How resources are allocated among competing demands, how trade-offs are made and how effectively programmes are implemented to get the best results from limited resources are major political economy issues that depend critically upon the prevailing governance environment.

Globally there are many other delta experiences and Bangladesh can learn from these experiences with a view to avoiding their mistakes and adapting the positive experiences to the Bangladesh situation. Importantly, Bangladesh itself has a long experience in dealing with the delta issues and challenges. A solid review of these experiences, identifying areas of success

and areas where there are major gaps can provide useful lessons for building the institutional arrangements for the implementation of the BDP 2100.

Institutions are dynamic in the sense that they evolve over time. Starting with a thoughtful design that involves pragmatic solutions based on the present socio-political realities of Bangladesh and working within the umbrella of the overall capacity constraints in public administration, institutional changes can further evolve as implementation progresses. The immediate challenge is to develop a basic minimum core arrangement now without which the implementation of the BDP 2100 will falter. GED will look after and coordinate implementation of the Bangladesh Delta Plan 2100 as a holistic, techno-economic mega plan.

Governance Issues and Challenges for Bangladesh Water Resources Management

Bangladesh has a long history of water management with adoption of water policies, regulations and institutions partly in response to water-related natural hazards. Nevertheless, the main focus of water management has been the protection of agriculture. This is understandable in view of the dominant role of agriculture for food security and livelihood for the poor. One negative consequence of this primal focus has been the less attention to issues emerging from climate change, river transport, urban water supply and drainage including pollution of rivers and other water bodies. These later issues have now gained added significance in the context of integrated delta management. The legal framework for water management is provided by the Water Act 2013, which is comprehensive and covers all aspects of water management as an integrated resource. According to the act, the main objective is to "make provisions for integrated development, management, abstraction, distribution, use, protection and conservation of water resources". Since the act is of recent origin, the associated regulatory policies and institutions have not fully taken shape. But, the act provides a strong basis for moving forward. The Water Act 2013 currently operates through the use of a number of operating principles defined by the National Water Policy of 1999 and the National Water Resource Management Plan of 2001(adopted in 2004).

Successive governments have engaged in detailed technical studies with international technical experts, but implementation has suffered owing to political, financing and institutional constraints. A key challenge is the absence of local water management bodies and therefore the absence of key-stakeholders (beneficiaries) in related decision making. A third problem is the lack of integration of water issues with climate change, environment, land management and other delta-related challenges owing to inadequate institutional coordination.

Institutional Reforms for the BDP 2100

Moving forward, the implementation of the BDP 2100 will require institutional

reforms focused on three core objectives:

- Establishing effective institutions of inter-sectoral planning, rogramming, coordination and monitoring;

- Incorporating issues of climate change, environment, bio-diversity, agriculture, fisheries, forestry, inland water transport and land management and their interaction with water to develop a comprehensive view of the delta issues and challenges; and

- Converting each of the related institutions of water, climate change and environment management, agriculture and land management, and inland water transport management into strong institutions with adequate technical skills in the areas of economic management, financing, institution building, monitoring and evaluation and knowledge management.

Key elements of the governance and institutions under the BDP 2100

Coordination and facilitation of BDP 2100 Implementation: The government has agreed to assign General Economics Division (GED) the responsibility of overall coordination, facilitation, M&E of BDP 2100 implementation. Institutional capacity of GED needs to be enhanced for carrying out these tasks in an integrated and holistic manner for which a well-structured wing will be created. The 'Delta Governance Council (DGC)' is proposed as a small but high-level inter-ministerial forum chaired by Hon'ble Prime Minister. DGC is proposed as a supervising and guiding entity and the Planning Minister would be the Vice-Chair. The DGC would function as a formal linkage for achieving political commitments regarding BDP 2100, provide directions and makes decisions. It would provide strategic advice and policy guidelines.

To facilitate specific project/ programme selection for inclusion in the Delta Plan Investment Programme, a second coordinating committee named as Delta Plan Project/ Programme Selection Committee (PPSC) would be established with Member, GED in chair and comprising of representatives of Finance, Planning, Water, Environment and Forestry, Agriculture, Land, ivestock and Fisheries and Shipping. General Economics Division would manage planning and research, coordinate and facilitate the implementation of the BDP 2100 including selection of its investment plan, monitor Delta Plan implementation and update the Delta Plan. Actual implementation of BDP 2100 approved programmes and projects would be undertaken by related

ministries and implementing agencies.

Bangladesh Delta Fund: Bangladesh presently spends about 0.8% of GDP for water resources, mostly for new investments, which will increase gradually up to 2.5% by 2030. Given limited resources and the need for a coordinated and integrated approach to delta spending, Delta Fund would be initiated

with the consolidation of current ADP spending of 0.8% of GDP. The delta spending programme will be prepared and updated on an annual basis by GED and will include investments, O&M funding, research, capacity building and institutional development.

Approved programmes will be guaranteed funding for the full life of the project and proper balance between new projects and completion of ongoing projects will be ensured. O&M fund will initially come from the Delta Fund but over time it will be phased away by transferring responsibilities to the municipalities and the local water management bodies. Similarly, over time the Delta Fund will manage only a small number of national high priority projects, innovation and research. The financing of smaller projects will transfer to municipalities and local water management authorities with quality assurance on standards and inspection functions performed at the national level.

Local Water Management Bodies: The missing water institution in Bangladesh is the representation in decision making of beneficiary stakeholders linked with coastal management, river management, fresh water wetlands (haors and baors) management, large irrigation schemes and flood control. Establishment of this missing link in water management is an essential reform for successful management of the BDP 2100. These water management bodies fundamentally must represent the stakeholders and not government interests. The water management bodies should be established based on a careful review of international experiences, analysis of the past approaches to establishing water user's association in Bangladesh and the reasons for their failure, and doing additional stakeholder consultations.

Strengthening Core Delta Institutions: It is imperative to strengthen the core delta institutions for the BDP 2100 to succeed and also for the effective implementation of the Delta Plan itself. This is a tough challenge and involves long term effort. Yet some core institutions require mediate attention. These include: GED, BWDB, WARPO, DOE, DOF, DAE, LGED, FD, DBHW, etc., the municipalities (City Corporations and Pourashavas), the WASAs, the newly constituted local water management bodies and all specialized institutions within different non-water delta line ministries (specialized institutions working on delta-related issues in the ministries of agriculture, disaster management and relief, shipping and inland water, local government, environment, forests and climate change and livestock and fisheries). The Ministry of Water Resources is the primary water management institution in the country. Its work is supported by a number of specialized agencies including the two core institutions: BWDB and WARPO. Both institutions need considerable strengthening in terms of new technology, innovation, integrated planning, research, economic management and consultative processes. BWDB will also need to help out with the establishment of the

local water management bodies and learn to work with them collegially as a complementary institution rather than as a competing institution. The evolution of decentralized water management will face major challenges and will have obvious teething problems. GED, WARPO and BWDB can make this process smoother and less costly through proper support and coordination.

Strengthening Cross-boundary Dialogue and Related Institutions: As a lower riparian, Bangladesh faces some real risks from adverse developments upstream. The ability to think innovatively requires both diplomacy and technical skills. These skills are required to come up with well thought out and multi-purpose river basin projects. Accordingly, the capacity of the Joint Rivers Commission (JRC) will have to be considerably strengthened. Partnership and coordination of JRC with GED, WARPO, BWDB and other related institutions will need to be strengthened. Possible multi-purpose technical options and cost-benefit analyses of these options will need to be developed as background research to dialogue with riparian countries. Routine dialogue involving exchange of pleasantries and general purpose concerns/complaints and information sharing must give way to strategic dialogue aimed at problem solving and finding solutions. Satisfactory progress with cross-boundary water management is a sine-qua-non for successful implementation of the BDP 2100. Positive results on this count will have far-reaching consequences including lower-cost water solutions for Bangladesh. The priority assigned to this task should be as high as priority given to large water infrastructure projects.

Creating a Delta Knowledge Bank: Creation of a delta knowledge bank is an essential pre-requisite for undertaking adaptive delta management. This responsibility will be assigned to GED, who will create a knowledge unit with three main responsibilities:

(a) collate all relevant delta related knowledge globally and nationally into a digitized knowledge library;

(b) establish a delta data bank; and

(c) develop and implement a comprehensive delta knowledge and data updating effort.

As a first step, GED should undertake a quick stock taking of existing knowledge. A summary of the knowledge bank stock should be shared with other delta-related public and private policy and research institutions to develop a knowledge and data upgrading agenda. GED should review this agenda to check for consistency and relevance with the needs of the delta management, especially in the context of doing a sound monitoring and evaluation of the BDP 2100, and develop a 3-5 year data and research work programme with annual targets. Resource requirements should be determined. Following approval by the DGC of the knowledge work programme and budget, implementation may proceed through GED. Data

work can be implemented in conjunction with the Bangladesh Bureau of Statistics and other delta ministries. Research can be out-sourced to universities and local research institutions. GED should be responsible for coordination and oversight.

Developing Monitoring and Evaluation (M&E) System: The practice of conducting M&E of government policies and programmes needs to have a stronger link with Bangladesh policy planning. Water related M&E is no exception. A solid M&E effort is essential for sound implementation of the BDP 2100 in the context of ADM. So far as investment projects are concerned, the M&E is the responsibility of the implementing agencies. Similarly, M&E of sectoral policies and programmes should rest with the concerned sectoral ministry and the IMED. Regarding M&E of the overall BDP 2100 impelentaion, this will be a key responsibility of GED. As in the case of implementation of the knowledge agenda, GED can draw on the technical capabilities of its knowledge partners to help with the BDP 2100 M&E. Needless to say, the M&E for the BDP 2100 will need to be done consultatively, drawing on the analysis of the M&E at the project and sectoral levels and involving all inter-ministerial agencies dealing with delta issues and IMED.

Information and Knowledge Management and Approach : The comprehensive knowledge domains of delta issues as well as the adaptive nature of delta management emphasize the importance of knowledge management and the requirement of an approach. Five elements of the Approach are described below:

(a) Knowledge needs & agenda: The knowledge agenda identifies nine key subjects as burning issues along with the most important research questions.

(b) Knowledge accumulation: A start has been made with the compilation of the 26 Baseline Studies. These studies should be updated and new areas of research identified and implemented based on knowledge gaps.

(c) Knowledge availability: This is ensured through a web-based information portal, gathering geographical data layers, studies, policy documents and other technical reports.

(d) Value realization: This shall be done from delta knowledge once it is put to use in practice. For example, this can be done as input to the 8th Five Year Plan and the preparation of the Climate Atlas, or when related policies need to be informed by available knowledge and scientific findings.

(e) Delta Knowledge Community: This comprises of academics, policy makers, international donors, NGOs and field workers in a community of participants. This Delta Knowledge Community will be able to engage continuously making knowledge available to its stakeholders, enabling them to engage in Adaptive Delta Management.

Reviewing and Updating of BDP 2100: As the BDP 2100 is an adaptive and long term plan, it needs to be integrated with the planning process of the country. It should be periodically and regularly reviewed and incorporated in future Five Year Plans routinely. Moreover, integration with new knowledge and technologies is necessary to enhance the present status of the plan. Its implementation also requires continuous monitoring and evaluation in the future.

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General Economics Division (GED)

Bangladesh Planning Commission

Ministry of Planning

Government of the People's Republic of Bangladesh

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