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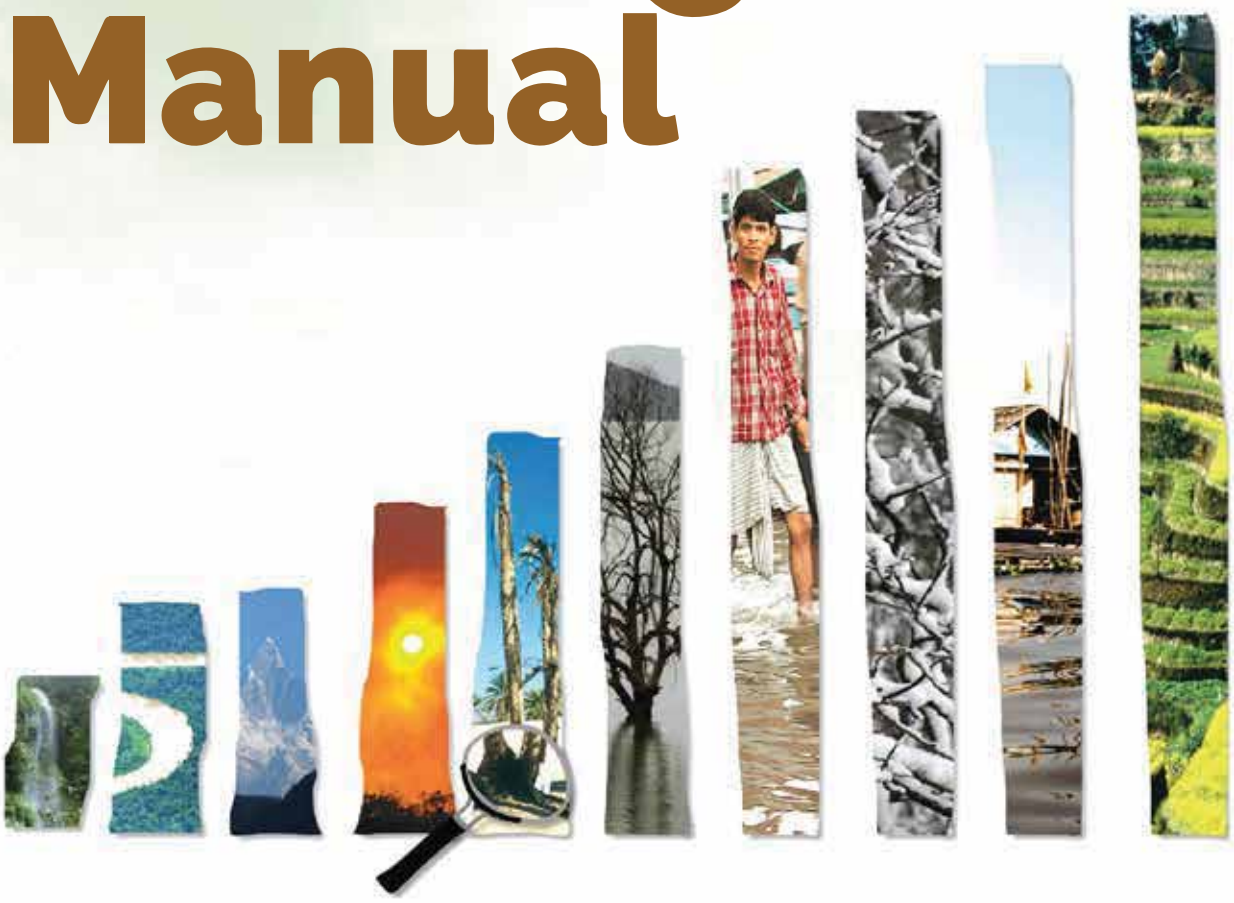
Integrating Climate Change Adaptation into Development Planning of Bangladesh

Training Manual



General Economics Division (GED)
Bangladesh Planning Commission
Ministry of Planning
Government of the People's Republic of Bangladesh
December 2021

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Foreword

Due to its geographical location, Bangladesh is one of the most climate vulnerable countries of the world. Climate change is both an environmental and developmental issue and it permeates all the sectors including development endeavors. Government of Bangladesh is committed to manage climate change in a way that the country is well protected from its adverse impact and the growth path remains stable and moves to a higher trajectory. Adaptation is one of the ways for Bangladesh to respond to climate change alongwith mitigation. The training course 'Integrating Climate Change Adaptation into Development Planning of Bangladesh' has therefore been developed with a view to putting appropriate adaptation strategies and measures in development planning, particularly in development projects of Bangladesh to manage climate change impacts.

This training course has been developed based on an original training course titled 'Integrating Climate Change Adaptation into Development Planning' adopted by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Organisation for Economic Cooperation and Development (OECD). GIZ and OECD developed this training course following a broad range of reviews from development agencies, NGOs and research institutions from around the world. This training course has been customized in the country context using examples and cases from the development field in Bangladesh and information and inputs mostly from the Seventh 5-Year Plan (7FYP), FY2016 – FY2020 of Bangladesh and the Bangladesh Delta Plan 2100, Third National Communication Report, latest IPCC reports and UNFCCC website and resources generated from Centre for Environmental and Geographic Information Services (CEGIS) and Centre for Climate Change and Environmental Research (C3ER), BRAC University.

The design and development process of this training course has been supported by Mr. Md. Mafidul Islam, Project Director of the Adaptation to Climate Change into the National and Local Development Planning project, General Economics Division (GED) of Bangladesh Planning Commission, Mr. Mathias Stumpf and Mr. M. Mahmudur Rahman of GIZ. Two pilot trainings had been conducted prior to designing this Bangladesh specific training course. The participants of these pilot courses have contributed to the development of this training course. The relevant officials from both GED and GIZ have also contributed in editing and formatting this training course. The efforts by all concerned are gratefully acknowledged.

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Abbreviations

7FYP	Seventh 5-Year Plan
ADP	Annual Development Programme
AF	The Adaptation Fund
BBS	Bangladesh Bureau of Statistics
BCCRF	The Bangladesh Climate Change Resilience Fund
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCCTF	Bangladesh Climate Change Trust Fund
BCM	billion m3
BDP	Bangladesh Delta Plan 2100
BTI	Bertelsmann Stiftung Transformation Index
CC	Climate change
CCA	Climate change adaptation
CCM	Climate change mitigation
CDM	Clean Development Mechanism
CDM	clean development mechanism
CETF	climate expenditure tracking framework
CFC	Chlorofluoro carbon
CFF	Climate Fiscal Framework
COP	Conference of the Parties
CTCN	Climate Technology Centre & Network
DA-WS	Department of Agriculture of the West State
DoE	The Department of Environment
DPP	Development Project Proposal
DWASA	Dhaka Water Supply and Sewerage Authority
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FY	Fiscal Year
GCF	The Green Climate Fund
GDP	Gross domestic product
GHG	Greenhouse gas
GoB	Government of Bangladesh

HFC	Hydrofluoro Carbon
HYV	High Yielding Varieties
ICT	Information and Communication Technologies
IMED	Implementation, Monitoring and Evaluation Division
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
M&E	Monitoring and Evaluation
MLD	millions of litres per day
MoEFCC	Ministry of Environment, Forest and Climate Change
MT	Metric ton
MW	Mega watt
NAPA	National Adaptation Programme of Action
NDE	national designated entity
NDP	National Development Plan
ODA	Official Development Assistance
OECD	Organisation of Economic Cooperation and Development
PEI	Poverty Environment Initiative
PRA	Participatory Rural Appraisal
RCP	The Representative Concentration Pathways (RCP
SA	Scientific assessment
SDG	Sustainable Development Goals
SDG	Sustainable Development Goals
SERES	Special Report on Emissions
SPCR	Strategic Programme for Climate Resilience
SSN	Social Safety Net
UNDAF	United Nations Development Assistance Framework
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WASH	Water, Sanitation and Hygiene

GLOSSARY

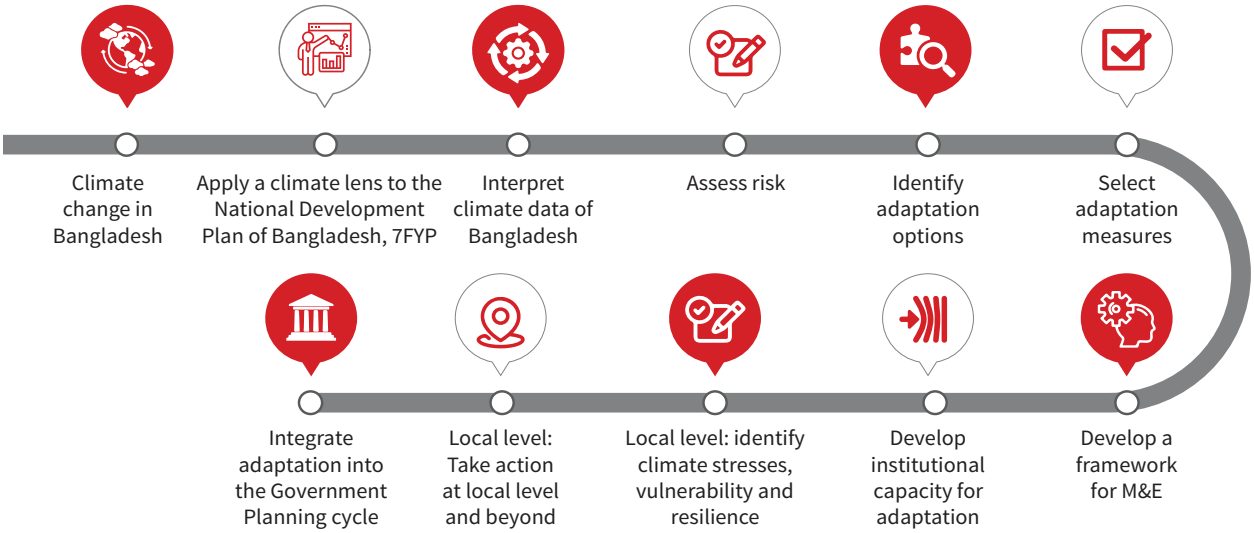
Adaptation	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects. See also Autonomous adaptation, Evolutionary adaptation, and Transformation.
Adaptive capacity	The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.
Adaptive management	A process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables.
Autonomous adaptation	Adaptation in response to experienced climate and its effects, without planning explicitly or consciously focused on addressing climate change. Also referred to as spontaneous adaptation.
Climate change	Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. See also Climate change commitment, Detection and Attribution.
Climate change commitment	Due to the thermal inertia of the ocean and slow processes in the cryosphere and land surfaces, the climate would continue to change even if the atmospheric composition were held fixed at today's values. Past change in atmospheric composition leads to a committed climate change, which continues for as long as a radiative imbalance persists and until all components of the climate system have adjusted to a new state. The further change in temperature after the composition of the atmosphere is held constant is referred to as the constant composition temperature commitment or simply committed warming or warming commitment. Climate change commitment includes other future changes, for example in the hydrological cycle, in extreme weather events, in extreme climate events, and in sea level change. The constant emission commitment is the committed climate change that would result from keeping anthropogenic emissions constant and the zero emission commitment is the climate change commitment when emissions are set to zero. See also Climate change.
Climate model (spectrum or hierarchy)	A numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions, and feedback processes, and accounting for some of its known properties. The climate system can be represented by models of varying complexity; that is, for any one component or combination of components a spectrum or hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical, or biological processes are explicitly represented, or the level at which empirical parameterizations are involved. Coupled Atmosphere-Ocean General Circulation Models (AOGCMs) provide a representation of the climate system that is near or at the most comprehensive end of the spectrum currently available. There is an evolution towards more complex models with interactive chemistry and biology. Climate models are applied as a research tool to study and simulate the climate, and for operational purposes, including monthly, seasonal, and interannual climate predictions. See also Earth System Model.
Climate scenario	A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as the observed current climate. See also Emission scenario and Scenario.
Contextual vulnerability (Starting-point vulnerability)	A present inability to cope with external pressures or changes, such as changing climate conditions. Contextual vulnerability is a characteristic of social and ecological systems generated by multiple factors and processes (O'Brien et al., 2007).

Coping	The use of available skills, resources, and opportunities to address, manage, and overcome adverse conditions, with the aim of achieving basic functioning of people, institutions, organizations, and systems in the short to medium term. This glossary entry builds from the definition used in UNISDR (2009) and IPCC (2012a).
Coping capacity	The ability of people, institutions, organizations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term. This glossary entry builds from the definition used in UNISDR (2009) and IPCC (2012a).
Detection and attribution	Detection of change is defined as the process of demonstrating that climate or a system affected by climate has changed in some defined statistical sense, without providing a reason for that change. An identified change is detected in observations if its likelihood of occurrence by chance due to internal variability alone is determined to be small, for example, <10%. Attribution is defined as the process of evaluating the relative contributions of multiple causal factors to a change or event with an assignment of statistical confidence (Hegerl et al., 2009).
Earth System Model (ESM)	A coupled atmosphere-ocean general circulation model in which a representation of the carbon cycle is included, allowing for interactive calculation of atmospheric CO2 or compatible emissions. Additional components (e.g., atmospheric chemistry, ice sheets, dynamic vegetation, nitrogen cycle, but also urban or crop models) may be included. See also Climate model.
Ecosystem-based adaptation	The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. Ecosystem-based adaptation uses the range of opportunities for the sustainable management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. It aims to maintain and increase the resilience and reduce the vulnerability of ecosystems and people in the face of the adverse effects of climate change. Ecosystem-based adaptation is most appropriately integrated into broader adaptation and development strategies (Secretariat of the Convention on Biological Diversity, 2009).
Emission scenario	A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse gases, aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships. Concentration scenarios, derived from emission scenarios, are used as input to a climate model to compute climate projections. In IPCC (1992) a set of emission scenarios was presented, which were used as a basis for the climate projections in IPCC (1996). These emission scenarios are referred to as the IS92 scenarios. In the IPCC Special Report on Emission Scenarios (Nakićenović and Swart, 2000) emission scenarios, the so-called SRES scenarios, were published, some of which were used, among others, as a basis for the climate projections presented in Chapters 9 to 11 of IPCC (2001) and Chapters 10 and 11 of IPCC (2007). New emission scenarios for climate change, the four Representative Concentration Pathways, were developed for, but independently of, the present IPCC assessment. See also Climate scenario and Scenario.
Exposure	The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected. (see Figure 1)
Evolutionary adaptation	For a population or species, change in functional characteristics as a result of selection acting on heritable traits. The rate of evolutionary adaptation depends on factors such as the strength of selection, generation turnover time, and degree of outcrossing (as opposed to inbreeding). See also Adaptation.
Hazard	The potential occurrence of a natural or human-induced physical event or trend, or physical impact, that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.
Impacts (Consequences, Outcomes)	Effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health status, ecosystems, economic, social, and cultural assets, services (including environmental), and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

Key vulnerability, key risk, key impact	A vulnerability, risk, or impact relevant to the definition and elaboration of "dangerous anthropogenic interference (DAI) with the climate system," in the terminology of United Nations Framework Convention on Climate Change (UNFCCC) Article 2, meriting particular attention by policymakers in that context. Key risks are potentially severe adverse consequences for humans and social-ecological systems due to the interaction of climate-related hazards with vulnerabilities of societies and systems exposed. Risks are considered "key" due to high hazard or high vulnerability of societies and systems exposed, or both. Vulnerabilities are considered "key" if they have the potential to combine with hazardous events or trends to result in key risks. Vulnerabilities that have little influence on climate-related risk, for instance, due to lack of exposure to hazards, would not be considered key. Key impacts are severe consequences for humans and social-ecological systems.
Low regret policy	A policy that would generate net social and/or economic benefits under current climate and a range of future climate change scenarios.
Maladaptive actions (or maladaptation	Actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.
Outcome vulnerability (End-point vulnerability)	Vulnerability as the end point of a sequence of analyses beginning with projections of future emission trends, moving on to the development of climate scenarios, and concluding with biophysical impact studies and the identification of adaptive options. Any residual consequences that remain after adaptation has taken place define the levels of vulnerability (Kelly and Adger, 2000; O'Brien et al., 2007).
Predictability	The extent to which future states of a system may be predicted based on knowledge of current and past states of the system. Since knowledge of the climate system's past and current states is generally imperfect, as are the models that utilize this knowledge to produce a climate prediction, and since the climate system is inherently nonlinear and chaotic, predictability of the climate system is inherently limited. Even with arbitrarily accurate models and observations, there may still be limits to the predictability of such a nonlinear system (AMS, 2000).
Projection	A projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Unlike predictions, projections are conditional on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized. See also Climate prediction and Climate projection.
Resilience	The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (Arctic Council, 2013).
Risk	The potential for negative consequences where something of human value (including humans themselves) is at stake and where the outcome is uncertain. This definition builds from the definitions used in Rosa (1998) and Rosa (2003). Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the consequences if these events occur. IPCC5 assesses climate-related risks.
Sensitivity	The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise).
System of interest	The 'system of interest' is the unit you chose to assess with respect to your question. You may determine your system of interest at different levels, e.g. a single crop system, an ecosystem, a region – depending on the objective of your analysis. (Imagine looking at your house from different angles.) Elsewhere, you may find 'system of interest' called 'exposure unit'.
Transformation	A change in the fundamental attributes of a system, often based on altered paradigms, goals, or values. Transformations can occur in technological or biological systems, financial structures, and regulatory, legislative, or administrative regimes.
Trend	Changes in climate that show a similar direction over time. An observed/historic trend could be, for example, the later arrival of rainfall over the last five years. Projected trends give a possible future direction, e.g. decreasing rainfall in summer, and if combined with a data range (decrease of 10 days of rain or decrease of X amount of rain) can help to devise adaptation measures.
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. More specific relevant terminologies can be read out from the Annex of Glossary of Special Report on Global Warming of 1.5 Deg Celcius.

MODULE 1:

CLIMATE CHANGE IN BANGLADESH



This module provides an entry point to the topic of climate change (CC) and climate change adaptation / mitigation (CCA/CCM). It summarises the major points of the basic scientific knowledge regarding climate change.

The module cannot provide answers to all questions the course participants may have. The module therefore, aims at alerting participants to important issues in the adaptation and mitigation debate.

1.1 Learning objective for the exercise

- To provide a knowledge update on climate change basics.
- To link important technical climate change aspects and important topics of the international debate to the Bangladesh context.

This module provides basic information on CCA and CCM in the form of an input presentation. The presentation is followed by a question and answer session to clarify important issues of understanding and provide room for discussion.

The session provides the background information for the following modules of this training and aims at bringing all participants to a similar level of information.

1.2 Introduction to Bangladesh

1.2.1 Geography and Hydrology

Bangladesh covers an area of 147,570 square kilometre and is one of the largest deltas in the world consisting of three big rivers, which are the Ganges, Brahmaputra and Meghna. These three rivers meet near the Chandpur district of Bangladesh and then flow into the Bay of Bengal from around the district of Bhola. Actually the delta begins with the distributaries flow southwards to the Bay of Bengal. It would comprise the lower delta and coastal zone and also most narrowly conceived. Bangladesh has a unique natural resource base and about 80% of it consists of floodplains and wetlands with over 700 rivers in the riverine network that sustains rare wildlife, flora and fauna. Given its geographic location near the Eastern Himalayas and being reception country of the three major rivers, Bangladesh is highly prone to floods. The topography is flat and majority of the landmass lies within 10 meters above mean sea level. Due to the rise in the average sea level, an increased area of the country may be extremely vulnerable to floods by 2030 (7FYP).

For water resource planning purposes, Bangladesh has been divided into 8 hydrological regions, which are the Northwest (NW), Northeast (NE), North-central (NC), Southeast (SE), South-central (SC), Southwest (SW), Eastern Hills (EH) and the main Rivers and Estuaries (RE). The 8 hydrological regions are shown in Figure 1 .1.

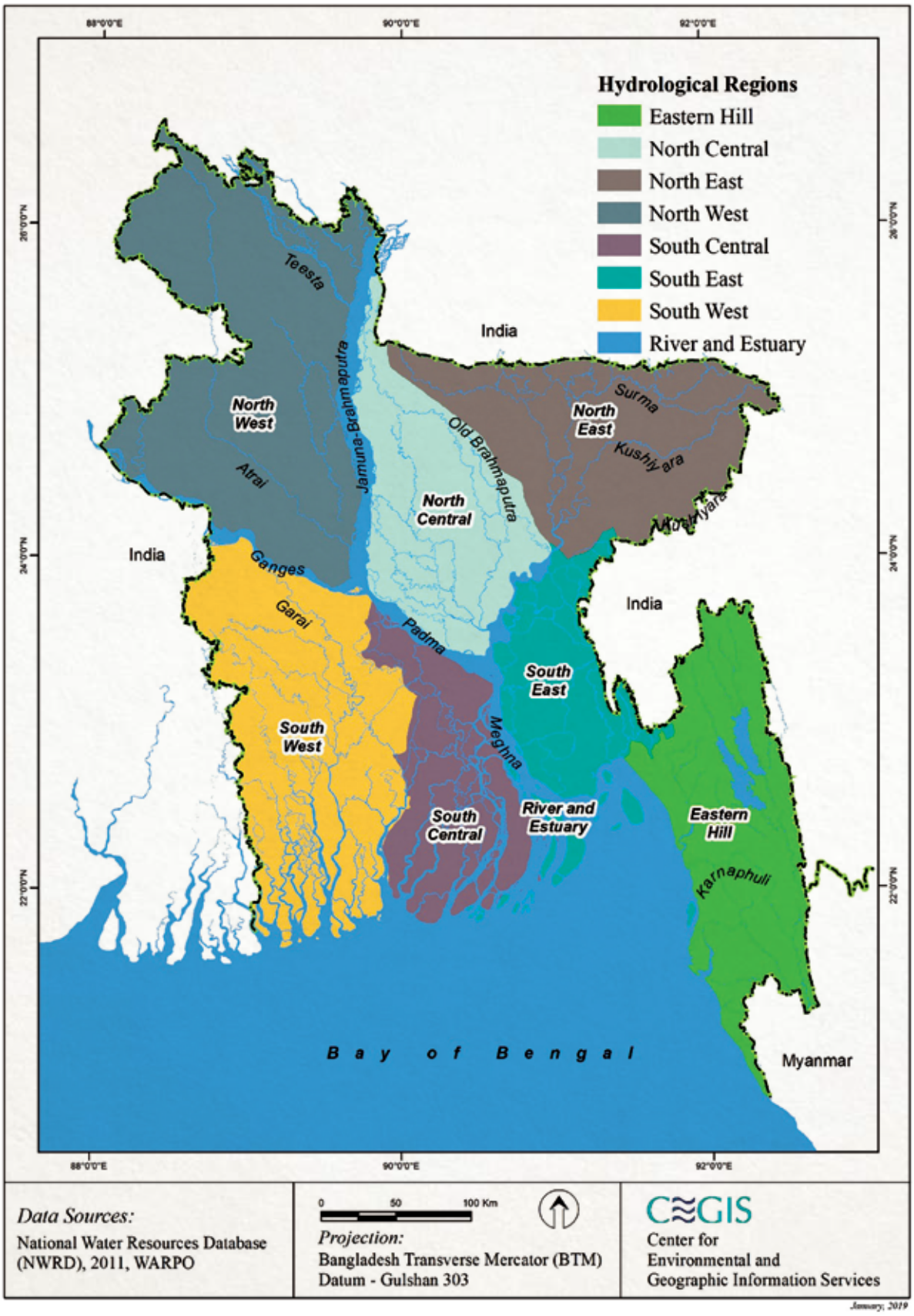


Figure 1.1: Hydrological Regions of Bangladesh (Source: CEGIS)

1.2.2 Demography

The current population with 160 million creates a population density of 1,200 people per km2 (BDP 2100, 2018) in the country. The population growth rate is currently 1.2% per year (in 2016 according to BDP 2100, 2018). Bangladesh has been experiencing quite rapid urbanization during the last few decades. Population growth is expected to follow a declining trend from FY2016 to FY2041. On the basis of the UN population projection, population growth is assumed to fall to 0.39% in FY2041 from around 1.2% at present. Lower population growth will contribute to higher per capita GDP growth.

Life expectancy has increased to 71 years in 2015 while it was 55 years in 1974. In 2014, child mortality rate declined significantly and it stood at only 31 per thousand while it was 240 in 1974. Furthermore, adult literacy has increased to 64% from 22% over the same period (BDP 2100, 2018). From 2005 to 2010, the literacy rate has increased by 6 percentage points and the rate stood at 57.9% in 2010. Later, it achieved 72.3% in 2016 (BBS, 2016). The enrolment rate in primary education is 98.5% and girls dominate in the ratio in both urban and rural areas (7FYP).

1.2.3 Economy

70% of the country is agricultural land and surface water used for irrigation at 6.6 km3 and the groundwater used for irrigation as 24.9 km3 (7FYP).

More than 62.5% of the labour forces (total 160 million) are directly or indirectly employed in the agricultural sector. In terms of sectoral contributions to GDP, the share of agriculture is however, less than 20% and the service sectors account for 52%. The remaining 28% is in the industrial sector.

Garment exports accounted for more than 80% of total exports and surpassed $25 billion in 2016 which was $15 billion and 8% of GDP in 2015 - are key contributors to Bangladesh's sustained economic growth and rising foreign exchange reserves (BDP 2100, 2018).

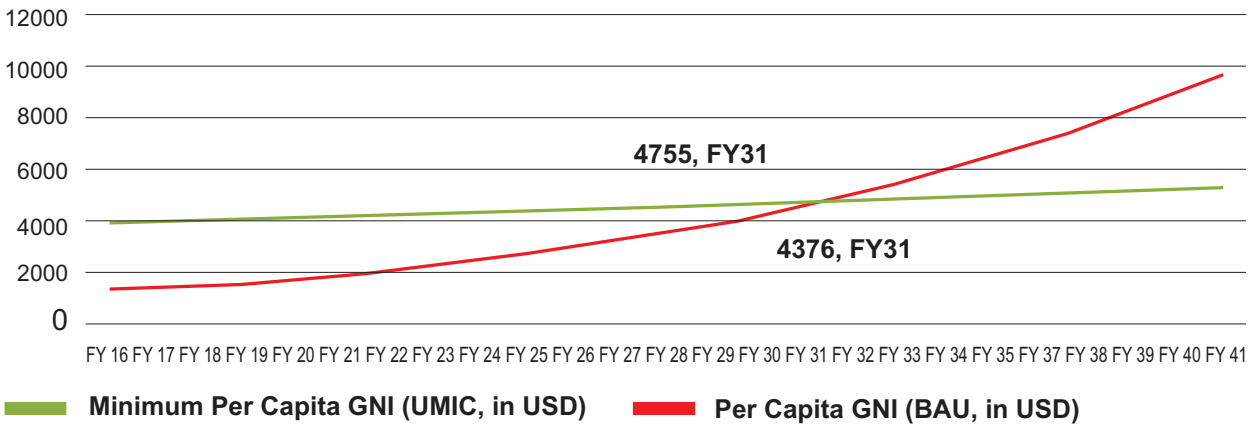


Figure 1.2: Per Capita GNI Comparison (US$) (Source: BDP 2100 Projections, GED, 2017)

GDP growth will slow down considerably from 7.2% in FY2017 to 7.1% in FY2031 and further to 5.5% by FY2041, resulting US$ 4,376 in FY2031, $379 lower than US$ 4,755 required to achieve the upper middle income country (UMIC) status by that year. More importantly, there is an average loss of real GDP of 1.1% over the government's target of achieving 8% average GDP growth and 1.7% per year when compared with the Delta Plan Policy Option Scenario. This later would add up to an approximate loss US$ 1,157 billion by FY2041.

Table 1.1: Key features of Bangladesh

Feature	Value	Notes
Government	Parliamentary republic	
Population	163 million	In FY16, Source: BDP 2100,2018
Population growth rate	1.2%	In FY16, Source: BDP 2100,2018
Literacy rate	72.3%	In 2016, Source: BBS 2016
Major rivers	Ganges, Brahmaputra and Meghna	One of the largest deltas in the world
Renewable water availability	1,211 BCM	1,190 surface water; 21 groundwater (BDP 2100, 2018)
Gross National Income per capita	US$ 1434	In FY16, Source: BDP 2100, 2018; GED, 2017
GDP growth rate	7.1% per year	In FY16, Source: BDP 2100, 2018
Composition of economy	Mixed	In 2016: Agric. (15%), Industries (29%), Services (56%)
Composition of employment	Mixed	Agric. (45%)
Energy sector	Mixed	Electricity, gas, coal, liquid fuel, wind energy, solar and other non-petroleum fuel

1.2.4 Climate

The climate of Bangladesh is characterised by substantial seasonal variations in rainfall, by high temperatures and high humidity. The major part of the country has a tropical savanna climate with generally hot temperatures and a dry period in winter. Some of the eastern parts can be characterised by tropical monsoon climate, while small regions in the north towards the bordering mountains have a humid subtropical climate.

Three seasons are distinguished in all parts of the country. The summer lasts from March to June and is hot and humid. The maximum temperature ranges are from 38°C to 41°C in summer. The rainy season from June to November is hot and characterised by the South-West monsoon. It is followed by a dry and mild winter from December to February.

Precipitation occurs mainly during the monsoon season and most of the country receives at least 2,300 mm per year. The driest part of the country lies in the north-west where the annual rainfall is about 1,600 mm. Towards the East, precipitation amounts are increasing especially in the region of Sylhet, where the average annual precipitation is 4,200 mm and the dry season is very short. From March to May and in October, Bangladesh is frequently hit by tropical cyclones coming over the Bay of Bengal. (Climate-Fact-Sheet).

1.2.5 Environment/ Ecology

The ecosystems of Bangladesh can be categorized into two major groups (i) Terrestrial and (ii) Aquatic. The terrestrial ecosystems include homestead, forest, and crop field; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and chars, and marine fall into the aquatic category.

Ecological systems of Bangladesh encompass unique mangrove forests of the Sundarbans, coastal and marine ecosystems; deep natural water basins called ‘haors’ and ‘baors’, arid areas in the upper mid-section to hill tracts in the Southeast and flat sandy riverine deltas in the middle down to South. The country has 29 agro-ecological zones that have microclimates of their own.

Bangladesh’s environment is under threat from natural causes compounded by human-induced excesses owing to the pressure of population.Demand for increased agricultural lands, collection of fuel wood, and non-timber forest products by the local communities are different reasons behind degradation of ecology system

and as a result natural habitats converted into human habitations, ecosystem fragmentation and loss of habitat. Human-made threats to the environment include:

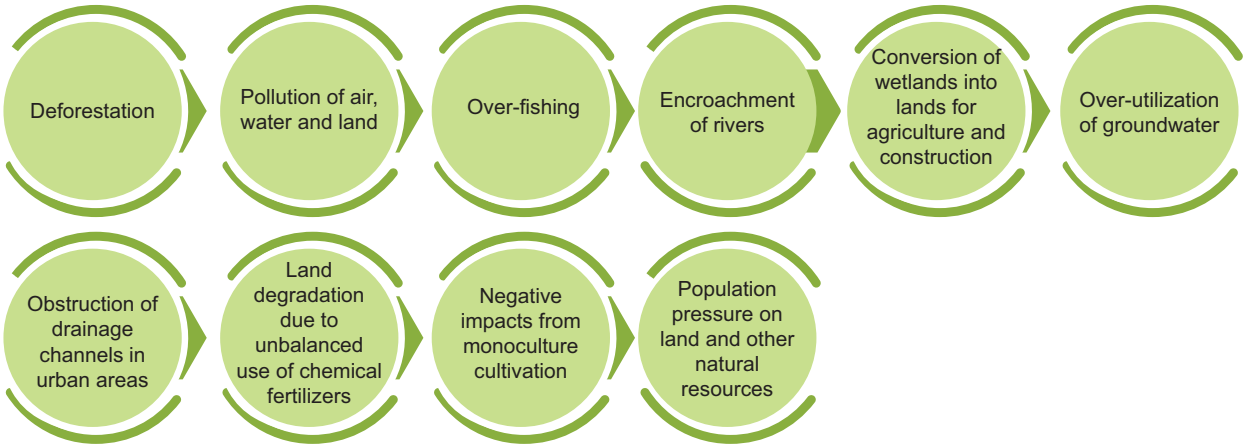
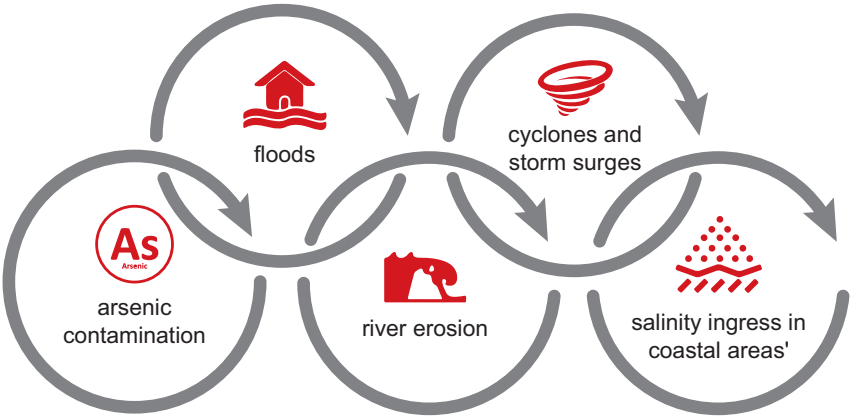


Table 1.2: Liquid waste from the textile sector

Impact of the liquid waste from Textile Sector on water resources	Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation.



1.3 Climate Science and Basics

Climate change has become table talk at present days. It is very important to know the basic science behind climate change. It refers not only to global changes in temperature but also to changes in wind, precipitation, the length of seasons, strength and frequency of extreme weather events like droughts and floods. The IPCC AR4 claimed that global warming is undeniably the result of human activities. CO2 emission has increased to about 380 ppm from 280 ppm before industrial revolution and may reach over 800 ppm by end of this century. Global average temperature has already upped by about 1°C. Some common terms related to Climate change should be known.

1.3.1 Climate and Weather

To understand the basic science behind climate change, it is important to know the difference between weather and climate. Weather is the state of atmosphere at any particular time while climate is the average weather over longer time frame (usually 25-30 year period).

Simply put, **weather** denotes the daily atmospheric condition, concerning various elements like temperature, precipitation, moisture, cloudiness, wind velocity and air pressure. It expresses the position of the atmosphere at a specified place and time, in degrees, i.e. hot or cold, clear or cloudy, dry or wet.

It constantly changes, i.e. hour after hour and day after day. Weather forecasting is the difficult task, as many times, it happens that on a sunny day, suddenly heavy rains occur or the sunshine occurs immediately after heavy rains.

The Sun is the fundamental cause of changes in weather because it is the primary source of energy to earth. The energy absorbed and emitted by the earth's atmosphere, surface and oceans have a great role to play in ascertaining weather of the region. Moreover, winds and storms also result in the changes in weather.

The term '**climate**', is used to mean weather trends at a specific region, over the course of many years. It is the statistical information of weather which signifies that common atmospheric pattern, in an area over decades, i.e. it does not indicate the weather changes occurring daily or weekly. So, when we observe that the temperature of a country the highest, then it means the climate of the place is very hot.

The climate of a place is greatly affected by two factors, which are temperature and precipitation, and other factors influencing it includes wind velocity, the sunshine, precipitation timing, humidity and so on. The standard length of time used to ascertain the climate of an area is 30 years.

1.3.2 Climate System

The climate system is the highly complex system consisting of five major components: the atmosphere (air), the hydrosphere (ocean, lake, rivers, etc.), the cryosphere (polar ice cap, sea ice, permafrost, seasonal snow cover, mountain glacier, etc.), the lithosphere/ geosphere (land) and the biosphere (ecosystems) and the interactions between them. The climate system evolves in time under the influence of its own internal dynamics and because of external forces such as volcanic eruptions, solar variations and anthropogenic forcings such as the changing composition of the atmosphere and land-use change.

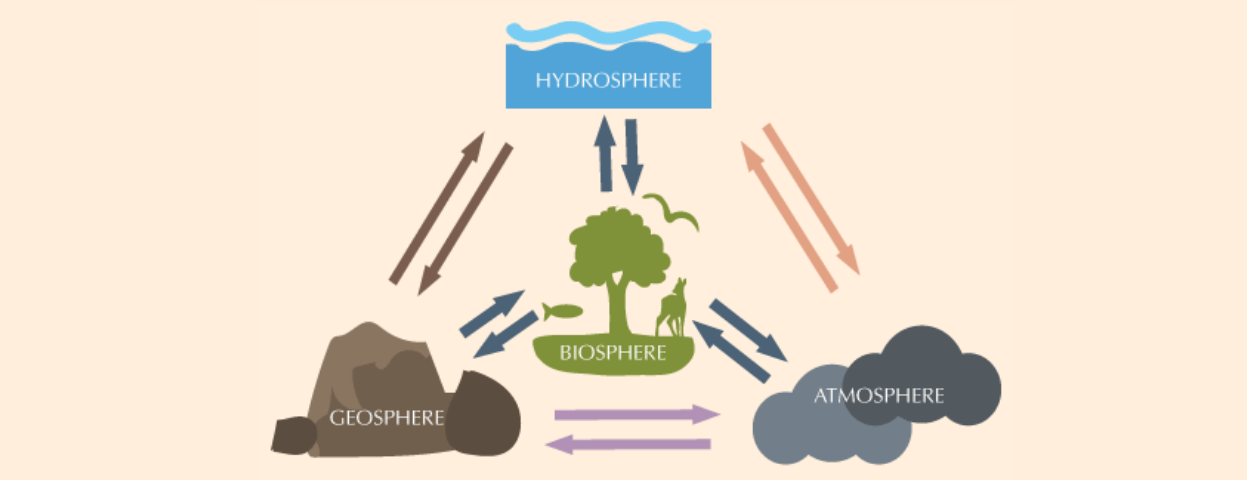


Figure 1.3: Climate systems

1.3.3 Global Warming

Global warming is an increase in the Earth's average surface temperature and mostly occurring due to human-made greenhouse gas emissions. According to IPCC AR5, The estimated increase in global mean surface temperature (GMST) averaged over a 30-year period, or the 30-year period centered on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified. For 30-year periods that span past and future years, the current multi-decadal warming trend is assumed to continue.

1.3.4 Greenhouse Effect

Greenhouses are made of glasses in polar countries. People grow vegetables in these glass houses. Sunlight enter through the glass and warms inside. The energy reflects back to the space but cannot escape through glass. The heat is trapped inside getting the greenhouse warmer. Same thing happens when greenhouse gasses cover earth's atmosphere. This is called greenhouse effect. The more greenhouse gas molecules there are in the atmosphere, the more heat is trapped, and the warmer it will become.

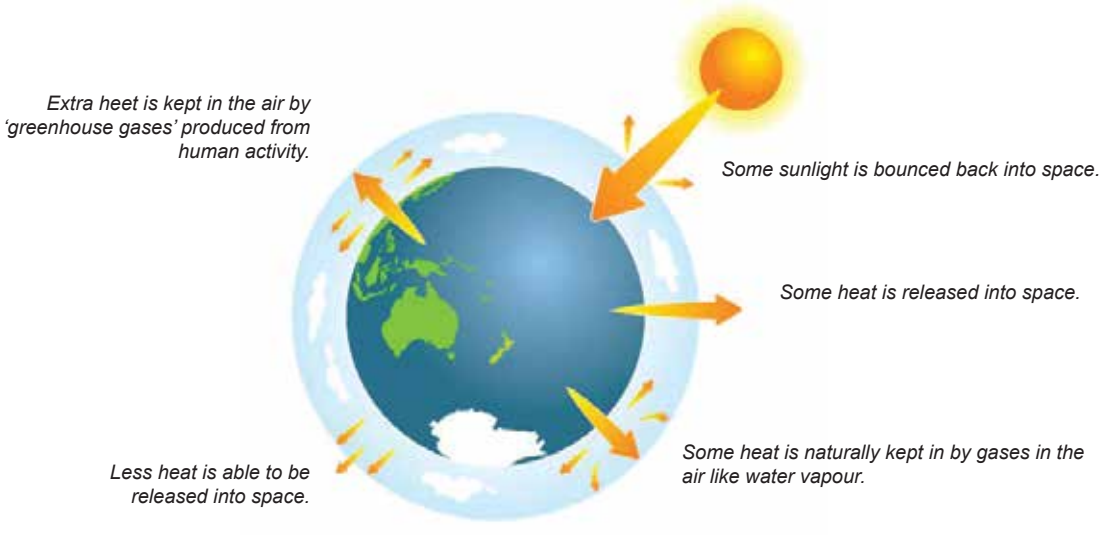


Figure 1.4: Greenhouse effect in Earth's atmosphere

Most abundant greenhouse gasses are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), chlorofluorocarbons(CFCs), hydrochlorofluorocarbons (incl. HCFCs and HFCs), etc. These gasses cause greenhouse effect absorbing and emitting radiant energy within the thermal infrared range.

Multiple gasses contribute to the greenhouse effect that sets Earth's temperature over geologic time. Small changes in the atmospheric concentration of these gasses can lead to changes in temperature that make the difference between ice ages when mastodons roamed the Earth, and the sweltering heat in which the dinosaurs lived.

Two characteristics of atmospheric gasses determine the strength of their greenhouse effect.

The first is the Global Warming Potential (GWP), a measure of the radiative effect of each unit of gas over a specified period of time, expressed relative to the radiative effect of carbon dioxide (CO_2). An amount of gas with high GWP will warm the Earth more than the same amount of CO_2.

The second is the atmospheric lifetime, which measures how long the gas stays in the atmosphere before natural processes (e.g., chemical reaction) remove it. A gas with a long lifetime can exert more warming influence than a gas with a short lifetime (assuming the GWPs are equal).

The table below presents values for these two characteristics for major greenhouse gases. The GWP and atmospheric lifetime values are periodically updated by the scientific community as new research refines estimates of radiative properties and atmospheric removal mechanisms (sinks) for each gas. These values are from the Fourth IPCC Assessment Report (AR4) released in 2007, which are commonly used in international reporting, despite the Fifth Assessment Report updating them in 2014.

Table 1.3: Global Warming Potential and Atmospheric Lifetime for Major Greenhouse Gases (IPCC AR4, 2007)

Greenhouse gas	Chemical formula	Global Warming Potential, 100-year time horizon	Atmospheric Lifetime (years)
Carbon Dioxide	CO2	1	100*
Methane	CH4	25	12
Nitrous Oxide	N2O	298	114
Chlorofluorocarbon-12 (CFC-12)	CCl2F2	10,900	100
Hydrofluorocarbon-23 (HFC-23)	CHF3	14,800	270
Sulfur Hexafluoride	SF6	22,800	3,200
Nitrogen Trifluoride	NF3	17,200	740

The table below shows the relative concentrations of these major greenhouse gasses and their sources. Some gasses (like CO_2) are made by both natural and man-made processes, while others (like the fluorinated gasses) are only the result of human industrial activity. CO_2 is typically measured in parts per million because it is 1,000 times more prevalent than the other gasses, but is shown as parts per billion in the table for consistency.

Table 1.4: Sources and Concentrations of Major Greenhouse Gases (IPCC AR5, 2014)

Greenhouse gas	Major sources	Pre-industrial concentration (ppb)	2011 concentration (ppb)
Carbon Dioxide	Fossil fuel combustion; Deforestation; Cement production	278,000	390,000 (in 2011)
Methane	Fossil fuel production; Agriculture; Landfills	722	1,803 (in 2011)
Nitrous Oxide	Fertilizer application; Fossil fuel and biomass combustion; Industrial processes	271	324 (in 2011)
Chlorofluorocarbon-12 (CFC-12)	Refrigerants	0	0.527
Hydrofluorocarbon-23 (HFC-23)	Refrigerants	0	0.024
Sulfur Hexafluoride	Electricity transmission	0	0.0073
Nitrogen Trifluoride	Semiconductor manufacturing	0	0.00086

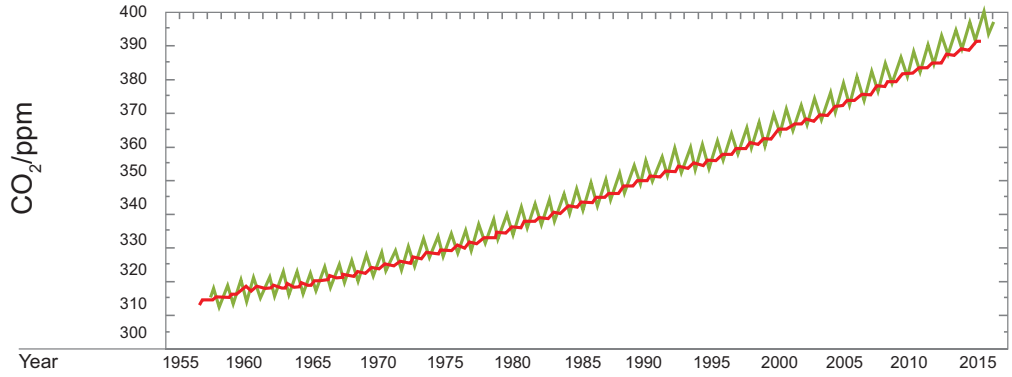


Figure 1.5: The Rise of Atmospheric Carbon Dioxide

NOTES

Measurements of atmospheric CO_2 since 1958 from the Mauna Loa Observatory in Hawaii (black) and from the South Pole (red) show a steady annual increase in atmospheric CO_2 concentration. The small up and down saw-tooth pattern reflects seasonal changes in the release and uptake of CO_2 by plants.

SOURCE: (Climate Change at the National Academies of Sciences, Engineering, and Medicine, 2017)

1.3.5 Climate Change

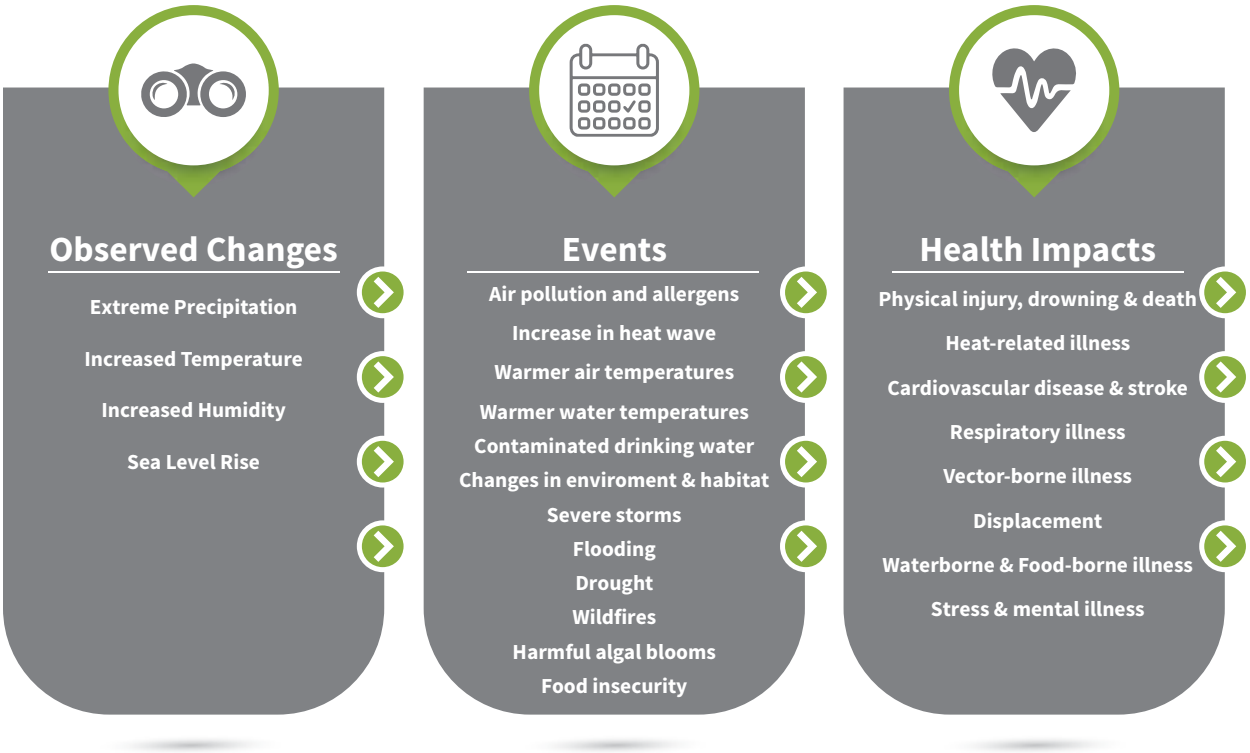
Climate Change is a significant change in global or regional climate pattern over time due to anthropogenic activity.

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.

UNFCCC defines climate change as: “A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.”

The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.



1.3.6 Reasons behind Climate Change

Main reason behind climate change is anthropogenic greenhouse gas emissions that have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.

Some anthropogenic reasons behind climate change can be divided into two main categories:

a. **Deforestation:** Due to deforestation, naturally absorption of CO_2, one of the main GHGs, is being hampered. And it increases GHG content in atmosphere.

b. **Technologies:** Use of different new technologies such as different types of vehicle, tool, AC, refrigerators, use of chemical fertilizers etc. increase GHGs emissions.

c. **Industry and fossil fuels:** Fossil fuels and industry (textile, steel, cement, chemical, food industry, etc.) emit large amount of GHGs.

Increase of GHGs in atmosphere drives temperature rise. Thermal expansion, melting of glaciers, sea level rise, increase in evaporation, change in rainfall pattern, shifting of seasons, etc. are triggered by rise in temperature. Figure 6 shows the process of climate change.

Climate Change Process

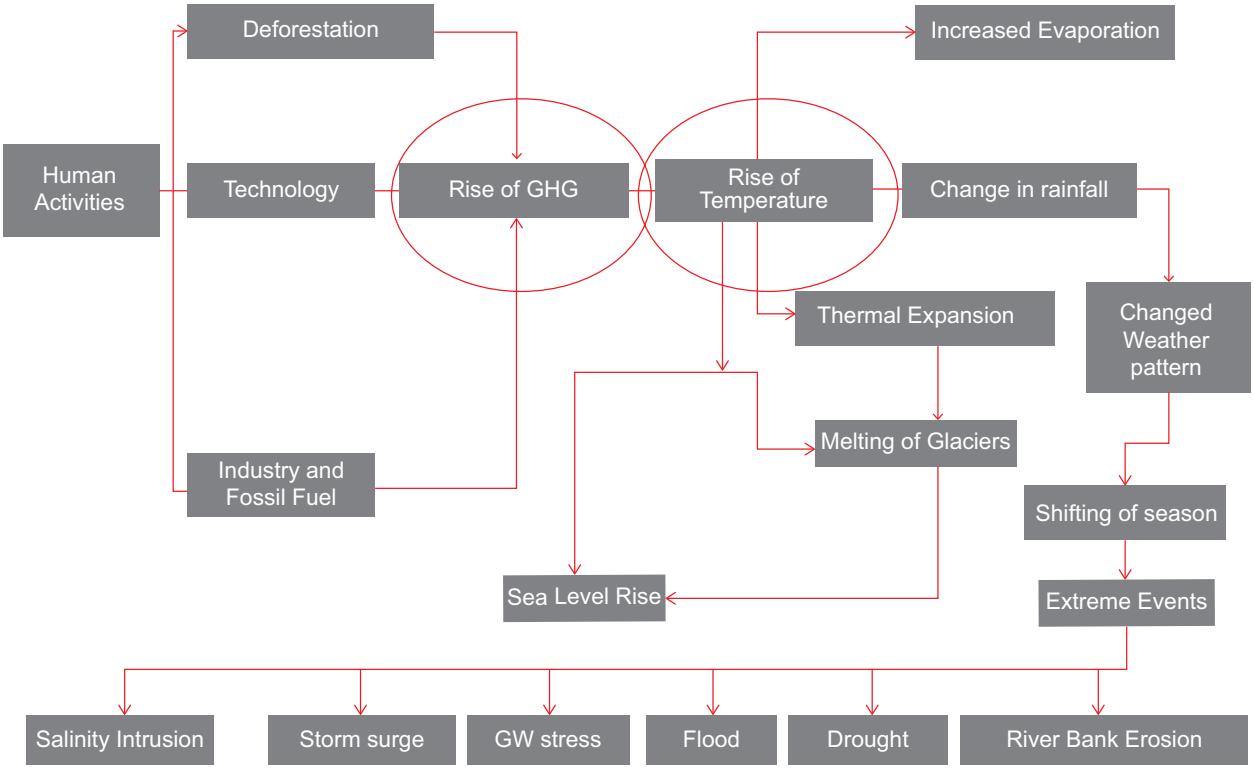


Figure 1.6: Climate change process

1.3.7 Evidence of Climate Change

Global Change

- **Increasing CO2:** Burning fossil, deforestation, increased GHGs emission increase CO2; GHGs may sink in ocean and cause acidification, also disrupt oceanic air circulation.

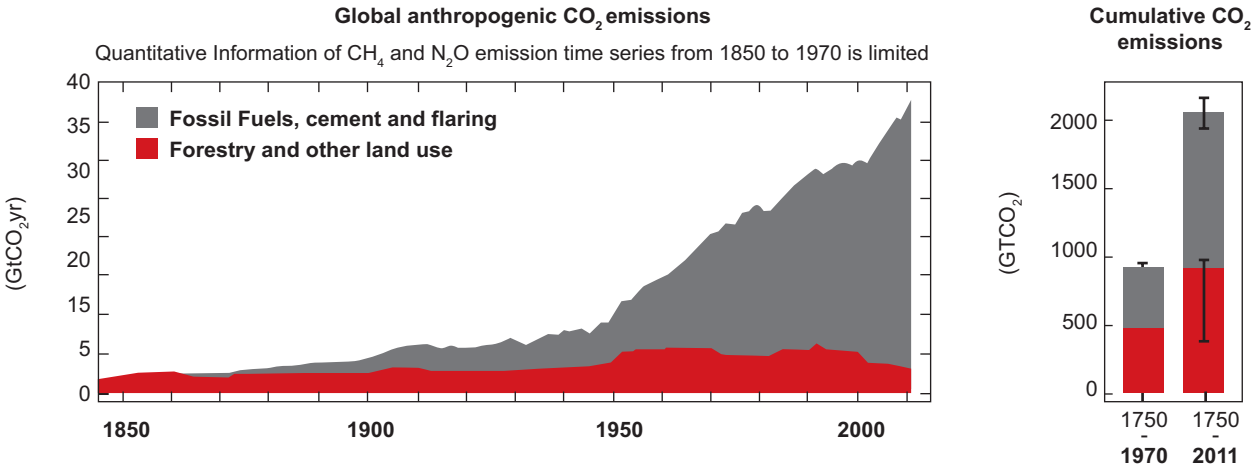


Figure 1.7: Trends of global anthropogenic CO2 emissions (IPCC AR5, 2014)

- **Increase in Global Temperature:** The combined global land and ocean surface average temperature data show a warming of 0.85 [0.65 to 1.06] °C, over the period 1880 to 2012. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850

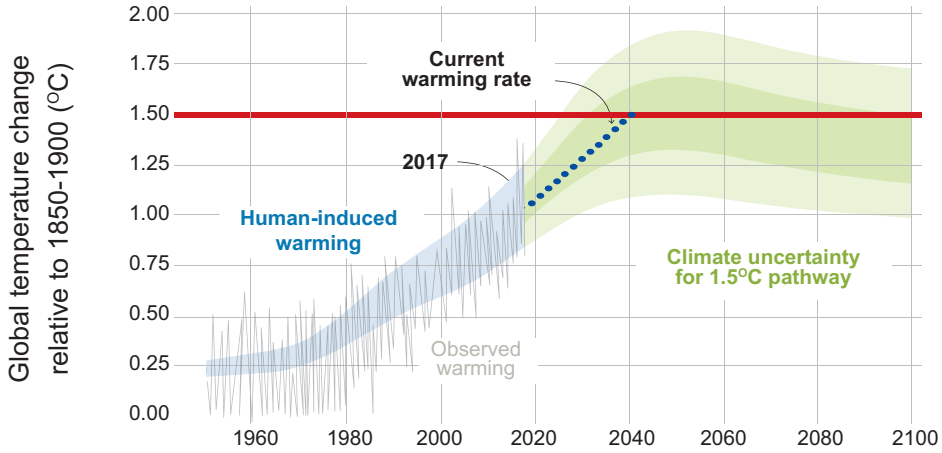


Figure 1.8: Human-induced warming reached approximately 1°C above pre-industrial levels in 2017 (Source: Global warming of 1.5˚- IPCC special report)

Figure 1.9: How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems (Source: Global warming of 1.5˚- IPCC special report, 2018)

Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks. Red indicates severe and widespread impacts/risks. Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence. White indicates that no impacts are detectable and attributable to climate change.

- *Reduction in Ice Cover:* Rise in temperature would cause glacier melting in the Himalayas. This may increase overland flooding and will affect the low-lying areas (wetland ecosystem).
- *Rising Sea Level:* Increased glacier melting would cause Sea Level Rise (SLR). This may hamper vital portions of the coastal, mangrove, and haor ecosystems of the country.

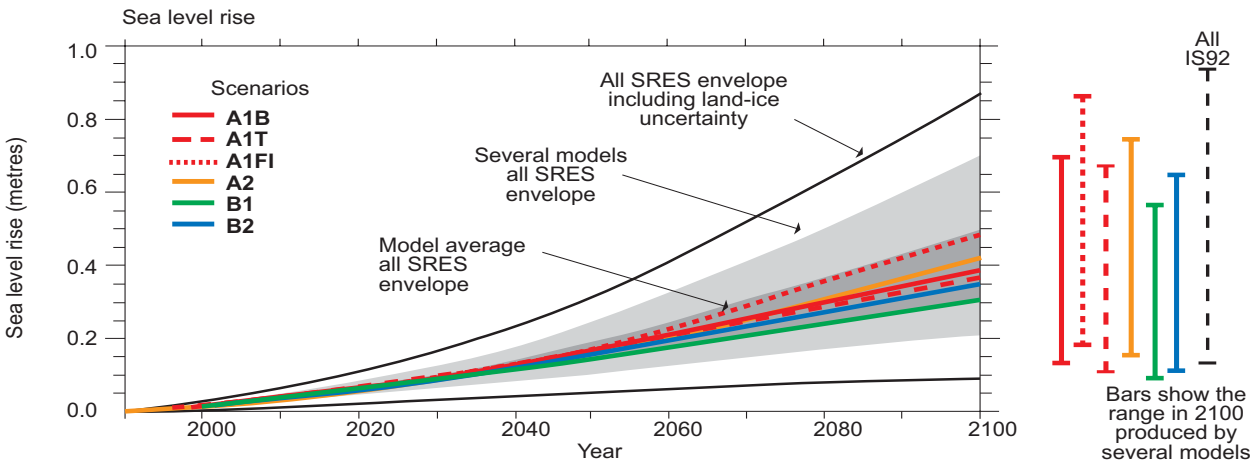


Figure 1.10: Trend of global sea level rise (IPCC AR5, 2014)

- **Increase in Greenhouse Gas Emission:** Total anthropogenic GHG emissions have continued to increase from 1970 to 2010 with larger absolute increases between 2000 and 2010, despite a growing number of climate change mitigation policies. Anthropogenic GHG emissions in 2010 have reached 49 ± 4.5 GtCO2-eq/yr 3. Emissions of CO2 from fossil fuel combustion and industrial processes contributed about 78% of the total GHG emissions increase from 1970 to 2010, with a similar percentage contribution for the increase during the period 2000 to 2010.

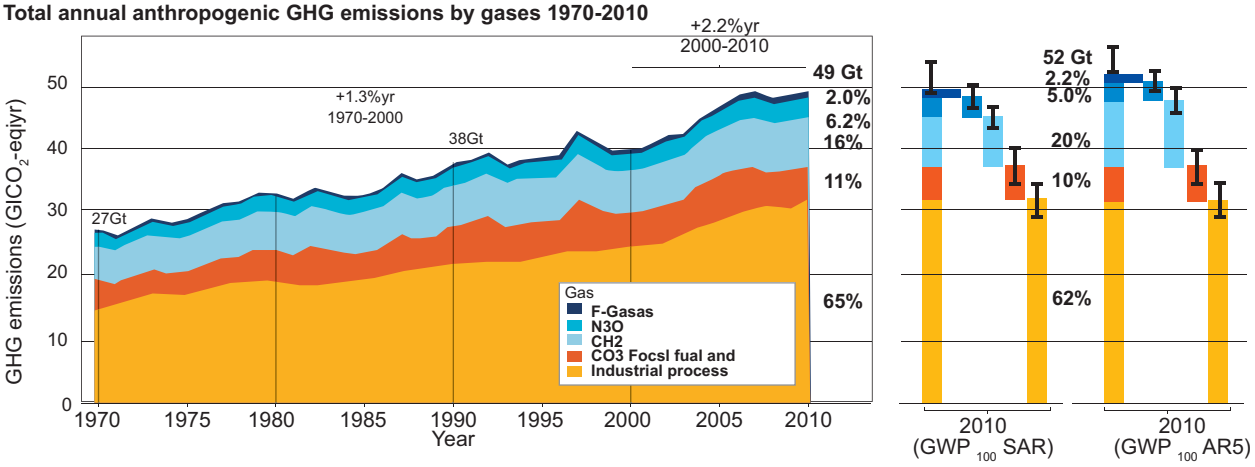


Figure 1.11: Trend of global GHGs emissions (IPCC AR5, 2014)

- **Increase in Global Precipitation:** Precipitation has increased since 1901 (medium confidence before and high confidence after 1951). For other latitudes area-averaged long-term positive or negative trends have been found.

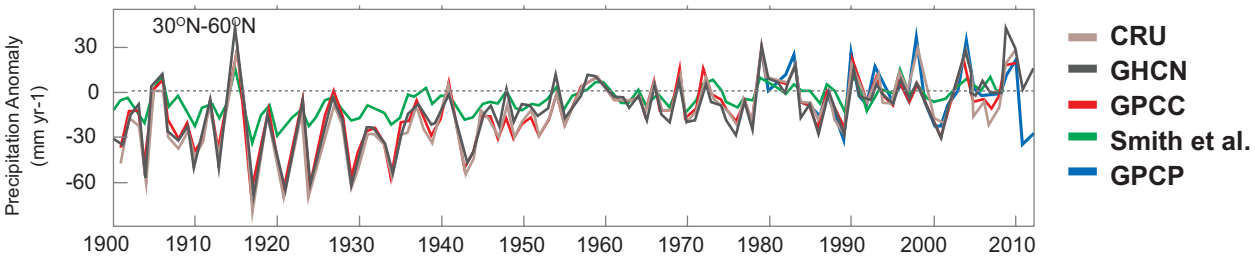


Figure 2: Change in average Northern Hemisphere precipitation over land (relative to 1981-2000) from five global data sets. Source: IPCC AR5 WGI, Chpt 2, Figure 2.28

Figure 1.12: Trend of global precipitation change (IPCC AR5, 2014)

Local Change

Bangladesh is one of the most climate vulnerable countries in the world. It is exposed to a high range of climate variability- e.g. erratic rainfall pattern, tropical cyclones and storm surges, sea level rises, salinity intrusion, floods and seasonal droughts. Climate change and variability is affecting the climate sensitive development sectors like agriculture, water, energy, forest, fisheries & livestock, health, social services and overall development

- Decadal change is the highest for average-maximum temperature with a value of +2.63°C.

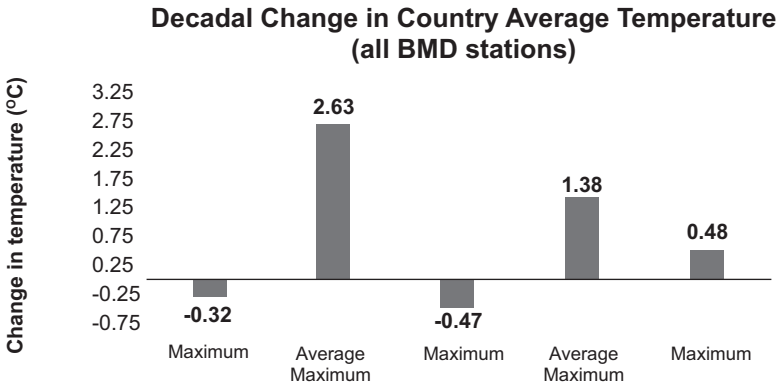


Figure 1.13: Decadal Change in Bangladesh Average Temperature (all BMD Stations)

- Countrywide average temperature shows increasing trend in Bangladesh through observance of last 100 years' record.
- Rainfall shows an increasing trend for most parts of the country in all the seasons.

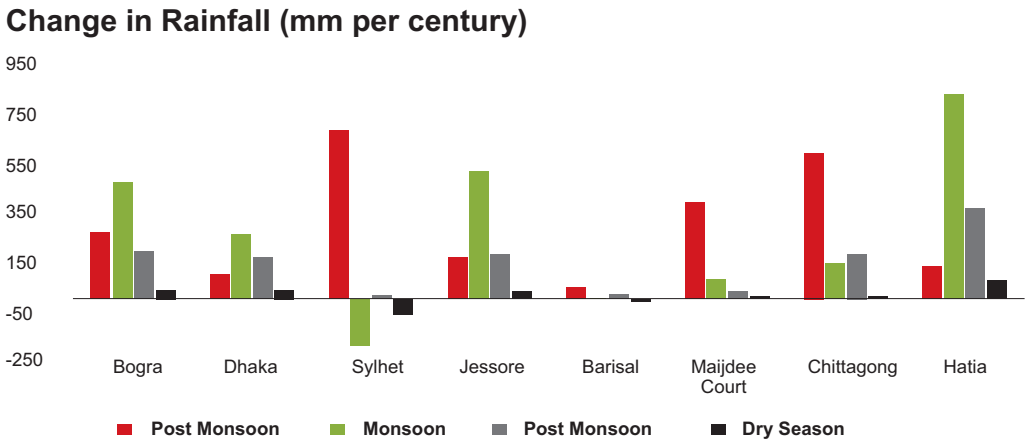


Figure 1.14: Change in Seasonal Rainfall in Bangladesh

- Average sunshine hours are declining for all over Bangladesh and declining rate is higher in West and North than in East and South regions respectively.
- Average cloud cover shows decreasing trend for Dhaka, Bogura, Jashore and Hatiya whereas Chattogram, Barishal, Sylhet and Maijdee court show increasing trend.
- The coastal areas (about 39,400 sq.km.), the Sundarbans, water management infrastructures, etc. are vulnerable to sea level rise.

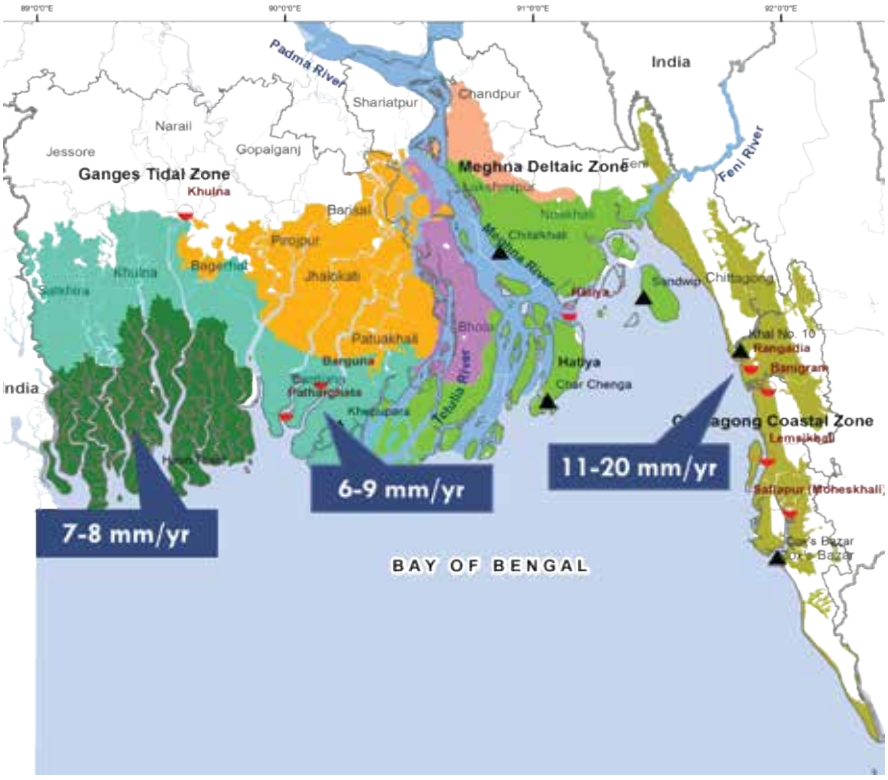


Figure 1.15: Observed Sea Level Rise in Bangladesh (Source: CEGIS)

1.3.8 Climate Change Scenarios

Scenario "is a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships. Scenarios are neither predictions nor forecasts, but are useful to provide a view of the implications of developments and actions (IPCC, 2014).

Table 1.5: Evolution of Climate Change Scenarios

Year	Scenario name	Used in IPCC report
1990	SA90 (IPCC Scientific Assessment 1990)	First Assessment Report (FAR)
1992	IS92 (IPCC Scenarios 1992)	Second Assessment Report (SAR)
2001 and 2007	SERES- Special Report on Emissions	Third and Fourth Assessment Report (TAR and AR4)
2013-14	RCP- Representative Concentration Pathways	Fifth Assessment Report (AR5)

Representative Concentration Pathway (RCP)

The Representative Concentration Pathways (RCPs) are used for making projections based on different factors such as population size, economic activity, lifestyle, energy use, land use patterns, technology and climate policy (IPCC AR5). It describe four different 21st century pathways of GHG emissions and atmospheric concentrations, air pollutant emissions and land use. Four pathways/scenarios have long been used by planners and decision makers to analyse situations in which outcomes are uncertain. The four RCPs are namely RCP2.6, RCP4.5, RCP6, and RCP8.5. RCPs are targeted to provide time dependent projections of GHG concentrations which are representative among several different scenarios with similar radiative forcing

and emissions characteristics and they also describe the trajectory over time that is taken to reach the long-term concentration outcome. Main Characteristics of RCPs are as follows:

Table 1.6: Characteristics of RCPs

Scenario Component	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Greenhouse gas emissions	Very low	Medium-low mitigation Very low baseline	Medium baseline and mitigation	High baseline
Agricultural area	Medium for cropland and pasture	Very few for both cropland and pasture	Medium for cropland but very low for pasture (total flow)	Medium for both cropland and pasture
Air pollution	Medium-low	Medium	Medium	Medium-high

1.3.9 Climate Model

Understanding the climate system is a problem of great intrinsic scientific interest. Our growing understanding of interactions between the atmosphere, oceans, biosphere, cryosphere and land surface is revolutionizing the Earth sciences. Moreover, in recent years, a sense of urgency has infused research on modelling the climate system. The prospect of human activities altering atmospheric composition, affecting climate globally and regionally, and ultimately affecting human economies and natural ecosystems, has stimulated the development of models of the climate system.Global climate models generally simulate global temperatures that compare well with observations over climate timescales. (IPCC, 1997).

The higher the resolution, the more specific climate information a model can produce for a particular region but this comes at a cost of long time to run because the model has more calculations to make.The following figure shows how the spatial resolution of models improved between the first and fourth IPCC assessment reports. Figure 1.16 shows the rsolution improvements.

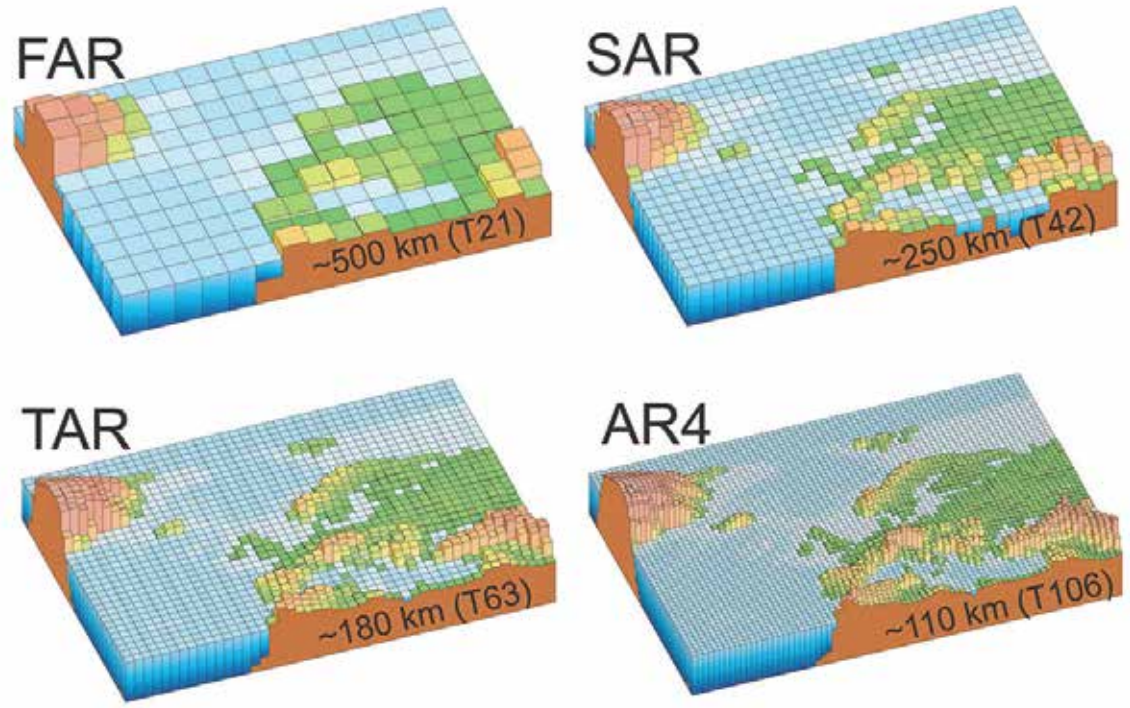


Figure 1.16: Improvement of Climate Model Resolution from IPCC FAR to AR4

Earth Balance Models (EBMs)
The oldest and simplest type of climate model which consider a balance of energy entering and leaving a system (i.e. the Earth). These models are one-dimensional in the direction of only the latitude of the Earth.

Regional Climate Models (RCMs)
Climate calculated by the GCM is used as input at the edges of the RCM for factors such as temperature and wind. This model use dynamic techniques to 'downscale' the coarse GCM results to local detail.

General Circulation Models (GCMs)
Represent physical processes in three dimensions, including the atmosphere, oceans, land, and the cryosphere, or sea ice and glaciers on land and more sophisticated than EBMs.

Statistical Downscaling Model (SDM)
Use statistical techniques to 'downscale' the coarse GCM results using the relationship between large scale predictors and local predictants like temperature and rainfall.

1.3.10 Hazards

Hazard can be defined according to IPCC AR5 as the potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts. Figure 1.17 shows hazard class map for Bangladesh.

Due to climate change, Bangladesh is now susceptible to frequent and longer period flooding, drought, sea level rise, frequent cyclone and storm surge, flash floods, etc. The country's exposure to hazards is compounded by its population's vulnerability and lack of resources. The mostly agrarian economy and the high population density leave large sections of the population exposed to hazards. The United Nations (UN) 2014 World Risk Report named Bangladesh the 5th most 'at risk' country for disaster in the world. Following figure 1.17 shows different major hazard-prone areas in Bangladesh.

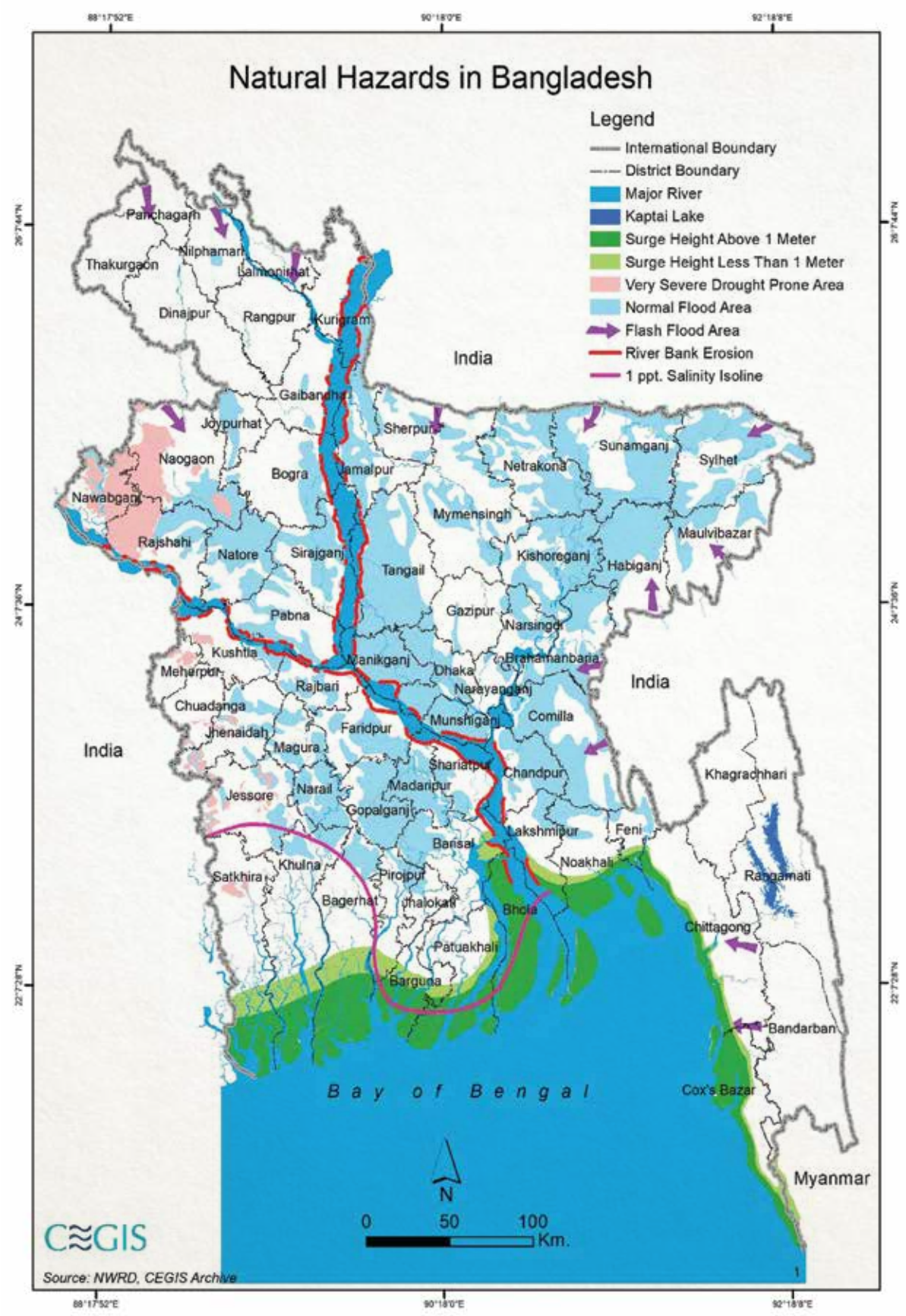


Figure 1.17: Hazard Map of Bangladesh by District(source: CEGIS)

Flood

Flood is an annual phenomenon generally affecting 30 per cent of the country, but up to 70 per cent in extreme years. Flood-related fatalities are decreasing, but economic losses have been increasing over the years. The government has been developing and implementing various measures to better equip the country to deal with floods. Important initiatives include the flood action plan, flood hydrology study, flood management model study, national water management plan, national water policy, flood early warning study and construction of flood embankments and flood shelters. The flood damage potential is increasing due to climate change, urbanization, growth of settlements in flood-prone areas and overreliance on flood control works such as levees and reservoirs.

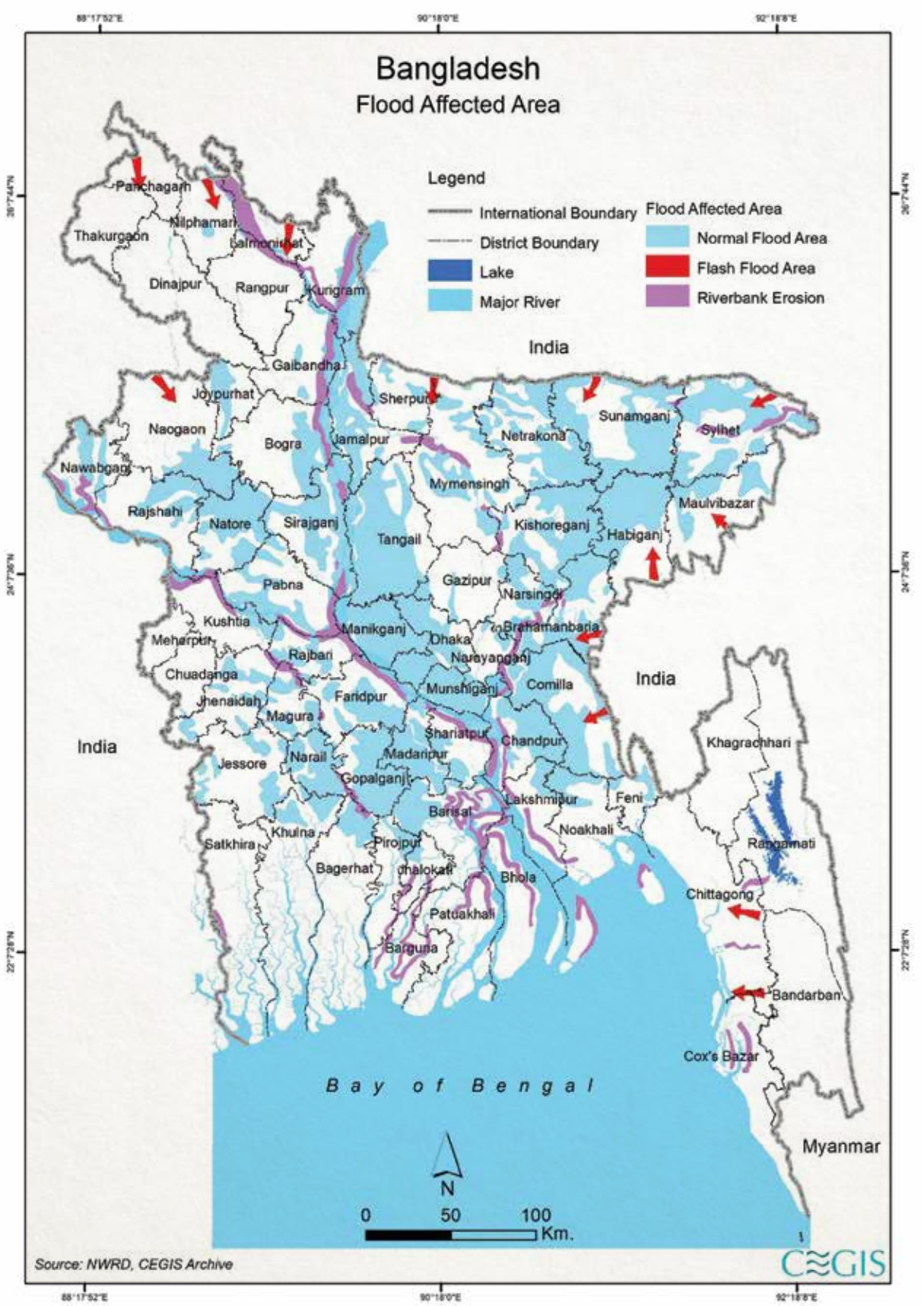


Figure 1.18: Flood inundation map for Bangladesh (Source: CEGIS)

Bangladesh generally experiences four types of flood:

Flash floods occur during mid-April before the onset of the south-westerly monsoon. In particular, flash floods can decimate an annual rice crop when they occur at harvest time. Crop decimation occurred four times from 2004 to 2014 in the Haor region. The city of Sylhet is also prone to flash floods.

01

Rain-fed floods generally happen in the deltas in the South-Western part of the country and are increasing in low-lying urban areas. In 1988, record floods inundated 250 square kilometers (sq km) of Dhaka for 3 weeks. Chattogram also experiences monsoon related floods.

02

River floods are the most common; the areas are inundated during monsoon season along the river and in cases far beyond the riverbanks. Extreme flooding occurs when the rivers flood at the same time, or when the rivers flood during a heavy monsoon. For example, Bangladesh's northern region experienced a shorter than average flood period in 2012, while the southwestern region of the country experienced flooding for 49 days.

03

Storm surge floods occur along the coastal areas of Bangladesh, which has a coastline of about 800 km Northern part of Bay of Bengal.

04

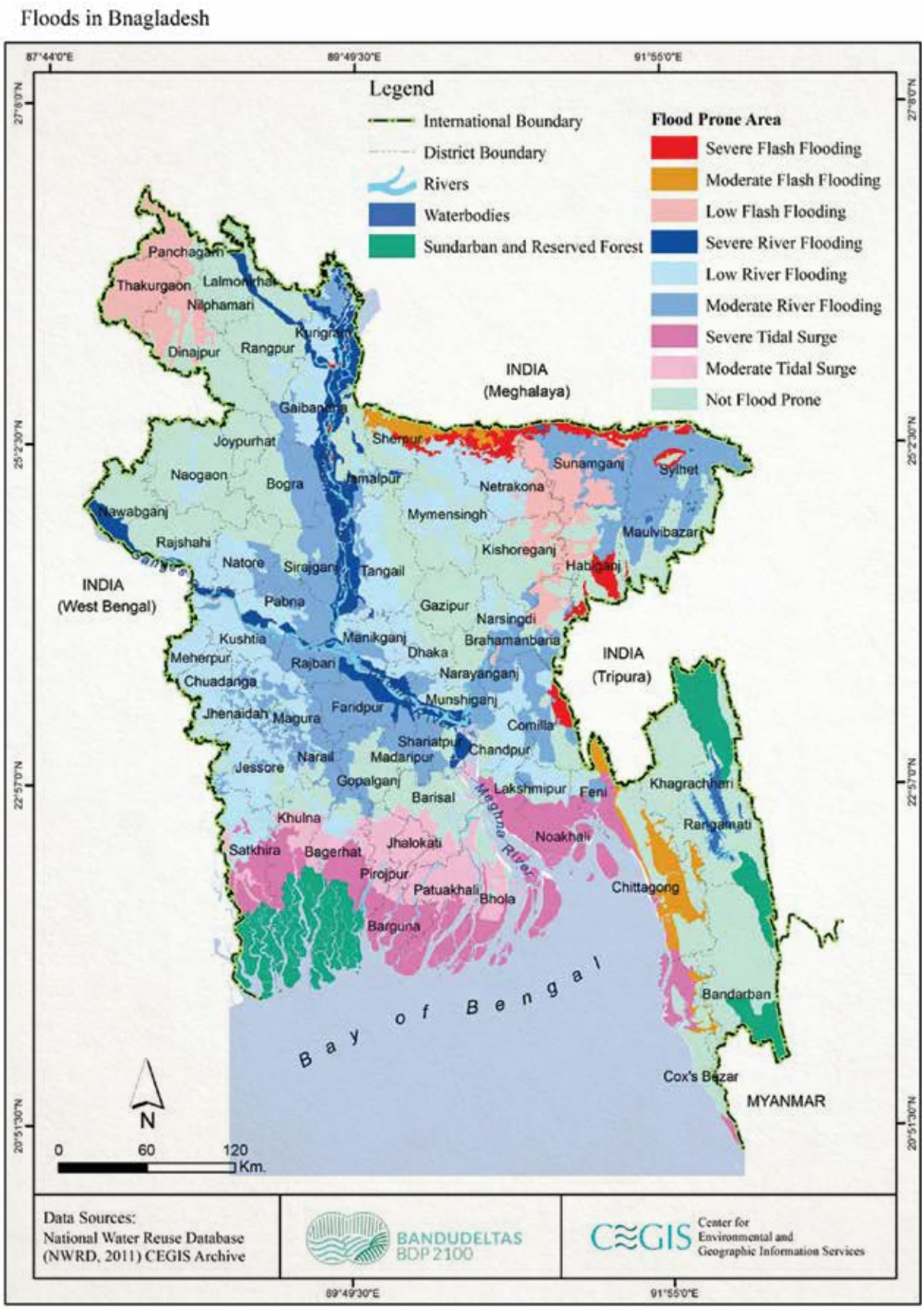


Figure 1.19: Spatial Extent of different types of floods in Bangladesh (Source: BDP 2100 Background studies, 2014)

Some historical mega floods are as follows-

Table 1.7: Historical Mega floods in Bangladesh

Year	Hazard		
	Inundation (%)	Estimated Damage (USD Billion)	Death toll
1954	28%		
1987	35	1	2,055
1988	61	1.2	6,500
1998	69	2.8	1,100
2004	38	2	700
2007	43	2.7	

Drought

Drought is seasonal – northwestern parts of Bangladesh experience drought in the crop season. During the last 50 years, Bangladesh suffered about 20 severe drought episodes. As much as 20 per cent of the main crop - wet season paddy - may be lost in a typical year due to drought. Drought-prone areas are also affected by cold waves with impacts on human health. There is opportunity for supporting resilience to drought through institutional initiatives. The consultations for developing NPDM 2016-2020 strongly suggested the need for addressing drought though structural and non-structural measures.

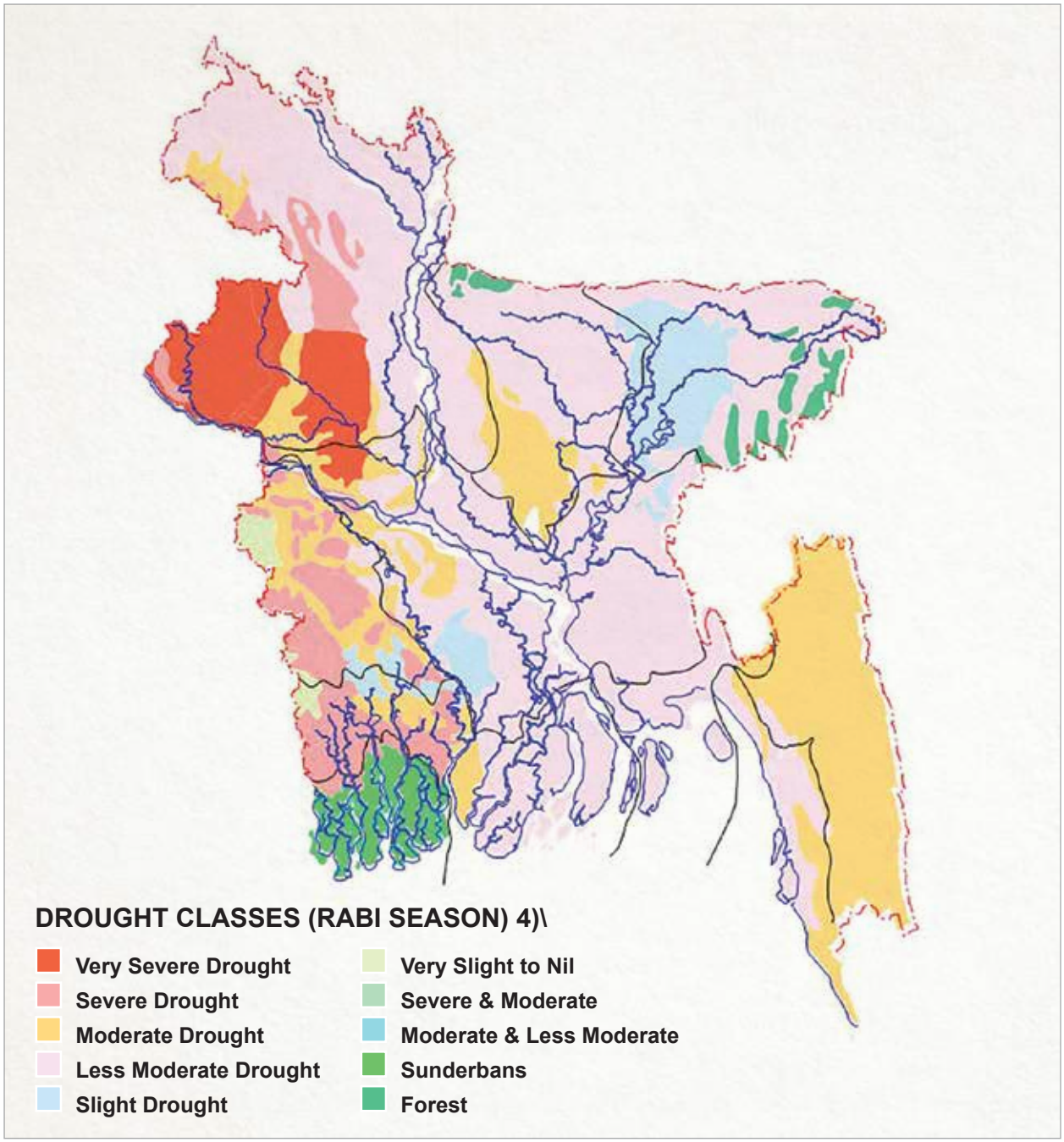


Figure 1.20: Water shortage during dry periods (More Drought)(Source: CEGIS)

Cyclone and surge, tornado

Severe cyclones with storm surges sometimes in excess of ten meters frequently impact Bangladesh's low-lying coast. GoB has a well-coordinated cyclone forecasting, early warning and evacuation system and the cyclone mortality rate has been reduced greatly from 300,000 in 1971 to 138,882 in 1991 from the same category of cyclone. However, growing and higher concentration of assets has resulted in increasing economic losses. Tornadoes are seasonal and occur in the pre-monsoons season. The frequency of tornadoes in Bangladesh is among the highest in the world. The Brahmanaria tornado of 2013 struck 20 villages and killed 31 people and injured around 500 in Brahmanbaria district.

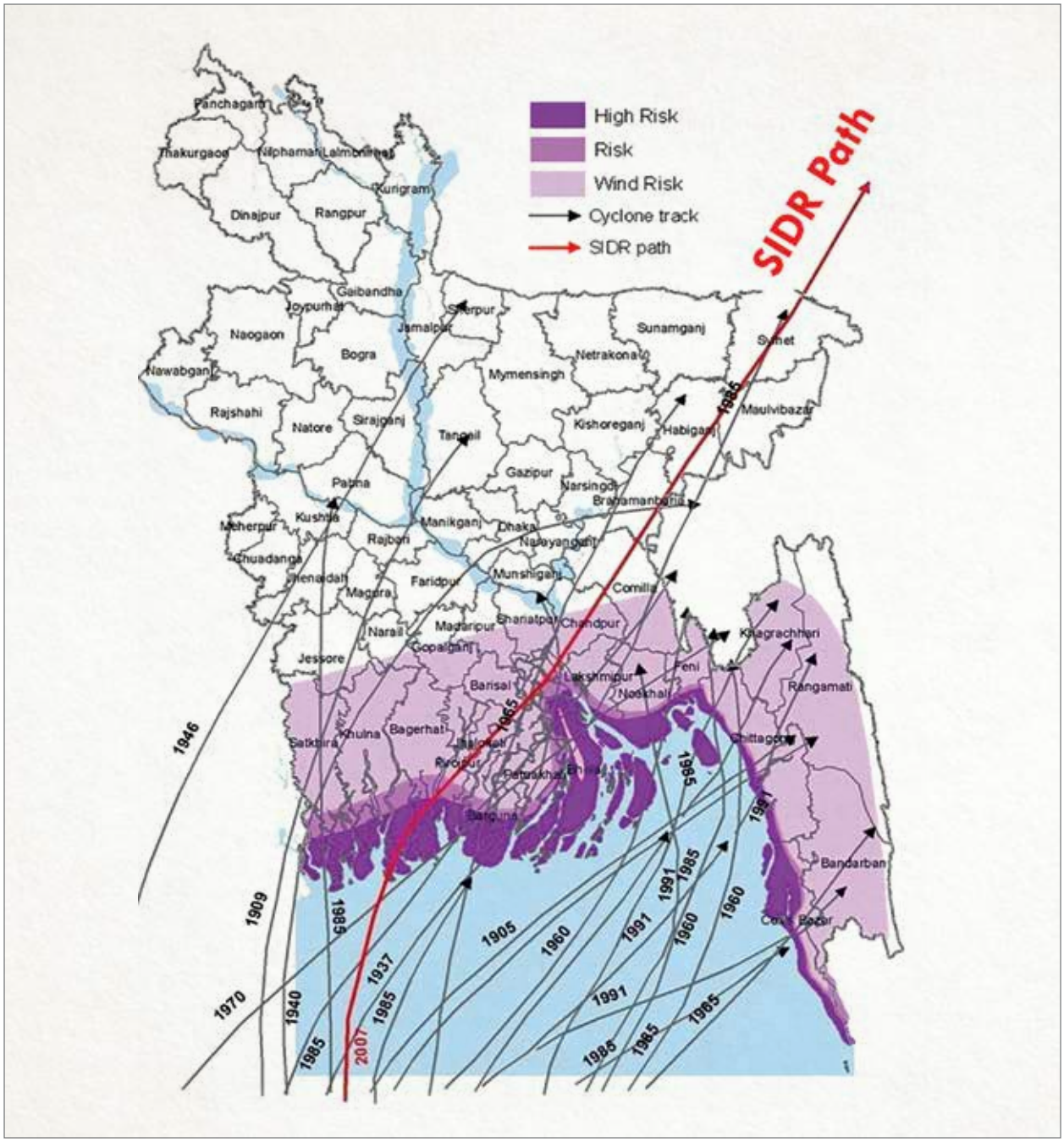


Figure 1.21: Cyclone tracks in Coasta area

Riverbank erosion

Riverbank erosion is a common problem in Bangladesh due to the deltaic topography and it has been forcing people to migrate or resettle. Riverbank erosion has rendered millions homeless; the majority of slum dwellers in large urban and metropolitan towns and cities are victims of erosion. The major rivers like the Jamuna, the Ganges, the Padma, the Lower Meghna, Arial Khan and Teesta are highly erosion-prone. Structural interventions are costly and need to be complemented by non-structural measures, such as erosion prediction and warning. From 2005, prediction activities were funded by the Jamuna-Meghna River Erosion Mitigation Project (JMREMP) and EMIN project of the BWDB and WARPO, and in 2008, by UNDP.

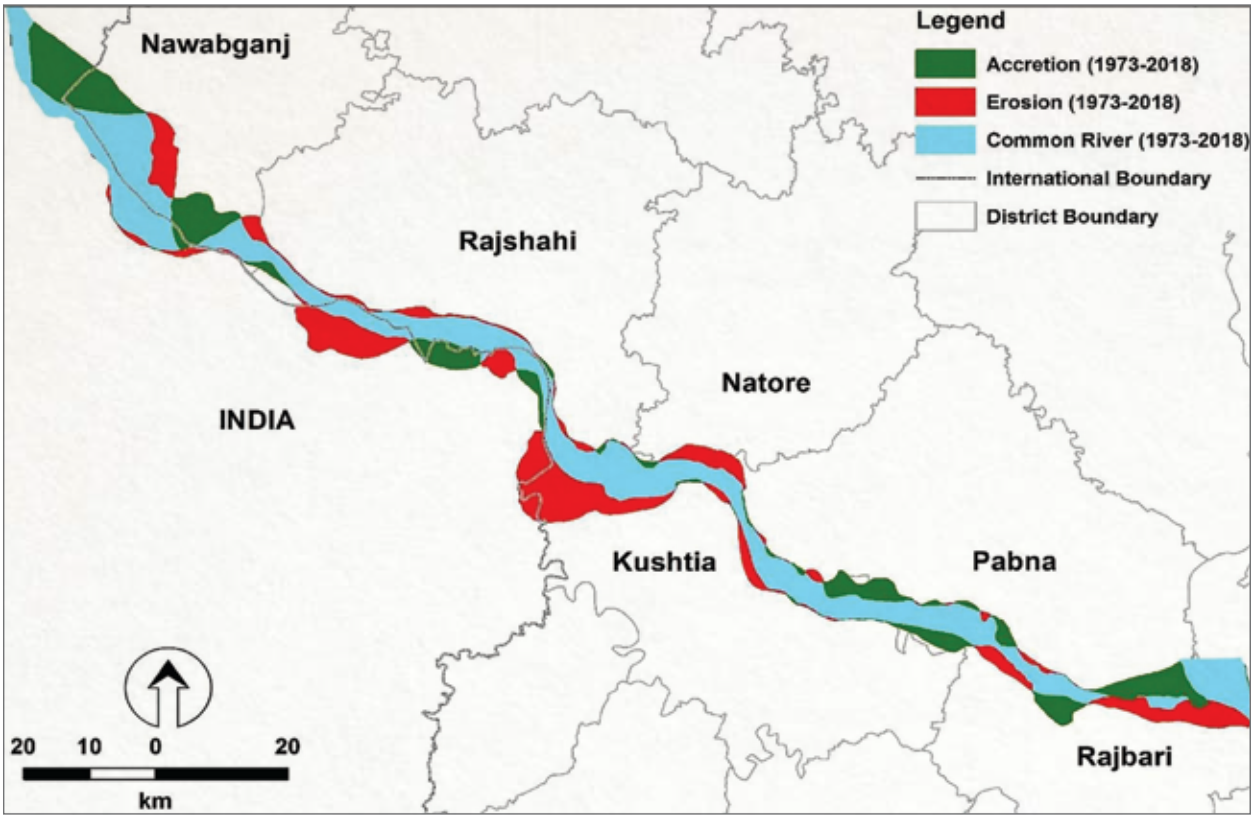


Figure 1.22: Riverbank erosion and accretion in Ganges (Source: BDP 2100, 2018)

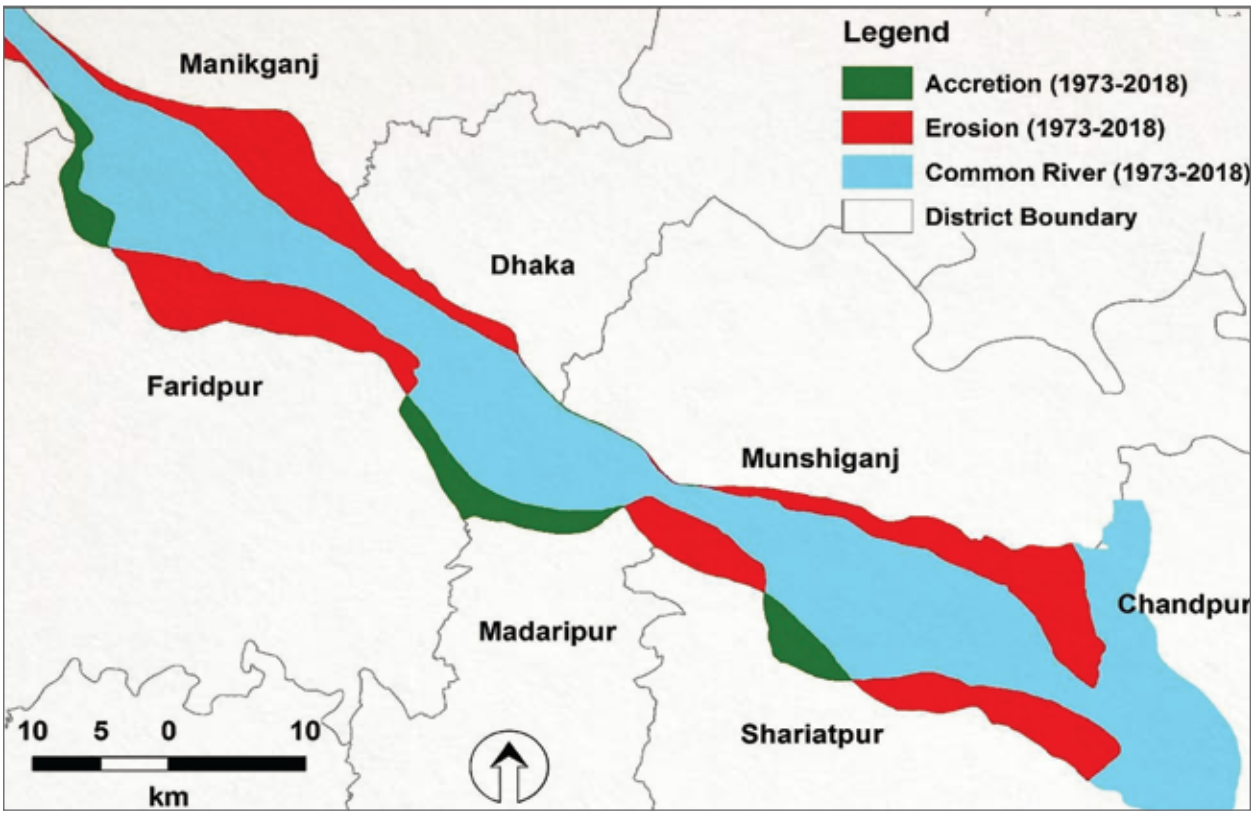


Figure 1.23: Riverbank erosion and accretion in Padma (Source: BDP 2100, 2018)

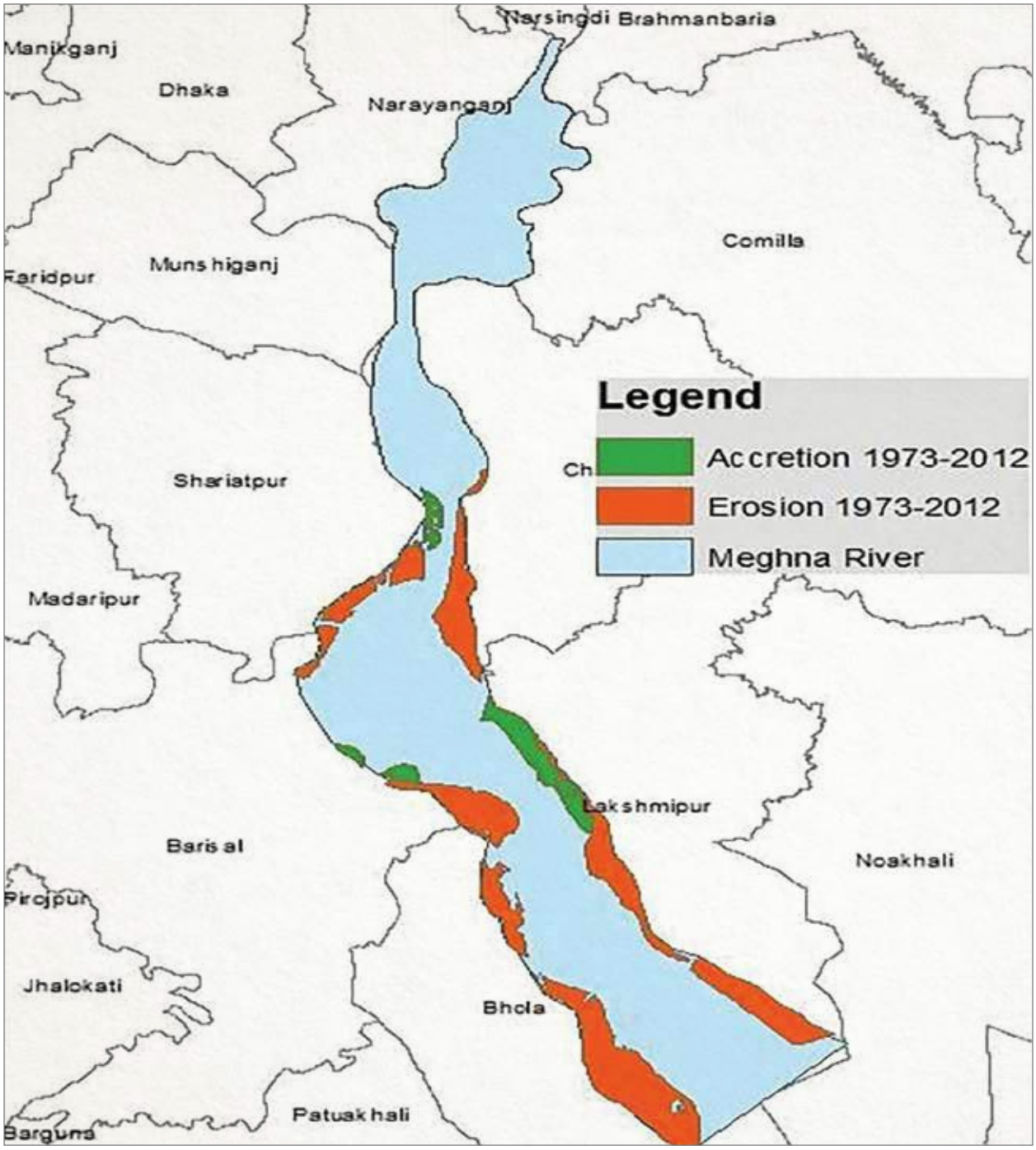


Figure 1.24: Riverbank erosion and accretion in Meghna (Source: BDP 2100, 2018)

Salinity intrusion

Salinity intrusion is an increasing hazard in the coastal areas of Bangladesh, posing a threat to ecosystems, livelihoods and public health and diminishing access to freshwater for household and commercial use. About 20 million people in the coastal areas of Bangladesh are affected by salinity in their drinking water. Bangladesh Water Development Board (BWDB) undertook studies on groundwater availability and found that there was no freshwater layer as deep as 300 meters in some coastal districts. In many cases, saline water was found in aquifers at 200 meters.

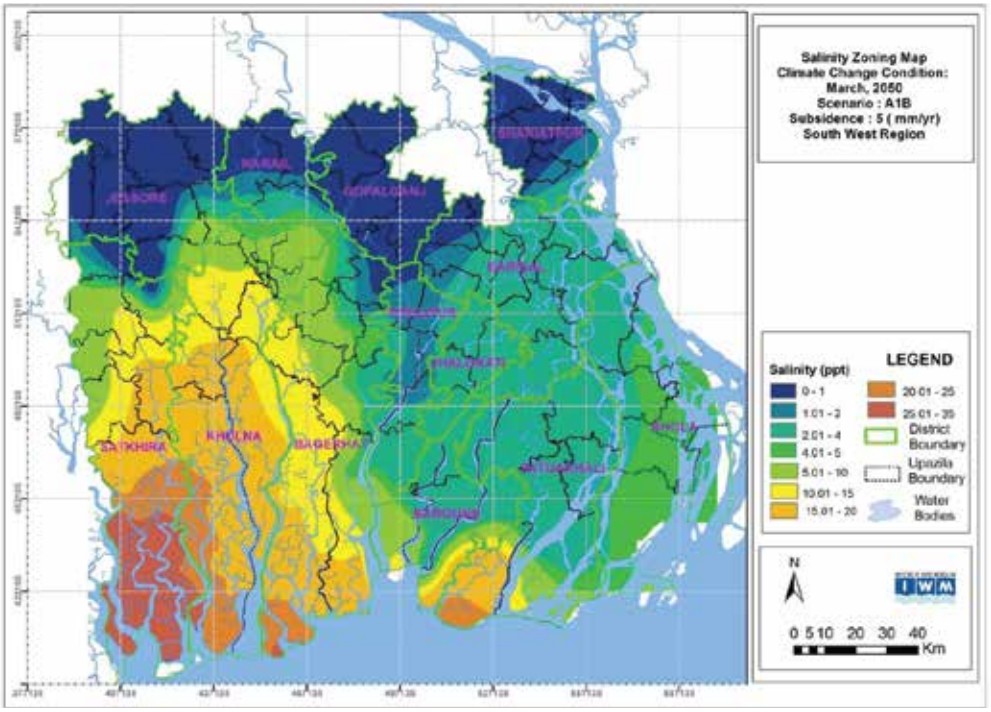


Figure 1.25: Effect of Sea Level on 2 ppt Salinity contour (A1B, 2050) (IWM)

Tsunami

The 2004 Indian Ocean Tsunami raised awareness of the Tsunami hazard, though Bangladesh suffered relatively minor damages. The Bangladesh Meteorological Department monitors Tsunami risk and early warning. A Tsunami inundation risk assessment was undertaken with support from CDMP for the coastal areas of Bangladesh. The assessment identified fault zones in the Bay of Bengal which could possibly cause Tsunami inundation in many coastal areas.

Lightning

Bangladesh is prone to electrical storms. Deaths caused by lightning strike often occur during the pre-monsoon season - usually between March and May and often in rural areas where people work outdoors. The open haor areas are particularly at risk. MoDMR has declared lightning strike as a hazard in Bangladesh . In recent years, Sunamganj has faced the highest lightening.

1.3.11 Exposure

The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected. Vulnerable populations are exposed to multiple risks including reduced agricultural productivity, risks to unique and threatened systems, increased exposure to disease vectors and extreme weather events. Simply, exposure is the fact of experiencing something or being affected by it because of being in a particular situation or place.

1.3.12 Sensitivity

Climate sensitivity refers to the change in the annual global mean surface temperature in response to a change in the atmospheric CO_2 concentration or other radiative forcing.

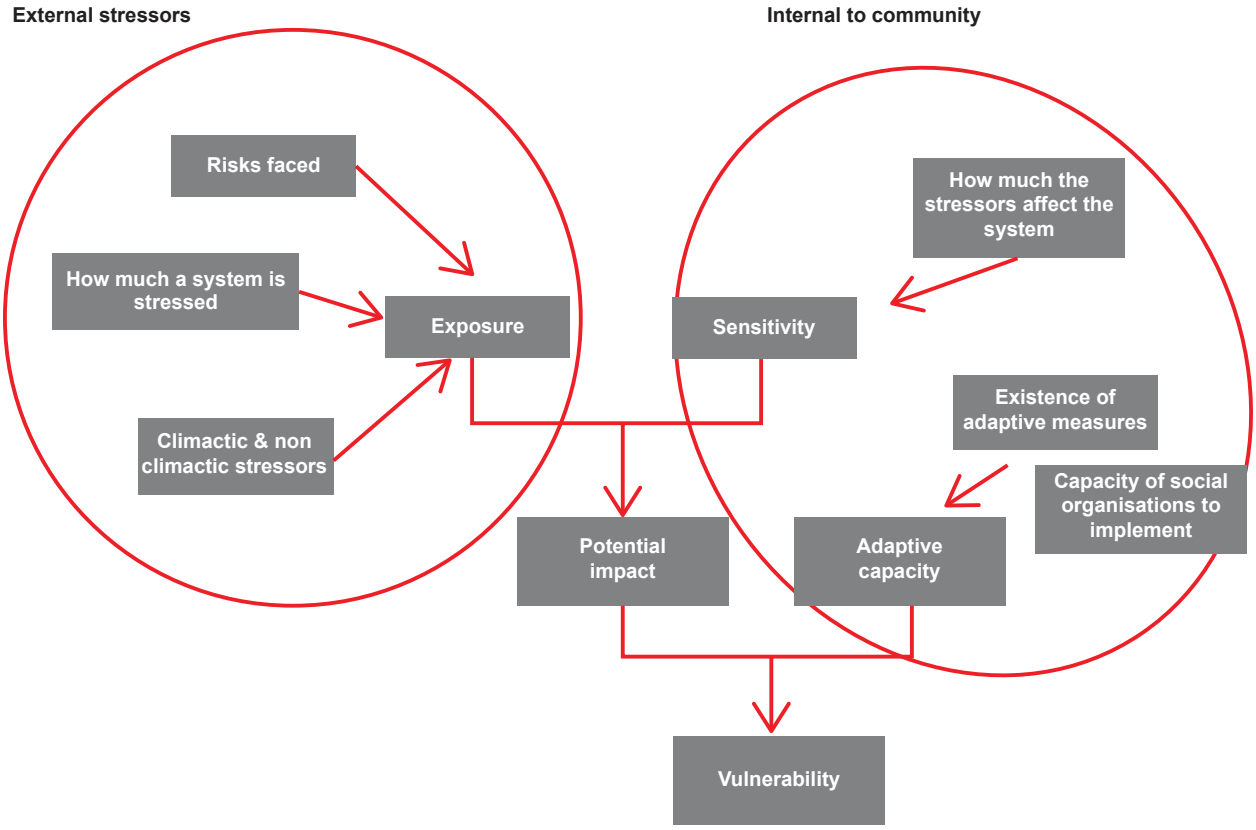
Equilibrium climate sensitivity- Refers to the equilibrium (steady state) change in the annual global mean surface temperature following a doubling of the atmospheric carbon dioxide (CO2) concentration. As a true equilibrium is challenging to define in climate models with dynamic oceans, the equilibrium climate sensitivity is often estimated through experiments in AOGCMs where CO2 levels are either quadrupled or doubled from pre-industrial levels and which are integrated for 100-200 years. The climate sensitivity parameter (units: °C (W m–2)–1) refers to the equilibrium change in the annual global mean surface temperature following a unit change in radiative forcing.

Effective climate sensitivity- An estimate of the global mean surface temperature response to doubling of the atmospheric carbon dioxide (CO2) concentration that is evaluated from model output or observations for evolving non-equilibrium conditions. It is a measure of the strengths of the climate feedbacks at particular time and may vary with forcing history and climate state, and therefore may differ from equilibrium climate sensitivity.

Sensitivity results from dependence on the environment for livelihoods, food, shelter and medicine; lack of access to decision making and justice, geographical context, a range of intersecting inequalities including financial, socio-economic, cultural and gender status. The 1991 cyclone in Bangladesh illustrates many of these issues. More than 90 percent of the estimated 140,000 fatalities were women; their limited mobility, skills set and social status exacerbated their vulnerability to this extreme weather event.

1.3.13 Adaptive Capacity

The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Adaptive capacity refers to the pool of assets (social, physical, financial, natural, human, and cultural) and resources (technological, knowledge and governance) which an individual, household or community may mobilize to build resilience to climate change impacts.



1.3.14 Vulnerability

The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Quantitative assessment of vulnerability is usually performed by constructing a 'vulnerability index'. This index is based on several sets of identified indicator that result in vulnerability of a region. It produces a single number, which can be used to compare different regions. Concept of vulnerability implies that the first two components together represent the potential impact and adaptive capacity is the extent to which these impacts can be averted. Thus vulnerability is potential impact (I) minus adaptive capacity (AC). E.g.

Vulnerability = Exporsure (E) + Sensitivity (S) – Adaptive Capacity (AC) or,
= Potential impact (PI) – Adaptive Capacity (AC)

1.3.15 Impacts of Climate Change

Effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

Global Impact

Global warming is likely to be the greatest cause of species extinctions this century. The Intergovernmental Panel on Climate Change says a 1.5°C average rise may put 20-30% of species at risk of extinction. If the planet warms by more than 2°C, most ecosystems will struggle. Many of the world's threatened species live in areas that will be severely affected by climate change. And climate change is happening too quickly for many species to adapt.

Climate change is amplified in the polar regions. The earth's North and South extremities are crucial for regulating our planet's climate and are particularly vulnerable to the impacts of global warming, which has global consequences.

According to IPCC AR5, some global climate change impacts are as follows-

- Rising temperatures, drought, and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces global yields of wheat by 6.0%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%.
- Globally, agricultural yields fall rapidly between 1°C -3°C of warming. Once local temperatures reach 3°C above pre-industrial levels, all crops are negatively affected, wherever they are in the world - including in temperate zones. Fish species go locally extinct, with serious impacts on fisheries.
- Glaciers in the high mountains of Asia play an important role in supplying water to millions of people living downstream. 800 million people are at least partly dependent on melt water from glaciers. Around a third of the ice stored in these glaciers will be lost by the end of the century under 2°C temperature rise.
- Under a high emissions scenario (RCP8.5) where temperatures rise 4°C-6°C by the end of the century, and unequal development practices, South Asia could see about 35.7 million climate migrants by 2050. By the middle of the century, climate migrants are predicted to make up about 23% of all internal migrants in South Asia.

- A 4°C temperature rise is estimated to lead to sea level rise of nearly nine meters over several hundred years as it triggers melting of the Antarctic and Greenland ice sheets. This level of sea level rise would inundate all the world's coastal cities. 470 to 760 million people currently live in at-risk areas, including 145 million people in China. Bangladesh, India, Vietnam, Indonesia, Japan, the Philippines, Thailand, and Myanmar all have more than 10 million people living in areas at risk.

Local Impact

Impacts of climate change in Bangladesh is highly apparent. Some impacts are as follows:

- Excessive rainfall at times, untimely and irregular heavy rainfall.
- Temperature variation, change of seasonal cycle, cloudy and cold winter.
- Intensity of increased mist/fog in the winter.
- Increase in frequency of flash flood.
- Increase in droughts and dry spells, storms and hailstorms.
- Increase in tidal bores, increase in number of cyclonic conditions and variation in tidal flow.
- Increase of intensity and duration of natural disasters such as floods, cyclones and storm surges.
- Salinity intrusion due to sea level rise.
- Inundation due to sea level rise leading towards "Climate Migrants".
- Effect on health and livelihood of coastal people.
- Effect on bio-diversity, ecology & the Sundarbans .
- Hampered food security & social security.
- SLR increases tidal limits in coastal rivers, and consequent river siltation causes drainage congestion and coastal flooding.
- Under a high emissions scenario (RCP8.5) where temperatures rise 4°C-6°C by the end of the century, Bangladesh could see about 6.7 million climate migrants by 2050. This is about 3.4% of the current population (IPCC AR5).

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. (BDP2100, 2018).

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. (BDP2100, 2018).

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. (BDP2100, 2018).

Agriculture will suffer additionally from the higher incidence of flooding caused by climate change, including from inundation caused by sea level rise. (BDP2100, 2018).

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 upland 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. (BDP2100, 2018).

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 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. (BDP2100, 2018).

Health hazards will also be intensified due to climate change. Water-borne diseases, such as diarrhea and dysentery, and vector-borne diseases, such as malaria and dengue, are climate sensitive. Projections show growing morbidity could occur from dengue and malaria. (BDP2100, 2018).

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. (BDP2100, 2018).

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. (BDP2100, 2018).

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. (BDP2100, 2018).

Sectoral Impacts

Due to the geographical location Bangladesh is one of the most vulnerable countries in the perspective of climate change (German Watch, 2016). Bangladesh is continuously facing the adverse effect of climate variability and changes throughout last two decades, which is threatening for the sustainable development and economic growth of the country. Due to the climate change, vulnerability of different sectors in Bangladesh is increased such as, Agriculture, Energy Sector, Water Resources and WASH (Water supply and sanitation), Public Health, Forest & Biodiversity, Industries and Infrastructure etc.

Agriculture, Livestock and Fisheries

Agriculture is highly dependent on the climate. Increase of carbon dioxide (CO2) in the atmosphere can increase some crop yields in some places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers and threaten food safety. The impact of climate change are causing change in crop-weed competition dynamics, range changes of pests & pathogens, expanded range predicted for many pathogens, less-cold winters allow increase in pests, different range changes between pests & pathogens and natural controls, decreased biodiversity in natural ecosystems, etc. The population, disease prevalence, THI index, feed intake, milk & egg production, conception rate, etc. of livestock are also being effected due to climate variability. Fisheries sectors are as well as realized the impact with the decrease in safety and efficiency of fishing operations, loss/damage to livelihood assets, and increase in adaptation & mitigation costs, etc.

Energy Sector

Increases in temperature will increase our energy demand but are likely to reduce energy generation efficiency. Along with the increase of cooling demand, it will create pressure on the capacity of generation and grid network. Hydropower generation is dependent on the annual precipitation, evaporation and many other hydrological parameter. Change in this parameter pattern, surface water discharge and also the increasing frequency and intensity of droughts can impact the power generation capacity of hydropower plant. Natural disaster or various extreme weather events, like stronger storms along with more frequency can reduce the fuel supply (coal, oil, gas) furthermore reduce the input of energy (e.g., water, wind, sun, biomass), hence damage the generation and also the grid infrastructure in general.

Water Resources and WASH

As a result of sea level rise, salinity intrusion has become a common cause for ground water pollution in the coastal zone of Bangladesh. By the reason of, less precipitation and river flow during dry season in the drought prone areas like north-western part of Bangladesh and salinity intrusion in coastal region, safe drinking water is likely to become an acute problem in those zone. Due to the sea level rise, longer and unpredictable periods of flash flood and flood, increment in intensity and frequency of extreme precipitation events; water logging and drainage concession are recently more frequent and likely to put sewerage networks under additional pressure. Reduction of groundwater recharge will have an adverse effect on the ecology during the dry season, due to the scarcity of water.

Specific levies (through a tariff system) already exist in the Water Supply, Sanitation and Health (WASH) sector. Current cost recovery levels in this sector are low, as well as their service levels, but WASH operators are gradually improving their business. Both WASAs in the major city of Dhaka and Chattogram are gradually operating in a more sustainable way, significantly upgrading their service level (including drinking water quality) and applying more affordable (block) tariffs aimed at full cost recovery in a 10-years period. In the short term, this process would also be started in cities where City Corporations are responsible for these services. Dependency on the GoB's budget for investments in this WASH sector will slowly come down as full cost recovery principles would be introduced gradually.

Public Health

Climate and weather have a compelling influence on human health and livelihood. A change in any climate variable is likely to alter our health and well-being. Many of these impacts on public health are greater risk of injury, disease and death by cause of more intense heat waves and fires; increased risk of under nutrition resulting from diminished food production in poor regions; consequences for health of lost work capacity and reduced labor productivity in vulnerable populations; increased risks of food- and water-borne diseases (very high confidence) and vector-borne diseases, etc.

Forest & Biodiversity

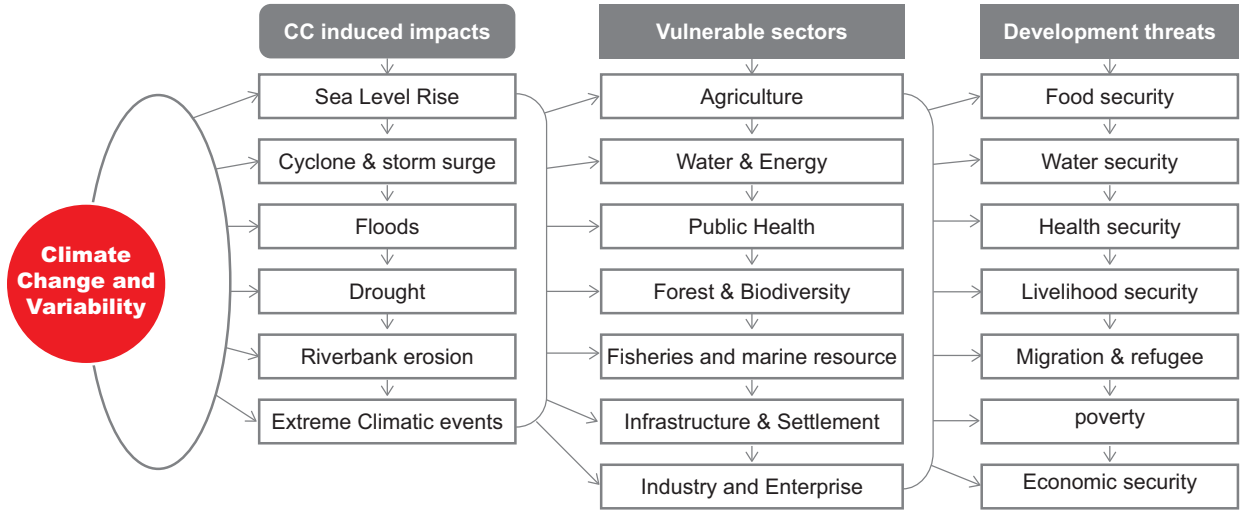
Climate related event will develop a negative impacts on the forests. According the report of IPCC (Intergovernmental Panel on Climate Change), the impact on the ecosystems of the tropical forest will be very severe. Reduction of natural forest due to non-stop deforestation is threatening for valuable wildlife and degrading the micro-climate in both forests and adjacent regions.

Loss of Biodiversity is caused by storms, floods, droughts, and other consequences of climate change. Climate change leads to the migration and extinction of some species, including the inability of many species to cope and adapt to change; an increase in the populations of alien invasive species; and major loss of biodiversity through changes in the community.

Industries and Infrastructure Sector

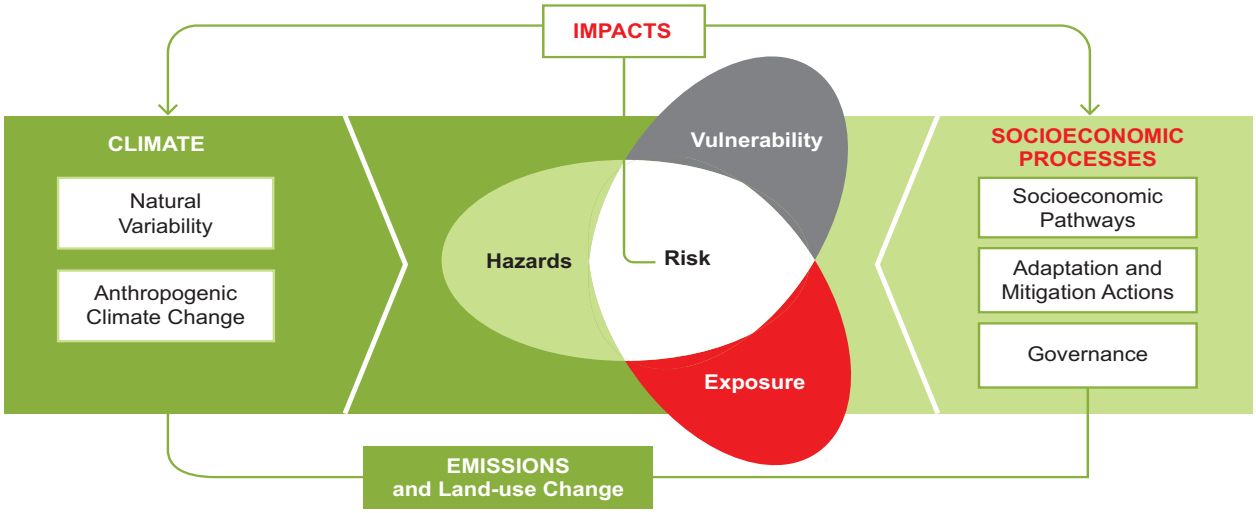
Most of the industries of Bangladesh use ground water for washing, dyeing and finishing, processes which require large volumes of water. Aquifer levels are falling day by day due to the extensive extraction of groundwater, which will results to water shortage in near future. Floods, especially the high intensity floods, often damage different physical infrastructure such as road networks, educational centers, market places, administrative buildings, flood protecting, etc.

Impact Vulnerability and Development Linkage



1.3.16 Risk

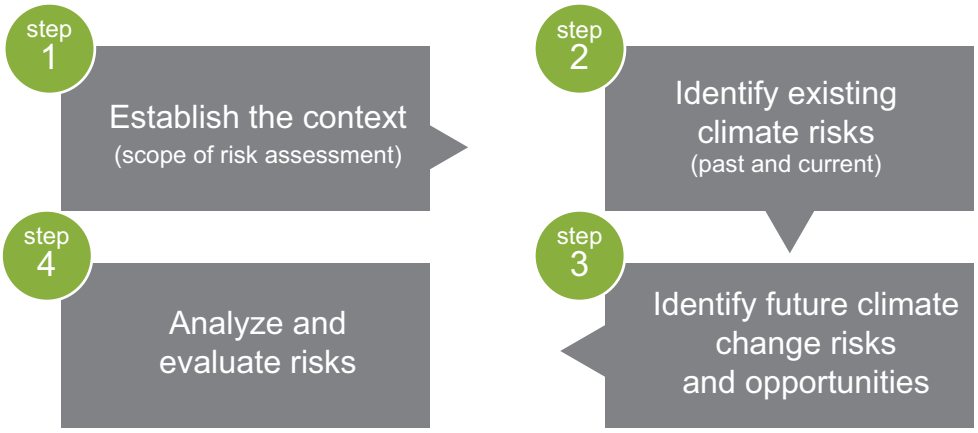
The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risks of climate-change impacts.



If any one of these sides increases, the area of the triangle increases, hence the amount of risk also increases. If any one of the sides reduces, the risk reduces. If we can eliminate one side there is no risk.

Climate Change Risk Assessment

Climate change risk assessment can help organizations identify their climate change related risks or to test their existing risk management strategies under climate change and therefore identify areas where new strategies are needed. A risk assessment is an integrated part of any adaptation planning process shown in following figure. However, the scale of the assessment should depend on the objectives as well as the resource availability of the organization conducting the assessment.



1.3.17 Mitigation

Climate change mitigation consists of actions to limit the magnitude or rate of long-term global warming and its related effects. Climate change mitigation generally involves reductions in human (anthropogenic) emissions of greenhouse gases (GHGs). Mitigation may also be achieved by increasing the capacity of carbon sinks, e.g., through reforestation.

Mitigation is an intervention to reduce the emissions sources or enhance the sinks of greenhouse gases while adaptation is an 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (IPCC 2001).

1.3.18 Adaptation

Climate Change Adaptation refers to adjustments in environmental, social or economic systems in response to climate change impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to increase benefit from opportunities associated with climate change.

The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Incremental adaptation: Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale.

Transformational adaptation: Adaptation that changes the fundamental attributes of a system in response to climate and its effects.

Transformation: A change in the fundamental attributes of natural and human systems.

Adaptation		
Protect	**Accommodation**	**Retreat**
▪ Dykes, Levees, Floodwalls ▪ Floodgates, Tidal Barriers ▪ Detached Breakwaters ▪ Wetland Restoration ▪ Afforestation	▪ Emergency Planning ▪ Insurance ▪ Improved Drainage ▪ New Techniques of Crop Cultivation ▪ Alternate Livelihood	▪ Establish Retreat Zone ▪ Relocate Threatened Area ▪ Erosion Control Easement ▪ Upland Buffers

For protection, the most visibly reassuring option may be to build hard structures such as sea-walls. But apart from being very expensive these can have damaging side effects, for example by displacing erosion and sedimentation. It may be better therefore to consider soft options that involve restoring dunes or creating or restoring coastal wetlands, or continuing with indigenous approaches such as afforestation (UNFCCC, 2006).

For retreat, the simplest approach might be to establish a set-back zone requiring development to be at a specified distance from the water's edge. And there are also intermediate options in the form of "easements" – legal agreements that restrict the size or density of structures within areas at risk and specify permitted types of shoreline stabilization. The area to which these apply can also be designed to automatically move or "roll" landward as the sea advances (UNFCCC, 2006).

For accommodation, there is a variety of options. These will include warning systems for extreme weather events, as well as longer-term measures such as new building codes, or improving drainage systems by increasing pump capacity or using wider pipes (UNFCCC, 2006).

Priority areas for climate change adaptation are food security, livelihood and health protection (including water security), comprehensive disaster management, coastal zone management including salinity intrusion control, flood control and erosion protection, building climate resilient infrastructure, increased rural electricity, enhanced urban resilience, increasing resilience of vulnerable groups, development of climate resilient cropping systems, development of surveillance systems for existing and new disease risks, ecosystem based adaptation (including forestry co-management), community based conservation of wetlands and coastal areas, implementing drinking water and sanitation programs in areas (e.g., coastal areas, flood- and drought prone areas) move at risk from climate change, policy and institutional capacity building, technology transfer, good governance, private public partnership (ppp), etc.

Adaptation priorities for Bangladesh are as follows: (Source: TNC 2018)

- Improved early warning systems for tropical cyclones, floods, flash floods and drought.
- Disaster preparedness and construction of flood and cyclone shelters.
- Protection against tropical cyclones and storm surge.
- Inland monsoon flood-proofing and protection.
- Climate resilient infrastructure and communication.
- Climate resilient housing.
- Repair and rehabilitate existing infrastructure (including coastal embankments, river embankments and drainage systems, urban drainage systems).
- Plan, design and construction of urgently needed new infrastructure (various types of shelters, low cost disaster resilient housing, protection schemes, water management structures, etc.).
- Improvement of urban resilience through improvement of drainage systems to address urban flooding.
- River training and dredging (including excavation of water bodies, canals and drains).
- Development and dissemination of stress tolerant (salinity, drought and flood) varieties of rice; improved varieties of livestock and fisheries.
- Research and knowledge management.
- Adaptation based on local-level perspectives.
- Adaptation to climate change impacts on health.
- Biodiversity and ecosystem conservation.
- Capacity building at individual and institutional level to plan and implement adaptation programmes and projects in Bangladesh.

1.3.19 Resilience

According to IPCC AR5, resilience is the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Resilience might come down to three things: the ability to adapt to changes, anticipate what might happen next and absorb shocks when they do come along. Efforts to build resilience to climate impacts – from more frequent droughts and stronger storms, to creeping sea-level rise and failed harvests – aim to ensure families, communities and governments can manage and bounce back from them.

1.3.20 Technologies

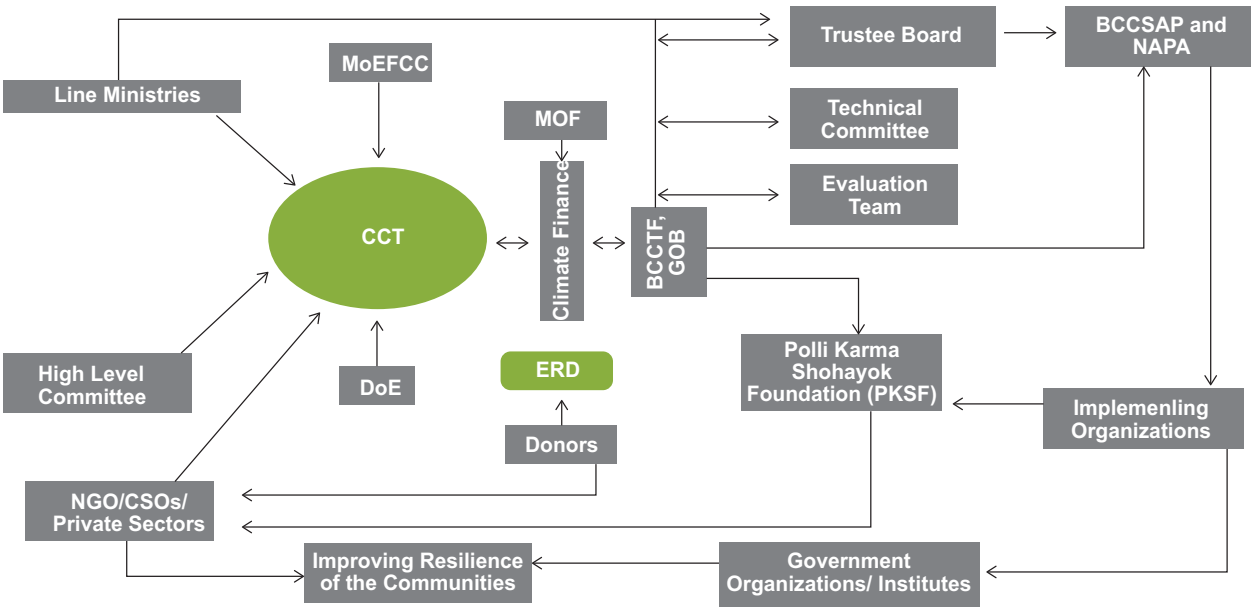
A fresh wave of technological innovation is deepening our understanding of tough environmental challenges — and also giving us new ways to solve them.

People may adapt to climate change by changing their behavior such as by moving to a different location or by changing their occupations. But they may also employ different forms of technology, whether “hard” forms, such as new irrigation systems or drought-resistant seeds, or “soft” technologies, such as insurance schemes or crop rotation patterns. They may also use a combination of hard and soft, as with early warning systems that combine hard measuring devices with soft knowledge and skills that can raise awareness and stimulate appropriate action. Many of these technologies are being used nowadays (UNFCCC, 2006).

Farmers have taken advantage of technological advances to cope better with arid environments, introducing new crop hybrids and making better use of scarce water, as with systems of drip irrigation. Nowadays human societies can also take advantage of “high” technologies such as earth observation systems that can provide more accurate weather forecasts, or crops that are based on genetically modified organisms (UNFCCC, 2006).

1.3.21 Capacity Development

Conceptual Framework on Institutional Arrangement to Address Climate Change in Bangladesh



1.3.22 Climate Change Financing

The government of Bangladesh has established a number of institutions/funds and other initiatives in the last few years for to address the issues of climate change considering the uncertainties and inadequacies of international adaptation finance from both multilateral and bilateral sources.

Initiative for National Funding

Bangladesh Climate Change Trust Fund (BCCTF) is managed and coordinated by the Ministry of Environment, Forest and Climate Change (MoEFCC). Government dedicated funding is provided to the projects, which include: food security; social protection and health; disaster management; infrastructure; knowledge management; climate change mitigation; and capacity building and institutional strengthening.

The Bangladesh Climate Change Resilience Fund (BCCRF) is a coordinated financing mechanism of the government, the World Bank, and development partners which address the impacts of climate change (BCCRF, 2013). Providing donor-funded support to implement the programs of BCCSAF is the main purpose of BCCRF. The fund was established in May 2010 with financial support from Denmark, the European Union, Sweden and United Kingdom. Australia, Switzerland and United States subsequently joined the fund. The Government of Bangladesh (GoB) approved Climate Fiscal Framework (CFF) in June 2014. This frame work ensure the effective use of domestic and international climate finance within the national budget process.

(Source: TNC 2018)

Table 1.8: Climate Change Finance Scenario of Bangladesh

Sources of climate finance	Intermediaries	Economic and financial instruments	Financial planning systems and institutional arrangements	Uses and users climate finance
National public finance (national budget)	Bangladesh Climate Change Trust Fund Ministry of Environment and Forest	Grants Fixed deposits	Bangladesh Perspective Plan (2010-2021) Sixth Five Year Plan (2011-2015) BCCSAP (2009) Bangladesh Climate Change Trust Act (2010) National budget	Various BCCSAP initiatives, implementing government agencies, local non-governmental organizations, universities, research organizations
National private finance	Green banking through Central Bank Commercial Banks	Concessional loans Refinancing	Policy guidelines for green banking (2011)	Renewable energy, green buildings, clean transportation, water management, waste management, land management
Multi-donor international public finance	Bangladesh Climate Change Resilience Fund World Bank	Grants	BCCSAP	Various BCCSAP initiatives
International public finance	Climate Investment Funds Multilateral development banks Ministry of Environment and Forests	Grants (45%) Concessional loans (S5%)	BCCSAP	Improving climate resilient agriculture and food security, strengthening the security and reliability of fresh water supply, sanitation, infrastructure, enhancing the resilience of coastal communities and infrastructure
	GEF (Least Developed Countries Fund)	Grants	BCCSAP GEF policies and procedures	Biodiversity, climate change, land degradation

(Source: TNC, 2018)

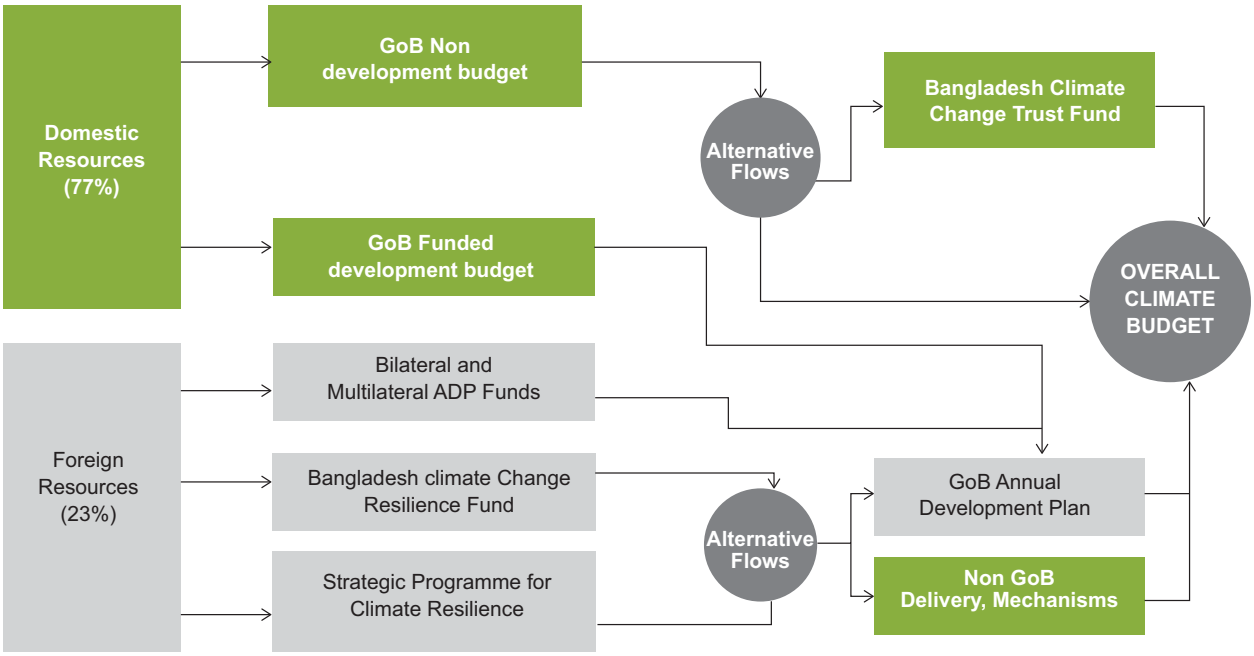
Initiative for International Funding

Strategic Programme for Climate Resilience (SPCR) Bangladesh: The Climate Investment Funds (CIFs) at the World Bank proved to be controversial at their inception in 2008 with DFID in the UK as a principle funder, when it announced allocating what at that time were termed the Environmental Transformation Funds through the World Bank.

Clean Development Mechanism (CDM) is a flexible mechanism of the Kyoto Protocol which is controlled by United Nations Framework Convention on Climate Change (UNFCCC). With an emission-reduction or emission-limitation commitment under the Kyoto Protocol a developed country is allowed to implement an emission-reduction project in developing countries. A two-tier designated national authority (DNA) is established to implement CDM activities in Bangladesh.

Climate Technology Centre & Network (CTCN) is the operational arm of the UNFCCC technology mechanism to facilitate the transfer of technologies among the member countries of the UNFCCC. The Department of Environment (DoE) is the national designated entity (NDE) of the CTCN in Bangladesh. To finance concrete adaptation projects and programmes in developing countries that are parties to the Kyoto Protocol and that are particularly vulnerable to the adverse effects of climate change Adaptation Fund (AF) was established. It is financed from the share of proceeds on CDM project activities and other voluntary sources of funding. The newest edition in the multilateral climate finance architecture is the Green Climate Fund (GCF) in 2015.

(Source: TNC 2018)



1.3.23 International Debates and Negotiations

COP

The COP (Conference of the Parties) is the supreme decision-making body of the United Nations Framework Convention on Climate Change. Currently, there are 197 Parties (196 States and 1 regional economic integration organization)to the UNFCCC. The COP meets every year, unless the Parties decide otherwise. The first COP meeting was held in Berlin, Germany in March, 1995. The COP meets in Bonn, the seat of the secretariat, unless a Party offers to host the session.

Key task for the COP is to

- Review the national communications and emission inventories submitted by Parties.
- Assess the effects of the measures taken by Parties and the progress made in achieving the ultimate objective of the Convention.

Paris Agreement

The Paris Agreement has enshrined three pillars for action to combat climate change:

- Mitigation: reduce emissions to keep global temp well below 2°C above pre-industrial levels, but with the ambition to limit it to 1.5°C);
- Adaptation: To adapt to the impacts these rising temperatures will trigger – more severe and more frequent droughts, flooding, cyclones and hurricane.
- Loss and Damage: The impacts that the world cannot mitigate or adapt to.

The Paris Agreement entered into force on 4 November 2016. The Paris Agreement requires all Parties to put forward their best efforts through Nationally Determined Contributions (NDCs). There will be a global stock take every 5 years to assess the collective progress towards achieving the purpose of the Agreement. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework. A "rulebook" is agreed on COP24 last December, is the detailed "operating manual" needed for the Paris Agreement to enter force in 2020.

Special Report on Climate Change: Global Warming of 1.5° C

- Floods are projected to be more frequent and flood magnitudes greater at 2°C than at 1.5°C in the Brahmaputra River in Bangladesh.
- In coastal regions, increases in heavy precipitation associated with tropical cyclones combined with increased sea levels may lead to increased flooding.
- In a GW dependent irrigated region in NW Bangladesh, the average groundwater level during the major irrigation period (January–April) is projected to decrease in accordance with temperature rise.
- Countries with at least 50 million people exposed to SLR would have high exposure to SLR in the 21st century using 1.5°C and 2°C scenarios.
- Bangladeshi Ganges-Brahmaputra, Indian Bengal, Indian Mahanadi and Ghanese Volta delta land area (without defences) would be exposed unless sedimentation occurs.

This report has not been formally accepted yet because some parties are object to the fact of taking difficult and drastic measures right form to keep temp rise up to 1.5°C.

Negotiations

Climate Change Negotiations take place by groups of countries, LDC and SIDS, G77 and China, African group, Arab Group, EU as a whole and separately, also others Latin American countries.

Negotiation takes place in three issues:

- Funding for adaptation.
- Technology transfer for capacity development.
- Mitigation.

1.4 Mainstreaming Climate Change in the National Planning Process

It is necessary that adaptation of policies or strategies are formulated as part of broader policies for development rather than as a separate hub, for the cross-cutting nature of climate change impacts. As a result, the mainstreaming of climate change issues in the national development planning processes is very important tool to ensure climate change adaptation and to ensure that other development goals are implemented simultaneously (UNDP, 2011).

1.4.1 Bangladesh Delta Plan 2100

Bangladesh Delta Plan 2100 (BDP 2100) is formulated by the government in view of the special long term challenges for development outcomes presented by climate change and natural hazards. BDP 2100 seeks to integrate the short to medium term aspiration of Bangladesh to achieve upper middle income (UMIC) status and eliminate extreme poverty by FY2031. It is integrated with long term challenge of sustainable management of water, ecology, environment and land resources in the context of their interaction with natural disasters and climate change. Although The BDP 2100 looks primarily at the medium term delta agenda (2016-40), it should be mindful that the decisions taken today have implications for the longer term agenda for 2040 and beyond. It sets up a long term vision for the evolution of the Bangladesh Delta by the end of the 21st Century, as well as defines short and medium term goals as steps to reach that vision.

(Source: BDP 2100, 2018)

1.4.2 Perspective plan: Making Vision 2021 a reality

This plan is developed by the Government of Bangladesh (GoB) as a gateway to achieve a prosperous Bangladesh in 2021 within the principles of sustainable development. The plan intends to take positive measures like strengthening regional and national mechanisms for scientific assessment, forecasting and information sharing while building national and local capacities for greater ecological literacy and agro-ecosystem monitoring, and for assessing and managing risks. The plan also included a set of key management strategies to combat the climate change impact for ensuring sustainable development.

(Source: TNC, 2018)

1.4.3 Seventh Five-year Plan (2016-2020)

In the light of the achievement of the Sixth FYP, the Seventh FYP has been formulated with special focus on various dimensions of development where the country is lagging behind. A sustainable development pathway that is resilient to disaster and climate change entails sustainable use of natural resources; and successfully manages the inevitable urbanization transition (planning commission 2015b) are the main focus of this plan.

(Source: TNC, 2018)

1.4.4 Bangladesh Climate Change Strategy and Action Plan, BCCSAP (2009)

BCCSAP is an integral part of the overall development strategy of the country under six thematic pillars and the main focus of the programme is adaptation of climate change impacts and the basic approach is to address economic development and climate change issues in an integrated fashion to increase the resilience of the people and manage climate change impacts through effective adaptive activities. Duration of the programme was 10 years (2009-2018).

(Source: TNC, 2018)

1.4.5 Sustainable Development Goals (SDGs)

In Rio de Janeiro, June 2012, The Rio+20 conferences (the United Nations Conference on Sustainable Development), initiated a process to develop a new set of Sustainable Development Goals (SDGs) which will carry on the momentum generated by the MDGs. For Implementation of SGD 6 which will ensure the availability and sustainable management of water and sanitation for all, United Nations and the World Bank formed a High-level Panel on Water (HLPW) in April 2016. The Prime Minister of the Government of Bangladesh was selected as one of the members of HLPW and the representative of Asia. The Government of Bangladesh has started preparing action plans to meet SDG goals.

(Source: TNC, 2018)

1.4.6 United Nations Development Assistance Framework (UNDAF) 2012-2016

The first five-year strategic programme framework is developed by the UN System in Bangladesh during 2006, which was a reflection of its commitment to national development priorities. Ensuring environmental sustainability is the main focus of this framework. The governments' priority areas were promoting better environmental sustainability and building better energy and other infrastructures. The expected outcomes under this pillar were: By 2016, populations vulnerable to climate change and natural disaster would become more resilient to adaptation to risk and vulnerable populations would be benefited from natural resource management (NRM); environmental governance and low-emission green development (UNDP, 2011b).

(Source: TNC, 2018)

1.4.7 National Plan for Disaster Management

In 1997, a standing Order on Disaster was introduced by the Ministry of Food and Disaster Management (now the Ministry of Disaster Management and Relief). National Plan for Disaster Management is lunched by the government which was implemented in the period of 2008 to 2015. The plan document includes climate change and country development policies and explains how different parts of the country become vulnerable to disasters. It also acknowledges that floods and riverbank erosion are rendering people homeless (The Disaster Management and Relief Division, 2010).

(Source: TNC, 2018)

1.4.8 National Adaptation Programme of Action (NAPA) 2009

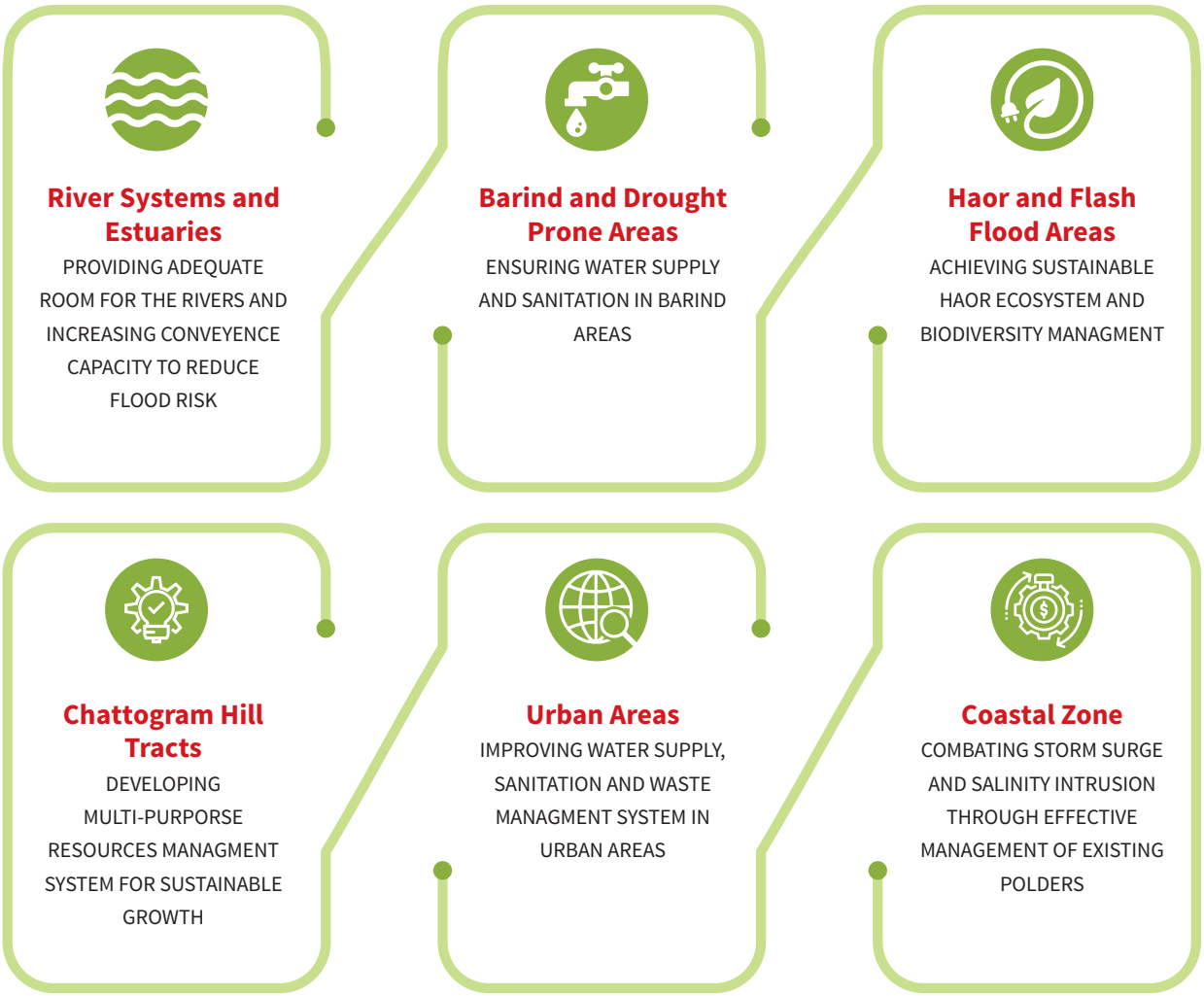
This programme is developed by LGED in 2005, which was further updated in 2009 and suggested 45 measures to address adverse effects of climate change, including variability and extreme events.

Under NAPA, one project that has been completed and received several awards is the 'Community-based Adaptation to Climate Change through Coastal Aforestation in Bangladesh' (coastal aforestation /NAPA project). 18,269 households, engaging citizens in aforestation, agriculture, livestock, and fishery-based livelihood adaptation and training measures was covered in this project. In the development of the FFF (Forest-Fish-Fruit) Model, one of the significant adaptation response measures was used which is, a mound-ditch model that comprises short and long-term resource and income generation, as well as livelihood diversi fication (UNDP, 2015).(Source: TNC, 2018).

(Source: TNC, 2018)

Exhibit 1: BDP 2100 Strategies

The BDP 2100 comes up with an adaptive, holistic and long term strategic plan to steer the opportunities for national development. After periodic review and update in Five Year Planning cycle, these adaptive strategies are selected offering integrated implementation with innovation, advanced information technology and strengthened institutional capacity. Following some of those strategies are selected for exercises in next few modules.



Strategies for Cross-Cutting Issues

a. Renewable Energy

- INCREASING SHARE OF RENEWABLE ENERGY IN TOTAL ENERGY PRODUCTIO

Exhibit 2: Fact Sheets on BDP2100 Hotspots and Cross Cutting Issue

Hotspots

In BDP 2100, 2018, these 8 hydrological regions are divided in 6 “Hotspots” shown in Figure 1.26. Hotspot is-a place of significant activity or danger. Hotspots are prototypical areas where similar hydrological and climate-change vulnerability characteristics and problems converge (such as sea level rise, river erosion, intensity of flooding, water shortages, siltation constraints, etc.). It is a gross definition and intensity of hazard and underlying risks can vary among districts and sub-districts within the hotspot zone.The six Hotspots are:

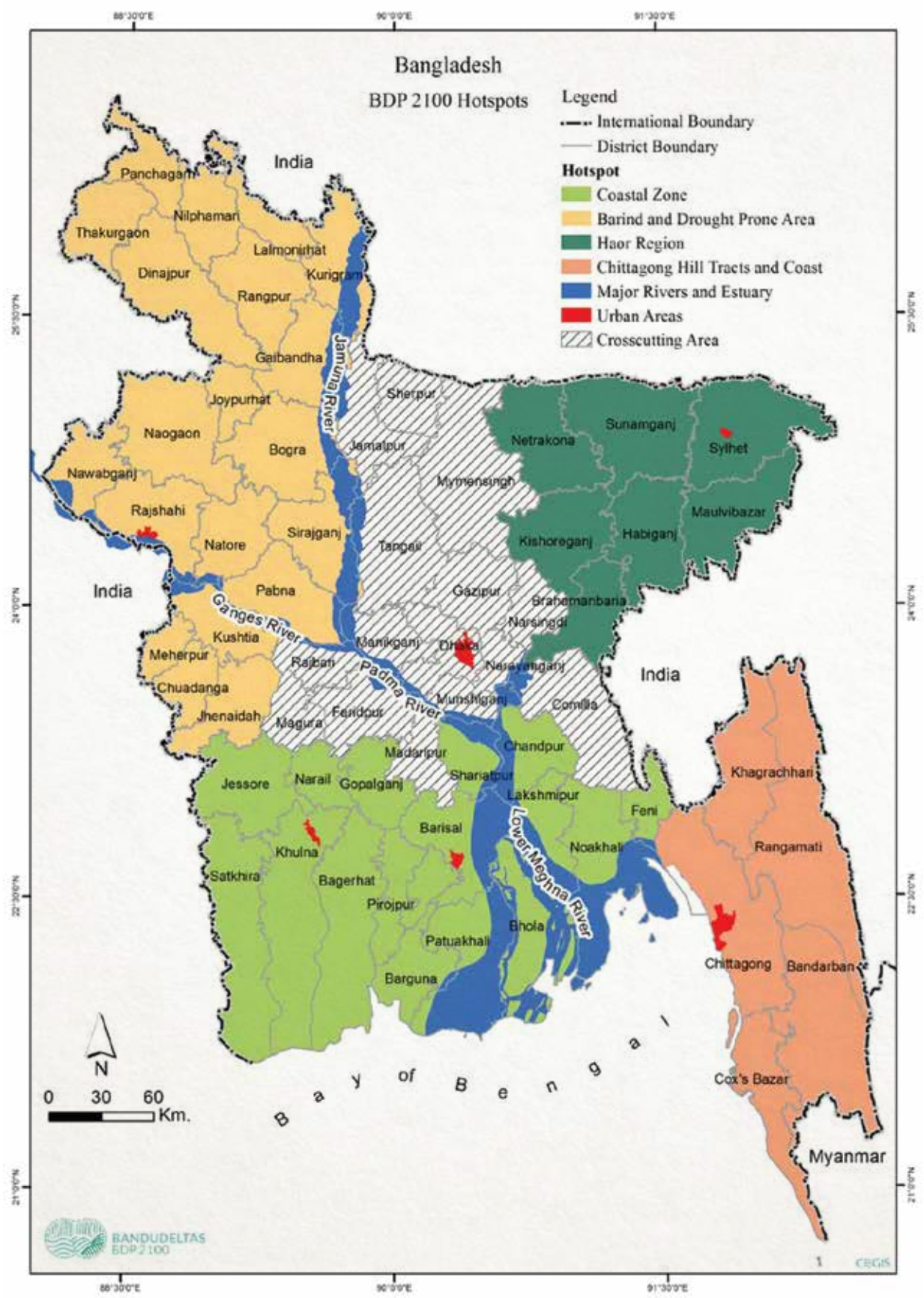


Figure 1.26: Hotspots regions (Source: BDP 2100, 2018)

1. River Systems & Estuaries

The river systems zone is about 35,204 square kilometre and shares 23.8%, which covers partially or fully around 30 districts including Bhola, Barishal, Brahmanbaria, Barguna, Bogura,Chandpur, Chattogram, Cumilla, Dhaka, Faridpur, Feni, Gaibandha, Jamalpur, Kurigram, Kushtia, Madaripur, Lakshmipur, Manikganj, Munshiganj, Natore, Narayanganj, Narsingdi, Noakhali, Pabna, Nawabganj, Patuakhali, Rajbari, Tangail, Sirajganj, and Shariatpur. It's in the regions of North Central, North West, South Central, South East, South West, Eastern Hill part of the country with 49 rivers like Brahmaputra-Jamuna, Meghna (Lower), Arial Khan, Dhaleswari, Dharla, Dudhkumar, Ganges, Gorai, Matabhanga, Meghna (Upper), Old Brahmaputra, Teesta Old Dhaleswari, Padma belonging to the Ganges, the Meghna & the Brahmaputra Basins.

Average width of jamuna, ganges, Padma, Upper meghna & Lower Megna are 12, 5, 10, 3.4 and 1.1 km respectively. Length of Jamuna 230, Ganges 269, Padma 121, Upper meghna 156 and Lower Meghna 65 km. Peak discharge of Jamuna , Ganges, Padma , Upper Meghna are 102535,70868,14200, 19900 cumec respectively with minimum discharge of 2 cumec by upper Meghna & maximum discharge of 70868 by Ganges. The total catchment area carry is about 1.1 billion tonnes of sediment annually.

Erosion rate of Jamuna is 20173.37 ha/yr, Ganges is 698.24 ha/yr, Padma is 828.8 ha/yr and Lower Meghna is 662.05 ha/yr. Accetion rate of Jamuna is 368.96 ha/yr, Ganges is 600.58 ha/yr, Padma is 316.58 ha/yr and Lower Meghna is 570.897 ha/yr.

Temperature varies from 7°C to 42°C. However, the annual average rainfall varies as 1,927 mm in the NW region, 1,950 mm in the south west-south central , 2,133 in the north central , 2,447 mm in the Southeast and 3,091mm in the Northeast region. Average maximum change of temperature is 2.63°C.

About 14 million people get affected by flood in this area. In the River Systems and Estuaries, the main risks are those of flooding and river erosion. The rivers during the last 250 years have changed their respective courses several times. River bank erosion causes the suffering of about one million people annually. The Jamuna river is particularly prone to river erosion with most land loses concentrated in Kurigram and Sirajganj. The river erodes Meghna's bank when any char develops and creates obstruction to the flow.

The embankments constructed and maintained by the BWDB are generally designed to withstand flood levels up to SL, so with 1/25 year safety level. Waterlogging refers to stagnant river floodwaters that are unable to recede. The southwest costal belt across Satkhira, Jessore, Jhenaidah and Khulna districts are primarily affected due to unabated encroachment of canals and a lack of proper drainage.

For the base year 2000, net floodplain erosion exceeds the net floodplain sedimentation over the entire region. The impact of net sedimentation process will completely reverse the net land subsidence in both south-east and south-west. However, floodplain erosion process in the central south-east will be expedited resulting a higher rate of net land subsidence. River bed dynamics are scenario-independent, however the impact of uncontrolled siltation increases with increasing use of the major rivers for waterway transport. Increasing climate variability is expected to negatively affect navigability of the rivers due to more frequent and more extreme high and low water levels.

Bangladesh is projected to lose around 2,270 hectares of land this year due to riverbank erosion, a study report has said. In 2017, CEGIS predicted for 29 locations out of which 20 are in the Jamuna, five in the Ganges and four in the Padma river.

The strategies that could be adopted to increase conveyance of rivers are the first intervention along the Main Jamuna – Padma River course is to control river bank erosion; Land reclamation through geo-bag erosion protection, plus flood embankments, will result in 150,000 ha of land being reclaimed, enough land to settle at least 1.8 million people. Navigation would be restored on the rivers in study area by establishing and maintaining safe navigation channels during low flow periods, utilizing low spurs, without restricting the cross section of the river during flood discharges. Environmental protection zones will be designated along the river courses enabling environmental restoration, and providing flora and fauna habitat.

Figure 1.27: Erosion Accretion Characteristics of Major Rivers (Source: BDP 2100, 2018)

2. Barind and Drought prone areas

The Barind and drought prone areas are the North West side of Bangladesh. The area of this hotspot region is 22848 km^2 covering partially or fully around 21 districts including Bogura, Chuadanga, Dinajpur, Gaibandha, Jhenaidah, Joypurhat, Kurigram, Kushtia, Lalmonirhat, Meherpur, Naogaon, Natore, Nawabganj, Nilphamari, Pabna, Panchagarh, Rajbari, Rajshahi, Rangpur, Sirajganj, Thakurgaon. The major rivers under this region are Atrai, Brahmaputra, Jamuna, Teesta, Dharla, Dudhkumar, Ganges, Garai, Ichamati Matabhanga and Mohananda. Barind and drought-prone areas adjacent to right bank of Jamuna river will be more inundated (around 30%) from the base by 2050 due to flooding in the extreme scenario. The mean annual rainfall in Barind and drought prone area is 1,250-1,750 mm, falling mainly in 4 to 5 wet months. In the drought-prone agro-ecological zones 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 zones. They had 96% tubewell water supply, 35.73% pucca sanitation facility and 47.22% electricity coverage in 2010. As a result of continuous pollution, environment of the Barind and Drought Prone Areas is under stress. The water of this hotspot is seriously affected by contamination of heavy metals (Cd, Cr, Cu, Fe, Pb, Ni, Zn, etc). If the pollution continues at this rate, in future it will cause a great harm to the people and aquatic life dependent on these rivers. This pollution is concentrated around the industrially developed and urban areas. In the rural areas, the rivers have much better water quality.

Droughts & Water scarcity in Kurigram, Nilphamari, Lalmonirhat, Gaibandha, Bogura, Rangpur, Naogaon districts. Due to climate change scenarios the production will decline of Aus by 27%, wheat by 61%, Boro by 55-62%. The socio-economic prospects of the Barind and drought-prone areas have improved dramatically in the last few years owing to the large-scale adoption of mechanized tube well based irrigation. Yet, the drought risk has been shifted forward as surface water reduction from the diversion of river water upstream in India and inadequate rainfall in the dry season continues to lower the water table. In northwest region, the Barind tract and the Atrai basin, a part of the Chalan Beel avulsion and westward shifting of the Brahmaputra River and construction of Teesta Barrage have caused significant changes in this region. Barind region has average income growth of 14.6% and 2.6% reduction in poverty and 31.6% reduction in poverty vulnerability. 55.4% have agriculture as main occupation. Labour participation in 57.3% among which 32.9 % are women and emplymed are 59.2%. The Barind and drought-prone areas have made the most impressive progress in reducing the incidence of poverty between 2000 and 2010.

3. Haor and Flash Flood Areas

Haor area covers 16,574 km^2 of north eastern and north-central parts of the country, and the haors and baors cover 1,140 km^2 area. A tremendous natural asset for Bangladesh is its rich and diverse ecosystem that not only provides it with the many advantages noted before, it also provides for a high quality of life in terms of the eco balance.

The majority of the natural ecosystems of Bangladesh are wetlands (Haors). Intricate networks of rivers that drain into and inundate Bangladesh have created many riverine ecosystems in the country. The Tanguar Haor, Aila Beel, Hakaluki Haor and Hail Haor are considered as Important Bird Areas (IBA). Remnant swamp forest patches are now restricted to sloping areas, helping to protect homesteads from wave erosion, while some are recently replanted areas.

The composition of plant and wildlife is almost same in the floodplain ecosystem. Vegetation of the floodplains changes with fluctuation of water levels; this type of seasonal wetland is dominated by grass and rooted floating plants. Tanguar Haor provides habitat for at least 135 fish and 208 bird species, including 92 waterbird species and 98 migratory bird species, and including 10 IUCN Red Book and 22 CITES listed species. About

30-40,000 migratory waterfowl converge on the area in the northern winter months, according to the site's Ramsar listing. Its geographical location, deltaic structure, and sub-tropical climate have made it a home of about 4,200 plant species.

Haor area is susceptible to flash floods, flash floods, excessive monsoon flooding, drainage congestion, insufficient pre-monsoon water shortage, encroachment of water bodies, river siltation, loss of biodiversity etc. Wetland and ecosystem habitat (mother fisheries, carp spawning ground, fish breeding and grazing ground, Ecological Critical Areas (ECA), Ramsar Site, Swamp Forests, etc.) are under threat of habitat aggradations due to siltation, habitat alteration and fragmentation; disturbance to pre-monsoon spawning migration caused by some the FCDI projects; over exploitation of swamp forests causing environmental degradation of this area. Shrinkage in wetlands (area and volume); 40% out of 260 species of freshwater fish threatened with extinction (IUCN). The latest animal Red List of Bangladesh has listed 390 species as threatened in Bangladesh – almost 25 percent of 1,619 species assessed.

The major challenges emerge from pressures that bring changes in land use in both terrestrial and aquatic environments. The factors included are demand for increased agricultural lands, collection of fuel wood, and non-timber forest products by the local communities, natural habitats converted into human habitations, ecosystem fragmentation and loss of habitat. Additionally, there is degradation of habitats in all ecosystems and landscapes, change in hydrological regimes, pollution, poorly managed and unsustainable tourism (Ratargul Swamp Forest), unsustainable agricultural practices, urban expansion, invasive alien species, and impacts of climate change including SLR. Wetlands, both in terms of their extent (area and volume) and biodiversity are in serious decline. Out of Bangladesh's 260 freshwater fish species, more than 40% are now threatened with extinction.

Identification of potential breeding, spawning, nursery and grazing grounds of fish and other aquatic fauna is needed. Research and education programs should be conducted identifying potential threatened, vulnerable and endangered aquatic flora and fauna.

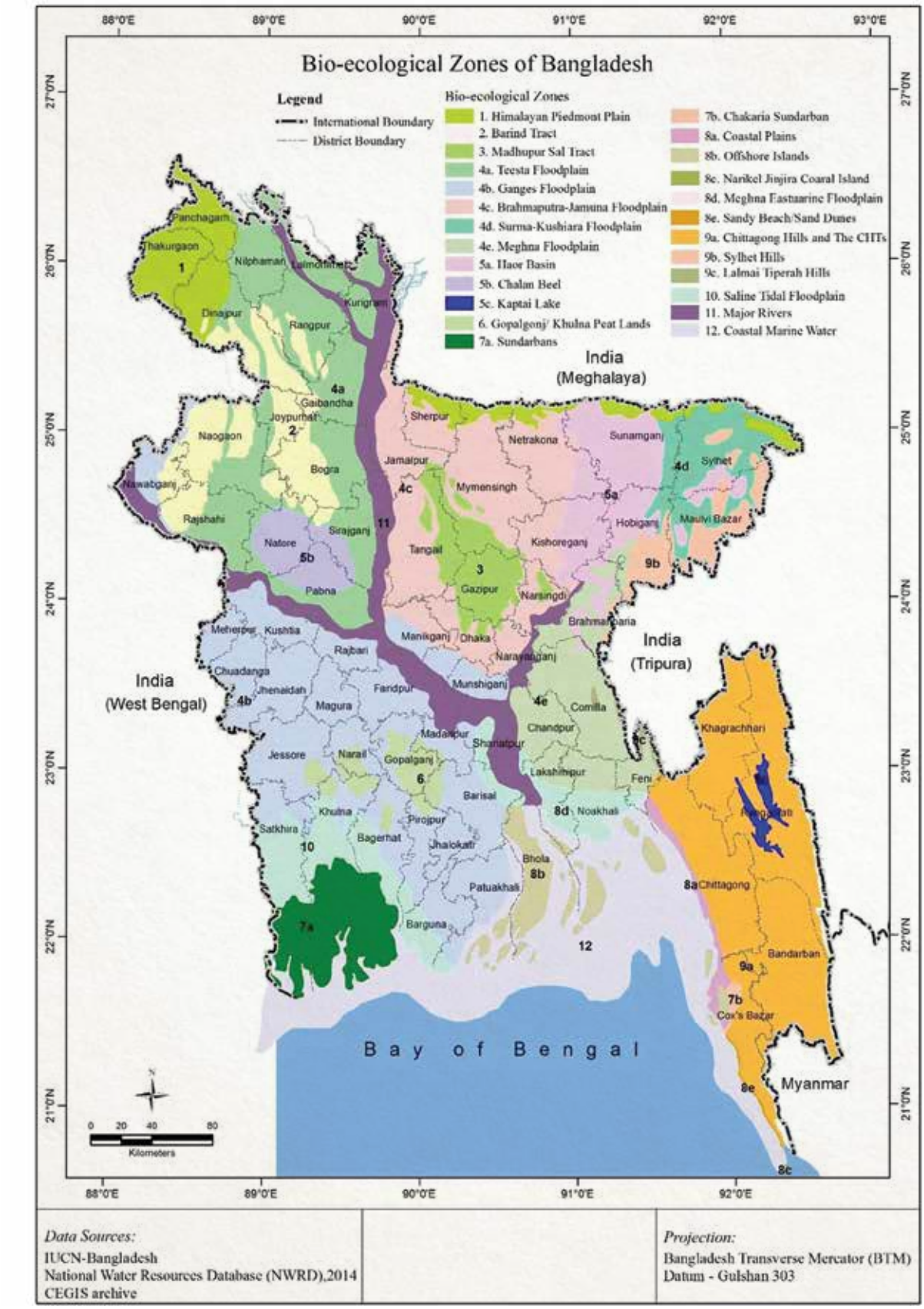


Figure 1.28: Bioecological zone of Bangladesh

4. Chattogram Hill Tracts

The Chattogram hill tracts cover Eastern Hills excluding Chattogram and Cox's Bazar covering of area 13,295 km^2 and have population density 128 (per/km^2) . The region is characterized by a huge network of trellis and dendritic drainage consisting of some major rivers draining into the Bay of Bengal.

Improvements in income distribution have been found in Chattogram (share of bottom and top quintiles - 8.1% and 44.4% respectively in 2000; the corresponding shares for 2010 were 11.1% and 35.7%); The Haor and Flash Flood Areas and the Chattogram are lagging behind in terms of non- income welfare indicators.

The south-eastern hill-range in the Chattogram Hills and the Chattogram Tracts is composed of tropical evergreen and semi-evergreen forests. While the hills are not very high, generally about 600 m, they are ragged and often steep; these hill forests are the most important watershed areas of the country. The undergrowth is usually a tangle of shrubs, in which cane, bamboo and wild banana are the prominent species. In comparison, the Sylhet hillocks average round 40-60 m, with the highest peak around 170 m.

Flash floods occur in the eastern and northern hilly regions. Flash floods have a relatively short duration, but generally have high velocities and a rapid increase in water levels. This makes them very destructive at local levels. Loss of forest and vegetation cover and unsustainable farming practices will intensify impacts of increased water runoff, soil erosion, landslides, and drying up of water springs and streams in this hotspot as a result of climate change.

The JRC has held 37 meetings(since March ,1972) at the ministerial level and discussed various issues such as sharing of transboundary waters, joint river basin management, sharing of data, control interventions, embankment & river bank protection, works adjacent to the international border and other pertinent issues of the transboundary rivers. The state level visits between India and Bangladesh in 2010, 2011 and 2015 paved the way for initiatives involving Nepal, Bhutan, India and Bangladesh to jointly manage the Ganges and the Brahmaputra rivers. So far, these initiatives are in an initial stage but seem as a promising development in regard to water diplomacy practices in the Ganges- the Brahmaputra- the Meghna basins.

The associated water management strategies have two dimensions: cross-boundary and national. Economic development programs have to be specifically focused on the needs of hill peoples and the ethnic groups; governance and administrative structures need to strictly implement land management practices conducive to forest and landscape conservation with mitigation steps (e.g. REDD) positively impacting climate change as well as benefiting local people and stewards of the forests. Sustainable land use is essential to coordinate efforts in environmental protection and the improvement of liveability of urban areas.

Environmental degradation is a typical cross-sector issue, produced by contradictory interests converging in one area. Spatial planning and the implementation of such plans provides a means of addressing these problems.

Sustainable agriculture, food security, nutrition and livelihood development through multipurpose resource management is an approach to problem solving of Chattogram hill tracts.

5. Urban Areas

Urban areas do not have any specific grouping but their rainfall runoff and population density is highest with which is their major characteristic. Area covered in 19,823 km^2 and population is 31.5 Million. Moreover, the river system also plays an important role in the urban areas as the water supply and the industrial sector are heavily dependent on the river resources. Urban water supply and sanitary coverage is 86%, 80% have electrical facility with 73.4% non-agricultural occupation. By 2021, Dhaka WASA wants to use 70% of water from surface water source and 30% of water from ground water extraction.

SLR is likely to cause significant changes in river salinity in the southwest coastal zone of Bangladesh during the dry season (October to May) by 2050, which will likely lead to significant shortages of drinking water in the coastal urban areas. Population dynamics show that there has been net out-migration from the Coastal Zone and from the River Systems and Estuaries primarily to the Urban Areas. Total investment costs of urban water supply for this scenario were estimated at Tk. 714,945 million, out of which Tk. 165,220 million would be required for short term (2011-2015), Tk. 280,467 million for mid-term (2016-2020) and Tk. 269,257 million for the long term (2021-2025).

The sewage generated in Dhaka area is 250-300 MLD and Pagla Sewage Treatment Plant is 120 MLD (peak flow rate). There is no sewage system in other cities. Improved sanitation coverage is 58.6% in cities, 56% in towns & 55% in rural areas. Due to migration to urban areas from rural regions, slums are growing and 20% of slum dwellers use open defecation. In Dhaka 20% are is under wastewater sewerage system overage, 70% is by septic tank but it Khulna & Faridpur 98.23% & 98.5% have on-site sanitation facilities respectively need emptying, safe transportation and treatment. About 221 textile and leather industries around Dhaka generate 32300 m3/d wastewater, and only 30.6% sludge is dumped in designated places.

Solid waste generation has been estimated to reach 47,064 (tons/day) by 2025 . For City Corporations, the amount varied between 0.16 and 0.34 kg/c/d while in the case of Paurashavas the amount varied between 0.19 and 0.36 kg/c/d and 97.15% waste is organic. Waste collection is 76% in Dhaka city, 11.25% in Dinajpur, 85% in Mymensingh city. Dily waste management cost varies from 2,000 to 300 tk/ton/d. income from solid waste management is 1133 tk/ton and expenditure is 2597.33 tk/ton. Except for Dhaka and Rajshahi, collection efficiency in the urban centers including Chattogram is around 50% or lower. There has been a 28.13% increase in the growth of plastic as a solid waste.

The strategies which can be applied to improve wastewater and solid waste management are strengthening institutional capacity, increasing community participation, cost recovery and private sector involvement like “polluters pay” principle, increasing technical capacity with technology land use planning to prevent urban in-flow.

6. Coastal zone

The Coastal Zone is about 27,738 sq. km in area covering districts of South West, South Central and South East. Sea facing portion of the coastal zone is mainly prone to coastal flooding.

Intensity of cycolnes and storm surge water level will increase with rising Sea Surface Temperature (SST) and sea level. Though time-series records of storm-surge height are scarce, existing literature indicates a 1.5 m to 9 m height range during various severe cyclones. The Bay of Bengal has favourable conditions for the formation of tropical cyclones, and about 149 cyclones have crossed the Bangladesh coast between 1891 and 1998. Since 1970, four severe cyclones with maximum wind speeds greater than 220 km/h and associated surges more than 4m high have hit Bangladesh (November 1970, April 1991, May 1997 and November 2007).

During the past 20 years, Bangladesh has managed to reduce deaths and injuries from cyclones. For example, the most recent severe cyclone of 2007 caused 4234 deaths, a 100-fold reduction compared with the devastating 1970 cyclone. Current storm surge heights are topping over polder embankments (Sidr and Aila cyclones); estimated cost of damage of Sidr alone was at US$ 1.7 billion (World Bank, 2010). Meghna deltaic estary and Chattogram coastal plain are directly exposed and vulnerable to storm surges.

SLR is likely to cause significant changes in river salinity in the southwest coastal zone of Bangladesh during the dry season (October to May) by 2050, which will likely lead to significant shortages of drinking water in the coastal urban areas, scarcity of water for irrigation for dry- season agriculture and significant changes in the coastal aquatic ecosystems. Simulation of salinity intrusion with SLR of 52 cm in 2050 shows that the freshwater zones in Bagerhat, Barguna, Barishal, Bhola, are likely to be lost. An area of 7,000 km^2 is likely to be affected by more than 1 ppt and about 8,400 km^2 would be affected by more than 2 ppt salinity in the

southwest and south central zones by 2050 with a 52 cm sea level rise. The 2 ppt salinity front moves about 65 km into Barishal division. Accordingly, approximately 40 million people of 70 Upazillas under 19 coastal districts of Bangladesh are under the direct threat of displacement causing homelessness. The projected land loss from a 1 meter increase in SLR ranges from a low of 3% (4,400 km^2) to a high of 21% (30,000 km^2). In the Southwest and South- Central, increase in vulnerability and losses in agricultural production, possible negative health impacts from salinity, and out-migration due to loss of livelihoods.

The strategies which shall be adopted to mitigate storm surge and salinity intrusion havoc include restoration of rural rivers/canals and livelihood improvement in interior coastal districts, conducting research on morphological behaviour of the Meghna estuary to assess the effect and potential of land reclamation, restoration of rivers for fresh water supply including river basin management for cross boundary rivers, and accelerating land reclamation process in the Meghna Estuary.

Cross cutting Issue

1. Renewable Energy

Bangladesh is expected to have enormous potentiality in renewable energy development. Solar photovoltaic (PV) panels are gaining acceptance of providing electricity to households and small businesses in rural areas. Development of off-grid solar home solutions has achieved international benchmark. However, potential of other renewable resources is still at the exploration stage. Strategies cover the following aspects: institutional, hydropower, harnessing tidal power, solar power energy and financing.

At present, the installed generation capacity was 200 MW in 1972-73, which has increased to 13,179 MW by April, 2017 (SREDA 2017). The contribution of natural gas is 62.7% of total installed capacity of 8,267MW. Coal based power is 1.9% of present installed capacity (250MW). There is only one hydropower plant in Bangladesh with a capacity of 230MW. Moreover, the installed capacity of liquid fuel (HFO, HSD) based power plants have reached 3,832 MW and 600MW power is imported from India. At present, 80% of the total population has access to electricity (including renewable energy) and per capita electricity generation is 371 kWh. Among selected South Asian countries, Bangladesh stands third in term of production.

Around 4.4 million solar home systems (SHSs) across the country have been installed, meaning that almost 18 million beneficiaries are getting solar electricity which is around 11% of the total population of Bangladesh. According to Renewable Energy Policy of Bangladesh, government has a target to supply of 10% energy from renewable sources by 2020. Furthermore, the Government has exempted all taxes from the devices and equipment used for the utilization of renewable energy, especially, solar energy.

Renewable energy is collected from resources that are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geo-thermal heat. The country is blessed with considerable solar radiation, and receives an average daily solar radiation of 4.6 kWh/m^2/day and has considerable potential for renewable energy (SREDA, 2017).

The Renewable Energy Policy 2008 envisions that 5% of total energy production will have to be from renewable sources by 2015 and 10% by 2020. Under the existing generation scenario of Bangladesh, Renewable Energy has a very small share of the total generation. The share of Renewable Energy is 2.7%. At present total renewable energy capacity is about 447.5 MW (SREDA, 2017).

Government has launched “500 MW Solar Power Mission” to promote the use of renewable energy to meet the increasing demand of electricity. Power Division is hosting 500 MW solar power development programmes which is the largest ever solar power development initiative in Bangladesh. Out of 500 MW solar power, 340 MW will be generated by private sector and rest 160 MW will be generated by public sector. Public utilities are involved in large scale grid-connected renewable energy based power project development. On the other hand, private sector is involved with off-grid home-based renewable energy solutions.

The power sector is facing many challenges such as, lack of adequate resources (private/ public/ external); issues relating to good governance; lack of adequate co-ordination; lack of appropriate cost and asset accounting system; irregular and insufficient gas supply; inadequate maintenance of power plants; tariff rate and structures; delay in implementation of power projects; organizing funds for project implementation; lack of prioritization of projects; lack of maintenance budget; failure in routine maintenance and forced shutdown of power plants. In addition, the power sector will face more challenges in future mainly due to expansion of the sector due to the increasing energy demands. GoB is gradually relying on innovation of new power technology like renewable energy. While expanding it in the rural areas several challenges have been identified. These challenges or bottlenecks are of threefold: (1) lack of technology and related knowledge and skills, (2) insufficient networks of actors, and (3) weak institutions.

For successful implementation of Renewable Energy (RE) technology in a certain area, local knowledge and skills must be available to implement as well as repair and maintain the systems. Furthermore, the relevant network of actors should be involved from the very start - future owners and people who will have to implement and maintain the technology. Finally, the local institutional context should fit with the technology including policy, programmes, financial incentives, levels of education, etc.

Renewable Energy provides attractive and environmentally sound technology options for power generation. It could offset a significant proportion of foreign exchange that is used for importing oil for electricity generation. Most renewable energy technologies utilize locally available resources and expertise, and would therefore provide employment opportunities for the locals.

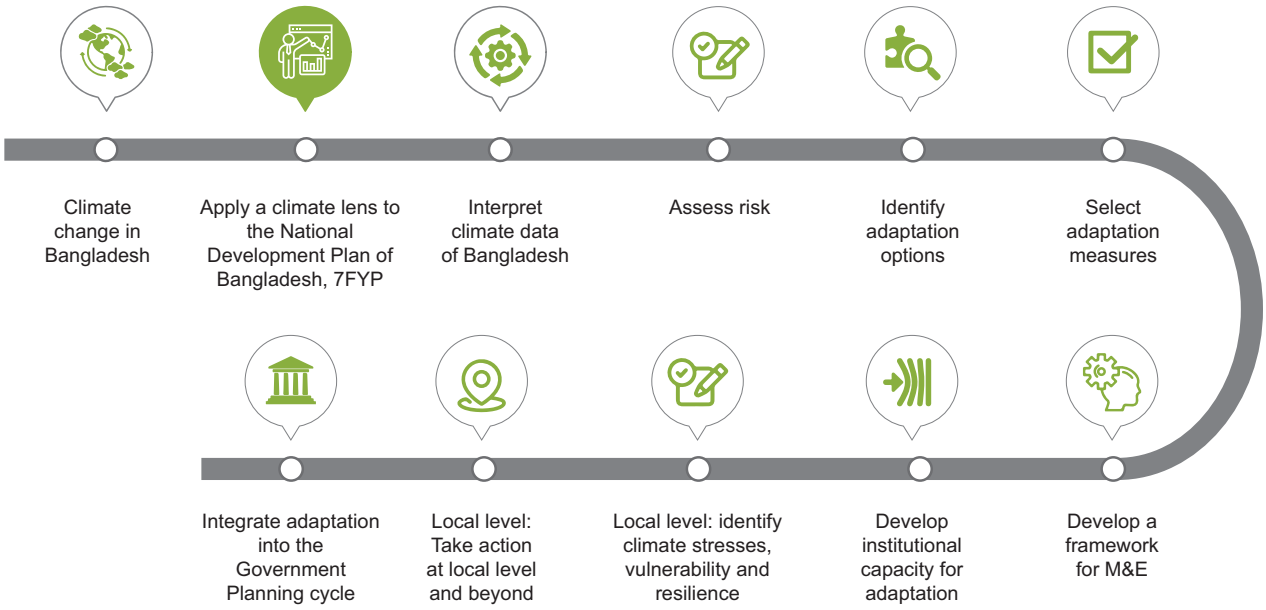
Bangladesh has considerable renewable energy potential, and significant past experience in developing renewable energy projects. Most of the existing Renewable Energy investments have been in off-grid technologies such as solar home systems (SHS), solar micro-grids, and solar irrigation pumps. The GoB has set several investment targets for grid-connected technologies including utility-scale solar, wind, and waste-to-energy.

Despite significant potential, the development of these grid-connected renewable energy technologies, however, has been slow to materialize. There are a number of regulatory, financial and technical barriers that, if addressed, could accelerate renewable energy investment in the country. Improved regulations, such as establishment of a formal feed-in tariff and provisions for compensating mini-grid investors after transmission expansion, would reduce risk and send strong signals to investors. The following strategies could contribute to the development and dissemination of successful Renewable Energy programs in the country.

(Source: BDP 2100, 2018)

Module 2:

CLIMATE LENS



2.1 Learning objective of the exercise

- Identify the relevance of climate change to a policy, programme, plan or project.
- Understanding the relevant climate change risks and opportunities is the first step of making it more resilient to climate change or more supportive of adaptation.

2.2 Context

The development path of the Peoples' Republic of Bangladesh is described in its (7FYP) published by the General Economics Division. The plan focusses on three overall themes:

- GDP growth acceleration, employment generation and rapid poverty reduction.
- A broad-based strategy of inclusiveness with a view to empowering every citizen to participate full and benefit from the development process.
- A sustainable development pathway that is resilient to disaster and climate change; entails sustainable use of natural resources; and successfully manages the inevitable urbanization transition.

The process of planning for the seventh 5-year plan, (FYP) in Bangladesh coincided with the launch of the UN post-2015 Sustainable Development Goals, the so-called SDGs (annex 1).

The government of Bangladesh is aware that the development process has to be inclusive and has to consider the views of all actors. Similarly, the plan considers sustainability of the development process a central element and identifies climate change and the related challenges to agriculture and the natural environment as a major threat to be tackled.

The core targets of the 7FYP are shown in exhibit 1. The grey shaded targets are selected and used for various exercises in this training manual.

2.3 Instructions for case work

Imagine, for the exercises and group works throughout this training that you are members of the Government's 'Climate Change Advisory Group'. And that the Government has requested your group to come up with suggestion for climate change adaptation in the country.

Exhibit 2 (page 51) is an information input for this exercise. It shows the core targets of the Bangladesh 7FYP[1]. The shaded core targets are selected to work with in this exercise. These shaded core targets are shown again in column A of matrix 1 (page 20). Exhibit 2 (page 25) gives an informative overview of general climate change impacts projected for Bangladesh.

Matrix 1 assists in examining the core targets of the 7FYP through a 'climate lens'. The climate lens is a synonym for the ability to look at one's own work in for example agriculture, industries, services etc. with a specific focus on climate change. By using a climate lens Government planners can identify the relevance of climate change to the targets of the 7FYP.

2.4 Your task

Your task is to process matrix 1 aiming to put the projected climate change impacts for Bangladesh into a regional and administrative context for further analysis.

Use matrix 1 to guide you through the following steps:

- In **column A** find the selected core targets from the 7FYP.
- In **column B** identify for each core target if and how it could be affected by impacts from climate change (for example: climate change could affect the natural resources upon which a core target, for example rice production, depends). If time pressed, please select 2 or 3 core targets.
- In **column C**, based on what you know about Bangladesh, select the region(s) especially at risk. You may use the Bangladesh map for that.
- In **column D**, identify those key actors at local, regional and national level who need to act, e.g. supporting further understanding and identifying the risks and responses, taking responsibility for the next steps.

Please use exhibits 1 and 2 as information sources but consider that the data and information base will never be complete. Therefore, you as planners often need to decide under uncertainty and may not find the ideal solution.

Please process the matrices in a horizontal manner that is working through all columns first before moving to the next row.

The examples in italics each cell serve to demonstrate possible types of answers / information.

[1] *Refer to 'The Bangladesh 7th 5-year Plan - Accelerating Growth, Empowering Citizens' (page 25)*

Matrix 1: Assess the relevance of climate change to selected core targets of the 7FYP

A Core target	B How could the core target be affected by impacts from climate change?	C What region (s) in Bangladesh is/ are most at risk?	D Which actors need to act and contribute to next steps?
Please answer the questions and give a brief explanation as to the HOW			
Reduction in extreme poverty by about 4.0 percentage points	EXAMPLE • Agricultural production and incomes depend on predictable crop yields, which are affected by rainfall patterns • Rice production due to increased average temperatures, especially during flowering periods	EXAMPLE • Sundarban area due sea water intrusion • Rice production areas due to	EXAMPLE • Farmers as they have knowledge on alternative plant breeds • Local and national planners because…

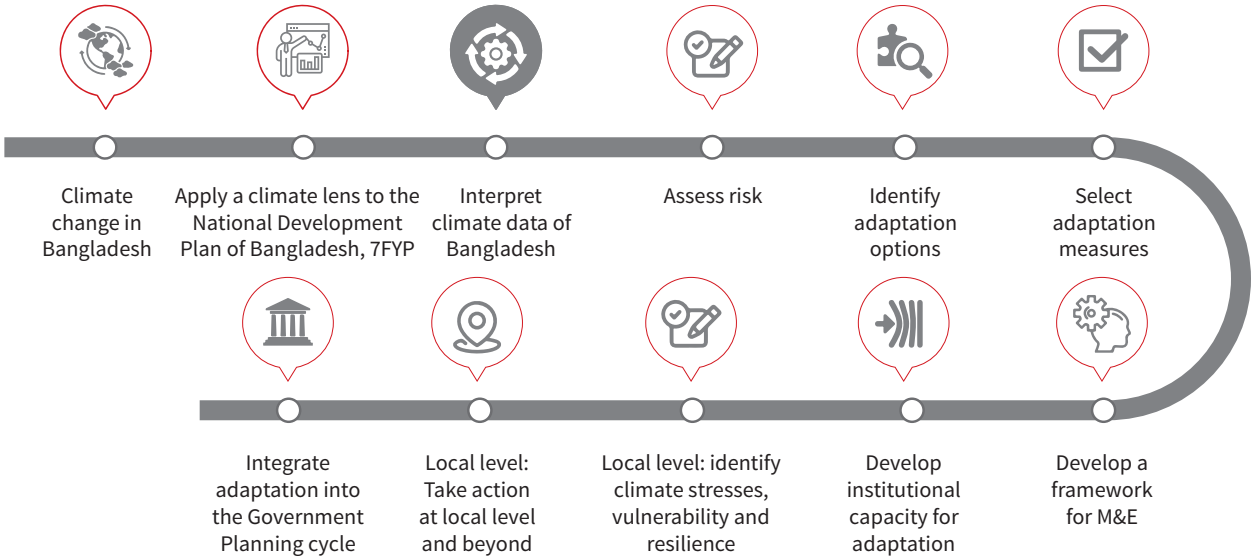
Significant growth of the agriculture, industry and service sectors

Inclusive urban planning based on sustainable land use planning and zoning

A Core target	B How could the core target be affected by impacts from climate change?	C What region (s) in Bangladesh is/ are most at risk?	D Which actors need to act and contribute to next steps?
Please answer the questions and give a brief explanation as to the HOW			
Under 5 mortality rate to be reduced to 37 per 1000 live birth			
Safe drinking water for all			
Construction of about 26 km long Dhaka Elevated Expressway			
Spending on Social Protection as a share of GDP to be increased to 2.3% of GDP			
Increase productive forest coverage to 20 percent			

Module 3:

CLIMATE DATA



3.1 Learning objective for the exercise

- Understand how to use and interpret a standard set of climate data and consider how to integrate the information into development planning.

3.2 Context

In order to base planning on solid data and information, your group will begin the planning process by identifying, sorting and understanding climate related data and information.

3.3 Instructions for case work

Historical precipitation (sample, not for Bangladesh)

This step request you to examine selected sets of data in order to train the reading and understanding of climate data. As members of a climate change advisory group and, while searching for relevant data and information you might have come across a data source as shown in figure 4.

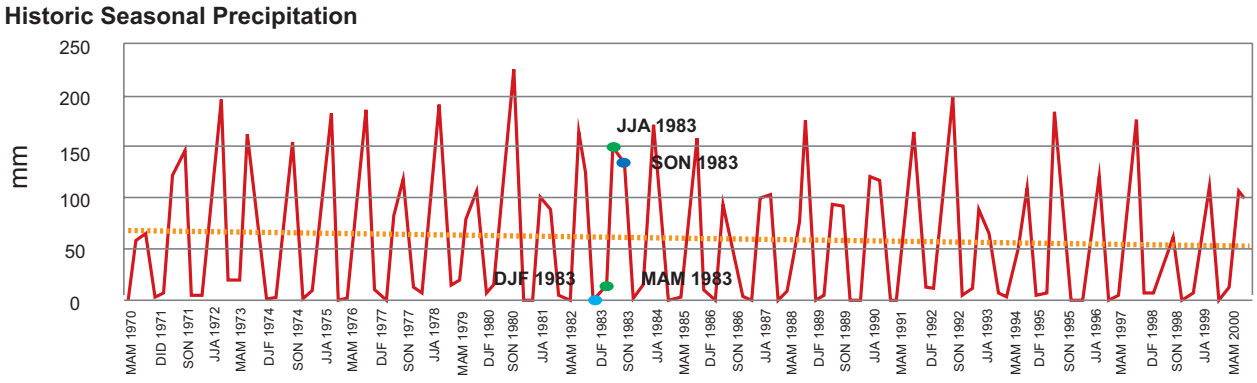


Figure 3.1: Scatter plot projections

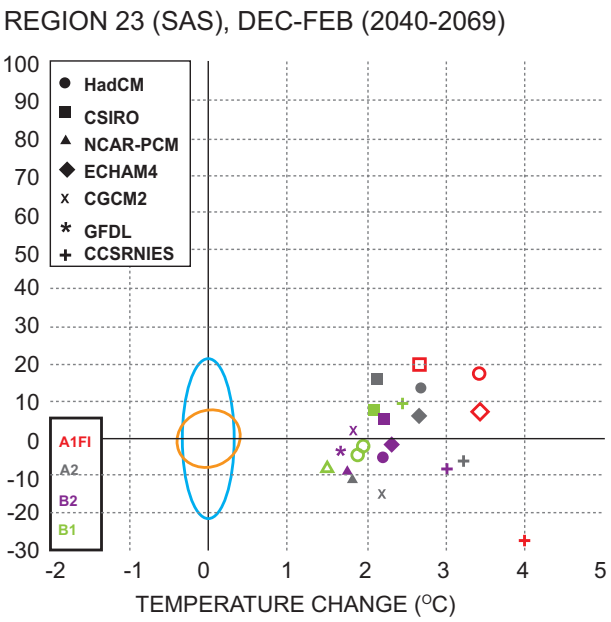


Figure 3.2: Scatter plot projections

Scatter plot projections (sample, not for Bangladesh)

Figure 5 shows the average projected data for 2040-2069 from December to February. The change in ambient temperature is projected on the x-axis while the precipitation change is projected along the y-axis. The various geometrical shapes of the projection points indicate the source of the projection (see legend at the top left in scatter plot). For example, the:

- HadCM3, indicates that this projection is the CM 3 projection of the Hadley Centre, United Kingdom.

The various colours of the projection points represent the four underlying emission scenarios (see legend at bottom, left). These emission scenarios were used for climate change projections in the 4. Assessment Report of the IPCC.

- **A1F1:** results in the highest greenhouse gas (GHG) emissions among the four scenarios.
- **A2:** results in the second-highest greenhouse gas emissions among the four scenarios.
- **B2:** results in the second-lowest overall GHG emissions among the four scenarios.
- **B1:** results in the lowest overall emissions among the four scenarios.

The circles on the coordinate plane indicate the natural variability of temperature (orange) and precipitation (blue) based on historical averages.

Each projection points indicates the temperature changes (along the x-axis in °C) and precipitation changes (along the y-axis as a % change) from the historical average.

Matrix 2 assists the analysis and comparison of different data sources

Your task is to train interpretation of climate information. As such there is not right or wrong.

Use matrix 2 to guide your work

- In **column B** explore what the different data in figures 4 and 5 tell you with respect to temperature and precipitation.
- In **column C** discuss what the individual data sets cannot tell you, yet what you could be interested in regarding temperature and precipitation projections.
- In **column D** brainstorm what additional information you would need for sound decision-making in the two areas of particular concern. Think about key variables needed, appropriate resolution and time scale.

Matrix2: Analyse climate data

A Source of data	B What do the data tell you about rainfall and temperature projections?	C What do the data not tell you?	D Which other data do you need to develop adaptation strategies?
Historical rainfall data (figure 4)	EXAMPLE Oscillations are different over time periods	EXAMPLE Total amounts of rain over periods	EXAMPLE Important weather phenomena having influence on precipitation
Scatter plot projections of precipitation and temperature change (figure 5)			

Figures 6 and 7 show historical precipitation data and two rainfall trendlines of Bangladesh[2]

Precipitation data

Year	Dhaka	Tangail
1971	4247	
1972	3780	
1973	4056	
1974		
1975	4120	
1976	4214	
1977	3838	
1978	4229	
1979	3816	
1980	4198	
1981	3846	
1982	3787	
1983	4371	
1984	5012	
1985	4038	
1986	4486	
1987	4174	3659
1988	4470	4128
1989	3616	3568
1990	4093	3570
1991	4841	4739
1992	3161	3556
1993	4812	4572

Year	Dhaka	Tangail
1994	3534	3739
1995	3746	3847
1996	4040	3472
1997	3893	4008
1998	4308	4006
1999	4373	3400
2000	4241	3792
2001	3680	3573
2002	3797	4022
2003	3696	3799
2004	4351	4009
2005	4642	4022
2006	3925	3530
2007	4892	4265
2008	4225	3864
2009	3940	3400
2010	3533	3760
2011	3787	3850
2012	3341	3481
2013	3569	3195
2014	3413	3655
2015	4181	3886
2016	3381	3147

Figure 3.3: Historical precipitation data & trendline

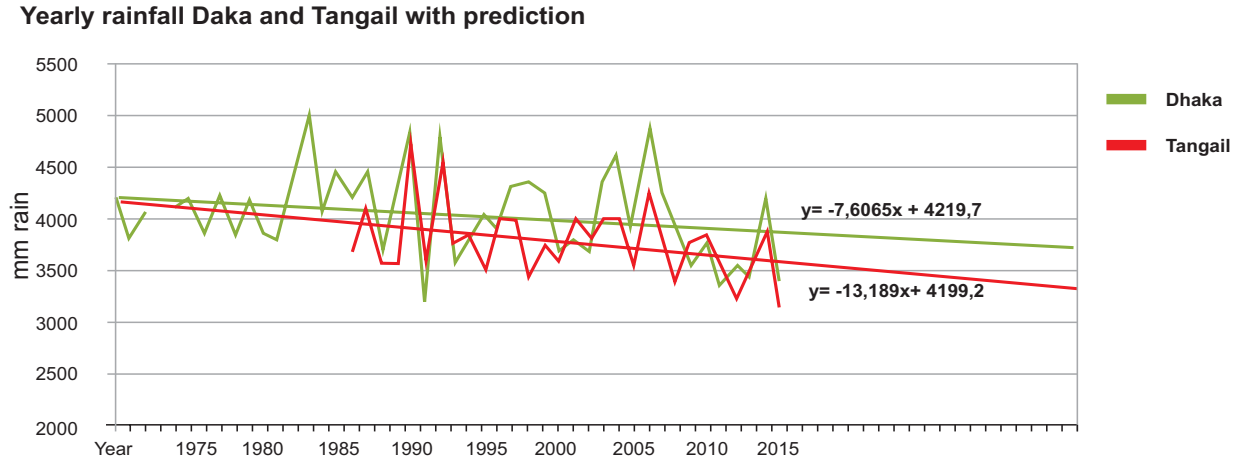


Figure 3.4. Historical precipitation data & trendline

[2] *Source: GIZ, Bangladesh*

Your task

Figure 6 is a collection of numbers and does not allow extracting immediate meaningfull information as such. Figure 7 depicts the same data shown in figure 6 in a visualised manner.

Remember: 'DATA leads to INFORMATION leads to ACTION'

Please study the two figures 6 and 7 and comment on:

The trends these figures show

...

…

The solidness of the database for the trends

…

…

Can the 'line of best fit' be a basis for rainfall predictions?

…

…

3.4 Climate Information (internet access required)

3.5 Learning objective for the exercise

- Practice the process of finding and interpreting relevant climate information from Bangladesh. Learn how to develop messages from climate information portals.

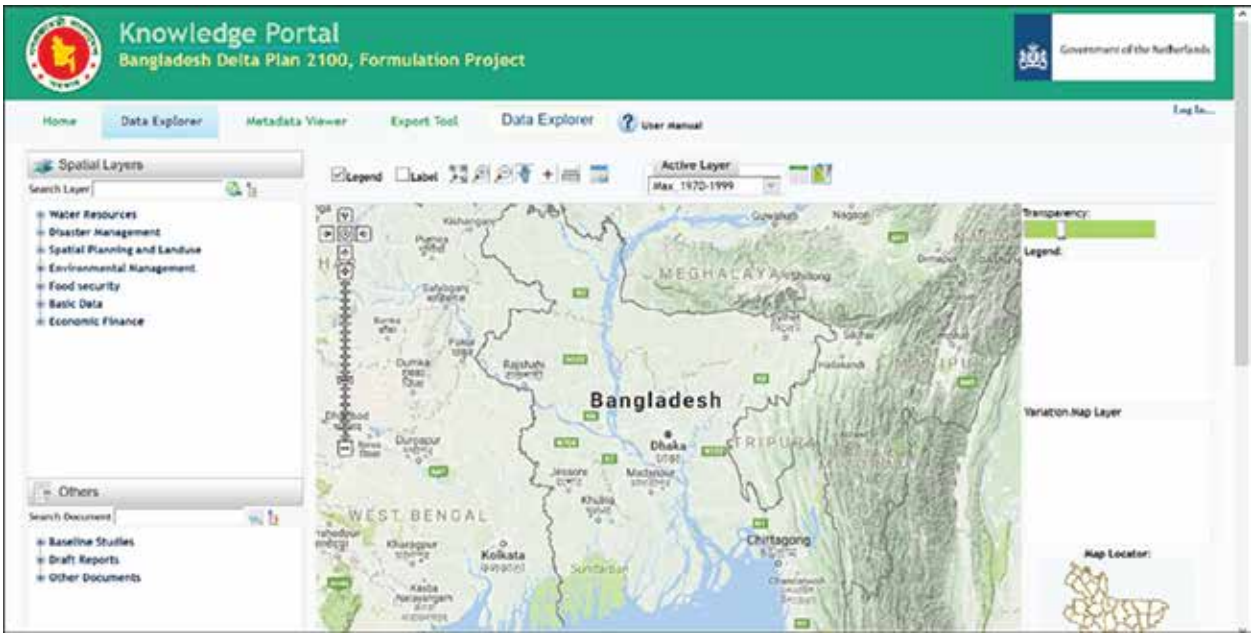


Figure 3.5: Bangladesh climate knowledge portal

3.6 Task 1: Finding information on temperature projections for Bangladesh

Please visit the website of the Knowledge Portal of the Delta Plan 2100:

http://202.53.173.179/delta/mapexplorer.aspx

Identify, under 'Disaster Management' (under Spatial Layers), the projected changes in temperature in various parts of the country and depending on the various IPCC scenarios. When doing the exercise, please work with the scenario called RCP 8.5. Fine-tune your search for only those days with temperatures higher than 35 degree Celsius Compare two scenarios:

- Max projections for 2006-2035, RCP 8.5; and
- Max projections for 2070.2099, RCP 8.5

Please summarise the information you got from this comparison in 3 statements

3.7 Task 2: Making sense of graphic climate information[3]

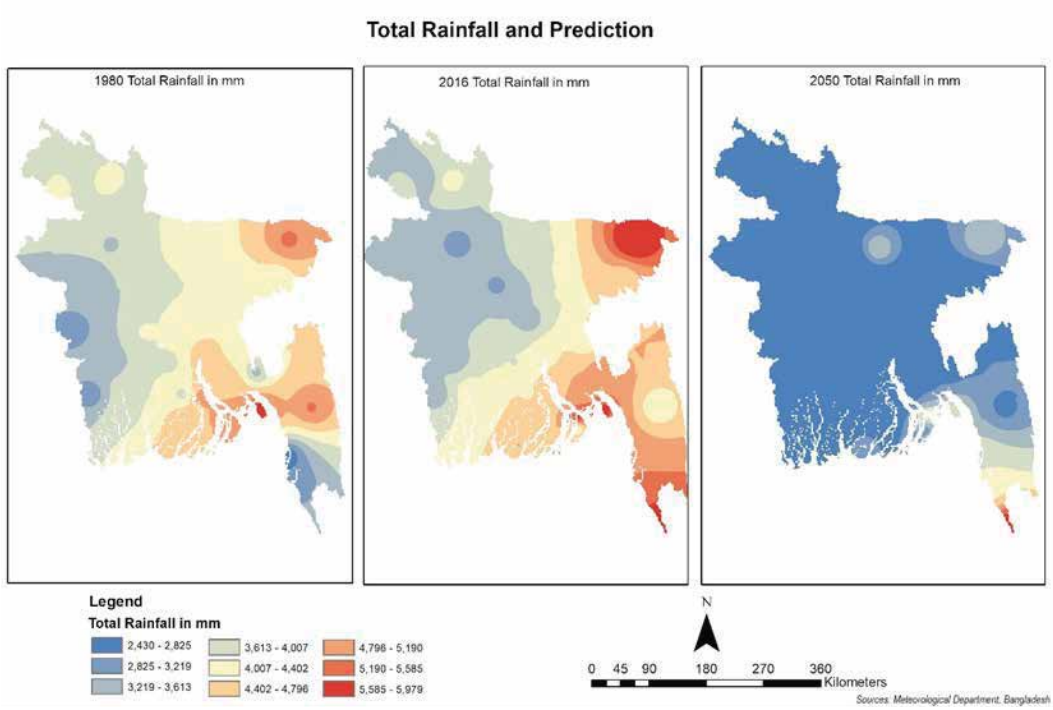


Figure 3.6: Bangladesh-total rainfall and prediction

Please consider the graphic in figure 9 and the information contained therein.

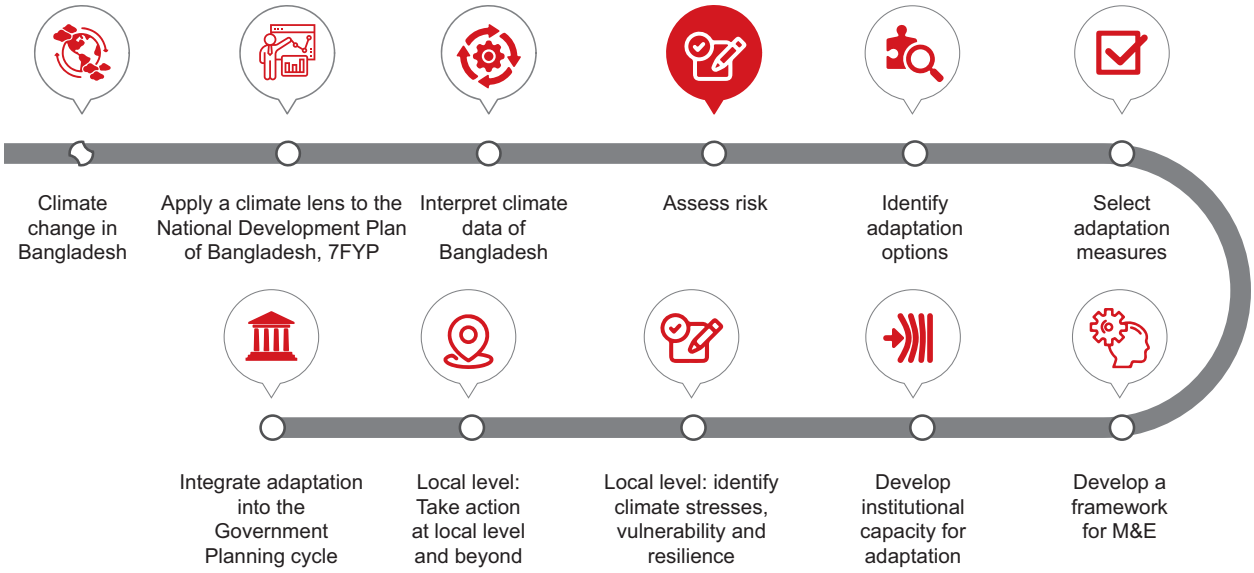
Discuss and conclude:

- What are the 3 main messages that can be extracted from the figure?
- What do the temperature projections mean for the rice production areas and for the jute production areas in Bangladesh?
- Does your own professional experience confirm the historical trend shown in figure 9?

[3] *Source: GIZ, Bangladesh*

Module 4:

RISK ASSESSMENT



4.1 Learning objective for the exercise

- Learn how to analyse the risk caused by climate change within a system of interest.
- Identify factors that contribute to risk in a system taking into account the current situation and climate projections: climate hazards, exposure, sensitivity, adaptive capacity, vulnerability and potential impacts.
- Define the need for action according to the risk or the probability of climate hazards and the expected extent of damage.

4.2 Context

Bangladesh is highly threatened by climate change impacts, due to its geographical position at the northern tip of the Bay of Bengal, because two-thirds of the country are less than 6 meters above sea level, because a majority of the population works in agriculture and because urban centres are rapidly growing.

4.3 The Case

You have the task to support the integration of climate change adaptation into 7 of the strategies of the BDP 2100 (Exhibit 1). Hotspot specific 6 strategies and 1 cross cutting strategies were selected for this case work.

The selected 7 strategies are: (For detail information see Exhibit 2,):

Your task consists of 2 parts:

Part 1 – This part is a preparatory step for the subsequent evaluation in Part 2. It is a stocktaking of the current situation. (see your task for matrix 3).

Part 2– the risk assessment: deals with the climate related risks. It is an analysis of several factors that contribute to climate change: hazard, exposure, vulnerability and potential impacts. (See section 1.3.16).

Part 1 - Current Situation

In this part, you need to gather information to understand the current situation within the system/area of interest you identified. You need to get an overview of important current issues and questions.

Your Task

Use Matrix 3 to guide your work.

- **In column A,** please consider your system/area of interest[4], as described (Matrix 3). You may select another system/area of interest in case your group has a particular interest and information in specific regions or production systems.

A note on 'SYSTEM OF INTEREST'

Since the expression 'system of interest' may sound somewhat not familiar, please study the definition / explanation:

The 'system of interest' is the unit you chose to assess with respect to the question at hand. You may determine your system of interest at different levels, e.g. a single crop system, an ecosystem, a region, an administrative unit – depending on the objective of your analysis.

You may decide:

- to look at a rice production system only; or
- to look at the productivity of rice production; or
- at the watershed wherein rice production takes place; and/or.
- Include the input supply system (fertiliser, water, etc.) as well.

Although the decision is YOURS, please consider that, for example a rice production system often does not consist only of the rice fields but always takes place in a context of ecosystem services, input services, policies and legal administrative frameworks.

Elsewhere, you may find expressions like 'exposure unit' or 'system boundary'

[4] *The system/area of interest (See Matrix 3) is identified by considering one of the core targets of 7FYP, i.e. significant growth of the agriculture, industry and service sector: Promoting the use of agricultural technology with supportive policies, reforms, regulations.*

- **In column B,** list the key actors of the identified system/area of interest, e.g. ministries, farmers, consumers (maximum of 5 actors) and briefly describe their roles and responsibilities using key words.
- **In column C,** explore the current situation of the identified system/area of interest, such as, trends, policy need and problems).

Matrix 3: The current situation

A Suggested system/area of interest[5]	B Key actors: roles and responsibilities	C Current situation (Trend, Policy need and problems)
Rice productivity	**Farmers:** Farmers as producers have long traditional knowledge on rice production. **Ministry of Agriculture:** It formulates policy on production, and supports for inputs supply and output marketing through a large number of agencies under it. **DAE:** Department of Agricultural Extension provides the extension support for technical helps to farmers. **BRRI:** Bangladesh Rice Research Institute is a research institute whose mandate is to develop new varieties of rice to suit the various natural and environmental challenges to rice production.	■ Rice production is decreasing. ■ Policies for efficient water utilization strategy and relevant water management policy in agriculture. ■ Reduced availability of irrigation water particularly from ground water sources.
Task: Need to identify the system/ area of interest	Task: Need to identify roles and responsibility	Task: Need to identify current situation

[5] *The important elements of the strategy to achieve the objectives of the Delta Plan*

Part 2 – The Risk Assessment

In this part, you make use of the information identified in part 1 (actors and current situation). Part 2 assesses climate-related risks of the identified system/area of interest: climate hazards, exposure, vulnerability (sensitivity and adaptive capacity) and the resulting impacts.

Your Task

Use matrix 4 to guide your work:

- Please transfer from matrix 3 (column A) into matrix 4 **(column A)** the 'system/area of interest' you identified and intend to work on.
- In **column D**, identify the expected climate hazards such as rainfall and temperature changes of concern the system/area of interest may be exposed to. If possible, identify how often the system/area of interest will be exposed to these climate hazards (e.g. occasionally or once every 10 years).
- In **column E**, check if and how the system/area of interest can potentially be affected by climate hazards. Consider environmental and social sensitivity (e.g. local housing materials, the water needs for agriculture, the community's dependence on natural resources. Consider the current situation and trends of the system/area of interest).
- In **column F,** brainstorm the current adaptive capacity of the system/area of interest based on the climate conditions (e.g. access to reliable seasonal weather forecasts, the ability to interpret the information, a warning system, availability of a research budget, a participatory mechanism for planning at the local level). That is the adaptive capacity that individuals and communities have today.

Explore the potential impacts:

- In **column G**, brainstorm the potential impacts to the biophysical part of the identified system/area of interest: You have to consider the climate hazards (column D) in combination with the vulnerability factors (columns E and F), e.g. dry spells lead to lack of groundwater recharge, which is important for agricultural production.
- In **column H**, think of socio-economic impacts that you expect to result from biophysical impacts. Also take into account vulnerability factors (columns E and F), e.g.reduced production and loss of income as there is not enough water for irrigation.
- **Column I** asks you to define key risks taking into consideration the development objectives related to your system/area of interest and within a specified time horizon (e.g. 3 years for a project or 5 years for a strategy). It is necessary to assess the probability of climate hazards and the extent of impacts to estimate the level of risk.

Figure 4.1 is an example of an overview table. Combine in this table the probability of climate hazards with the extent of damage of impact in each case to estimate the level of risk (low, medium, high).

Probability of climate hazard	Extent of damage		
	Low	Medium	High
High		Level of Risk	
Medium			
Low			

Probability of climate hazard	Extent of damage		
	Low	Medium	High
High	Medium	Medium	High
Medium	Low	Medium	Medium
Low	Low	Low	Medium

Figure 4.1: Risk table

Matrix 4: Assess risk

A	D	Vulnerability			Potential Impact(s)		I
		E		F	G	H	
		Sensitivity					
system/ area of interest	Climate hazard of concern the identified action may be exposed to	Social	Environmental	Adaptive Capacity	Potential biophysical impacts (also considering vulnerability [E and F])	Potential socio-economic impacts (also considering vulnerability [E and F])	Risk level***
EXAMPLE Rice productivity	EXAMPLE ■ Erratic Rainfall ■ Drought	EXAMPLE Marginal Farmers are highly sensitive as they have lower economic capacity Day labourers are highly sensitive as they have lower economic capacity	EXAMPLE Crop variety as different crop variety have different sensitivity in terms of temperature and moisture. Both the parameters are affected by climate Irrigation water is sensitive to dry spell which leads to lack of ground water recharge	EXAMPLE Drought/ heat Tolerant variety Use of smart card to use irrigation water application	EXAMPLE Lowering of ground water table Reduced yield due phenological changes	EXAMPLE Reduction of household income Increase of malnutrition problem	EXAMPLE Medium
Task: Use Matrix-3, Colum A	Task: Need to identify climatic hazards	Task: Need to identify social sensitivity	Task: Need to identify environmental sensitivity	Task:Need to identify adaptive capacity	Task: Need to identify potential bio-physical impacts	Task: Need to identify potential socio-economic impacts	Task: Need to identify risk level

A Note on Risk Level Identification***

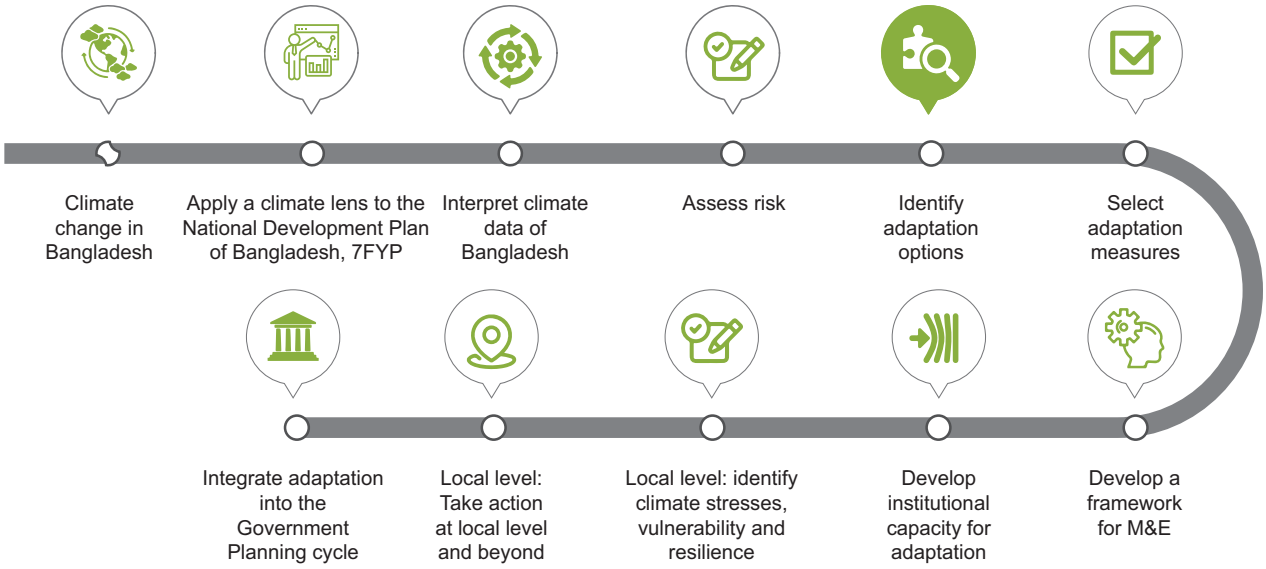
Because probability of frequent erratic rainfall or drought is high, but extent of impact is low or medium because adaptive measures are practiced by farmers and responsible authority. So according to Figure 4.1 Risk Level is Medium.

The risk level you have identified from the Matrix 4 will be important for your future planning process of climate change adaptation.

Climate hazards, vulnerability and potential impacts and adaptive capacity (See glossary) are important determinants for adaptation planning.

Module 5:

ADAPTATION OPTIONS



5.1 Learning objective for the exercise

- Learn about the different categories of adaptation (policy, technical measures, capacity development, and research).
- Learn about different starting points for adaptation (1) reduce exposure, reduce sensitivity, increase adaptive capacity – all of them leading to reduced climate-related risks and (2) enhance opportunities from climate change.
- Understand that adaptation includes low-regret options (see glossary) as well as options that address climate change specifically.

5.2 Your task

Use matrix 5 to guide your work. In the matrix you will find again in **column A** (similar to module 4) the predefined system/area of interest which are important for the realisation of the BDP 2100.

You have the task to support the integration of climate change adaptation into 7 of the strategies of the BDP 2100 (Exhibit 1, P-50 and Exhibit 2, P-51-63).

First, select into **column K** potential impacts (columns G and H, matrix 4). If you want, add from your work experience elsewhere.

- In **column L** brainstorm adaptation options (an option is something you may possible consider, like a basket of options from which you may select only a few as concrete measures later on. The bigger that basket, the greater the chance that you may be able to identify measures later on). You may also consider low-regret options or ecosystem based-adaptation options (refer to glossary).
- In **column M** identify relevant actors whose contributions will be necessary for implementing an option.

A Note on Identification of Adaptation Options

Module 5 deal with adaptation options. This training wants you to be open as possible in finding adaptation measures. One needs to think ''out-of-the-box'.

But many of us suffer from a normal level of ''professional biases'. That is humans have a tendency to immediately favour or disqualify even the thought of an idea. This module request you, to think freely, in a brain storming manner about possible adaptation options. That is you are requested to collect ideas, whatever strange at the first sight, which come to your mind when you identify adaptation options.

Matrix 5: Identify Adaptation Options

A System/area of interest	K Projected impacts	L Identify Potential Adaptation options	M Relevant actors / stakeholders
EXAMPLE Rice productivity	**EXAMPLE** ■ Lowering of ground water table ■ Reduction of rice output ■ Reduction of household income ■ Increase of malnutrition problem	**EXAMPLE** ■ Improved water management through new water policy ■ Efficient water pricing system for water usage ■ Alternative income generation ■ Promote surface water irrigation ■ Research for new drought tolerant variety	**EXAMPLE** ■ Farmers to save water ■ Government to draft appropriate water and agriculture policy
Task: Use identified system/area of interest from Matrix 4 Colum A	**Task:** Need to identify	**Task:** Need to identify current situation	**Task:** Need to identify relevant stakeholders

Adaptation

Protect	Accommodation	Retreat
■ Dykes, Levees, Floodwalls ■ Floodgates, Tidal Barriers ■ Detached Breakwaters ■ Wetland Restoration ■ Afforestation	■ Emergency Planning ■ Insurance ■ Improved Drainage ■ New Techniques of Crop Cultivation ■ Alternate Livelihood	■ Establish Retreat Zone ■ Relocate Threatened Area ■ Erosion Control Easement ■ Upland Buffers

Figure 5.1: Basics of adaptation

In general, adaptation aims to prevent, reduce or avoid the negative impacts and enhance opportunities from climate change. Or make use of new opportunities. Please find some examples of climate change adaptation. You may consider these examples and other measures as adaptation options.

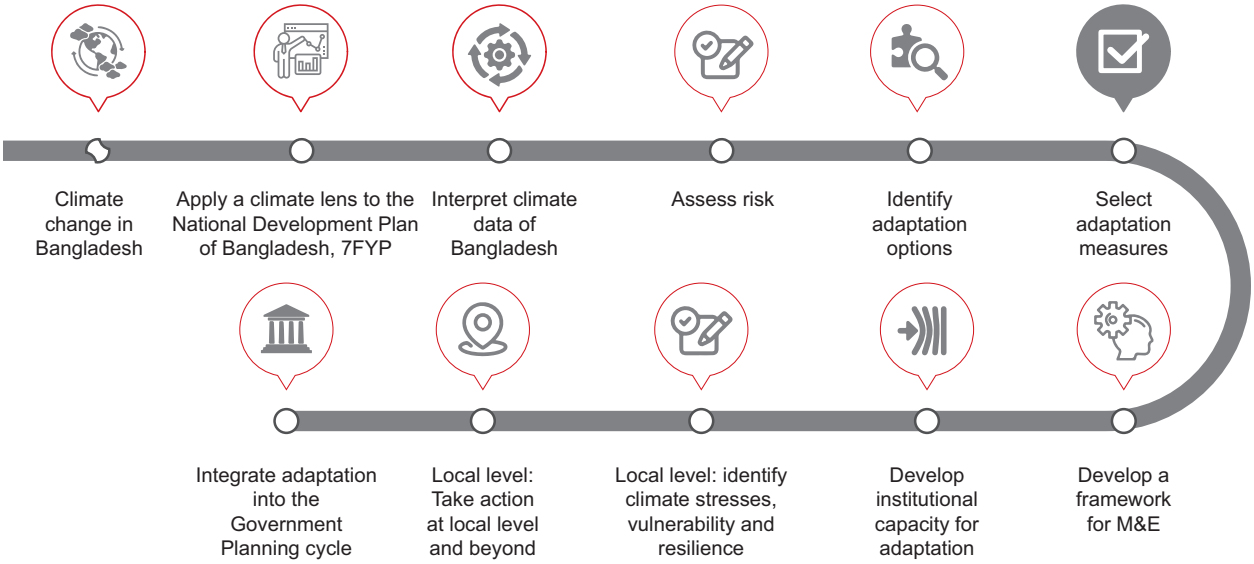
Ther are different categories of adaptation options:
Measures related to policy and legal framework
Measures related to capacity development
Measures related to technical interventions
Measures related to research

Some concrete examples:
Reduction of a system's sensitivity
Enhancement of adaptive capacity of a system
Improving plant and livestock breeds

Figure 5.2: Categories of adaptation

Module 6:

ADAPTATION MEASURES



6.1 Learning objective for the exercise

- Understand that strategic priority setting supports effectiveness.
- Learn how to select appropriate criteria for the selection of adaptation measures.
- Run a multi-criteria analysis to come up with a set of deliberately chosen adaptation measures.

6.2 Specific information on module 6

- Module 6 applies a set of selection criteria to the adaptation options identified in module 5 and helps prioritising and selecting a final set of adaptation measures.
- It asks: “Which adaptations options should be prioritized in order to ensure effective adaptation under limited resources and limited climate information?”.
- Module 6 encourages strategic thinking and the capacity to run a transparent and systematic selection process in order to create acceptability among stakeholder groups.

6.3 Your task

YUse Matrix 6 to guide your work.

Step 1: Agree on the selection criteria

- Transfer the identified adaptation options (module 5, matrix 5, column L, page 47) into **column L of matrix 6** below. For this exercise select a maximum of 4 options.
- In columns **N, O, P, Q, R** of matrix 6 below agree on the selection criteria. You find suggestions in figure 13 and you may add other criteria if desired.

Step 2: Select adaptation options to become measures

- In columns **N, O, P, Q, R** discuss the feasibility of each option using the criteria you selected. Score each criteria by using a scale ranging, for example from 1(not so good, expensive, difficult) to 5 (good, less expensive, feasible). You may use a different scaling as well. Be sure, for each column of your selection criteria.
- In **column S** rank each option according to its score. This will give you your selected measures. So, the option you initially brainstormed becomes a measure by selecting it. Measures are identified by selecting the 2 or more options having the highest scores.
- If too many options have similar scores, try to be more specific by introducing a wider range (for example 1 – 10) or weigh the criteria. For example the criterion "feasibility" may be comparatively more important than criterion "effectiveness". Hence, you multiply criterion "feasibility" by a factor of 2 or 3 or more. The choice of the scoring method is yours. In case your government uses option scoring methods in planning, you may choose to apply those methods.
- Using a 'bird's eye view' consider, at the end of the exercise whether the results you generated make sense:
  - Do the selected adaptation measures address the risks and priority areas of relevance for adaptation?.
  - Do they be effectively taking into consideration the development objectives of the system of interest?.
  - What actors are responsible or should be involved?.
  - What activities are necessary to enable actors to play their roles effectively?.

Matrix 6: Select adaptation measures

L Adaptation option	N Criterion 1: Effectiveness	O Criterion 2: Investment Cost	P Criterion 3: Technical Feasibility	Q Criterion 4: …	R Criterion 5: …	S Overall evaluation and selection into adaptation measures
Option 1…						
Option 2…						
Option 3…						
etc…						

Criteria for selecting adaptation measures

The OECD recommends the following key criteria:

- **Effectiveness:** describes the extent to which the adaptation option reduces vulnerability and provides other benefits. Think of effectiveness of the adaptation option under different scenarios.
- **Costs:** describes relative costs of an adaptation option. Think of investment costs as well as costs over time, such as operation and maintenance costs, reconstruction costs, etc. Think of economic and non-economic costs. Think of costs of avoided damage.
- **Feasibility:** answers whether the necessary legal, administrative, financial, technical, etc. resources exist. Adaptations that can be implemented under existing operational frameworks will usually be favoured.

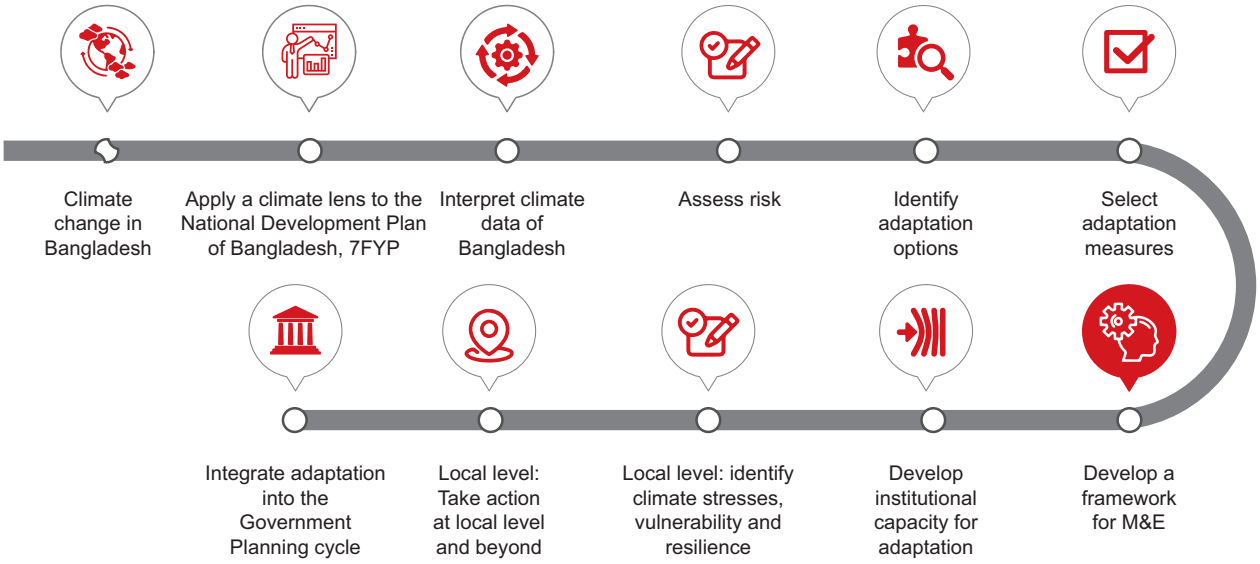
Additional criteria may include, depending on the context, e.g. political and social acceptance, urgency, biodiversity friendliness, relative speed of implementation or benefits, 'no regrets' potential, avoid detrimental effects on other development goals, alignment with funding requirements or other eligibility criteria, alignment with policy priorities, etc.

Other relevant questions are "What happens if you don't take a specific action?"; "If the adaptation measure is already being implemented, would it need additional funding to improve or to do more of the same"?

Figure 6.1: Criteria for selecting adaptation measures

Module 7:

DEVELOP A FRAMEWORK FOR M&E



7.1 Learning objective for this exercise

- Enhance the knowledge on logical frameworks and other project management tools.
- Understand how to develop a results chain and formulate associated indicators.

7.2 Context

The Government of Bangladesh (GoB), often in cooperation with bilateral and multilateral agencies, is implementing several sustainable development projects in different sectors. The Development Project Appraisal (DPP) is necessary for the approval of a project proposal formulated by the several implementing agencies (Ministries). The inclusion of these projects in the Annual Development Programme (ADP) depends on the process of project approval and revision conducted by the Planning Commission. A higher quality of a DPP during the project preparation leads to a more effective implementation of project/programmes in the ADP.

The Implementation, Monitoring and Evaluation Division (IMED) is the central body of Bangladesh for monitoring and evaluation of the public-sector development projects in the ADP. The GoB is aware that the inclusion of M&E into climate change adaptation would contribute to reducing the workload during project revision and approval, and consequently during the implementation phase monitored by IMED. However, it was observed that climate change issues were not so prominent during project formulation in general.

7.2.1 Instructions for case work

Case

The Ministry of Agriculture (in collaboration with the Ministry of Water Resources) is planning to implement an irrigation system in North-West Bangladesh for the improvement of Boro rice production. The project formulation phase has already started.

You remember that you as the advisory group has the task to support the integration of climate change adaptation, including a M&E system into the core targets of the 7FYP. The major issues and challenges for the core targets are:

Core target: Significant growth of the agriculture, industry and service sector

Major issues and challenges:

- promoting the use of agricultural technology with supportive policies, reforms, regulations and incentives in place for raising productivity and profitability.
- increasing diversification of production in line with consumption diversification to promote nutrition.
- increasing private sector participation in the agriculture and improving agro-processing value chains.
- reducing instability of production.
- increasing resource use efficiency.
- reducing loss of arable land.
- minimizing yield gap.
- maintaining food security, safety and quality; expanding irrigation and farm mechanization through appropriate technology.

Core target:Safe drinking water for all

Major issues and challenges:

- Building a climate resilient society is perhaps the biggest challenge for the country. The country needs to overcome its hurdles in tackling the consequences of frequently occurring natural disasters
- Maintaining the coastal polders is a major challenge, while ensuring community level climate sustainability is also important.
- Management of saltwater intrusion, flood risk mitigation, climate proofing, dry season flow augmentation, erosion protection and river navigability and connectivity restoration, removal of drainage congestion and water logging, restoring surface and groundwater quality in the sensitive areas, revitalizing regulated freshwater flow etc. are some of the salient challenges of Bangladesh.
- The country needs to ensure sustainable water utilization, especially in the north-west and north-central regions where water has gradually emerged as a scarce resource.

7.3 Various information help you in executing your task

- Exhibit 3 (in Module 11, page 73) gives an overview of the specificities of Boro rice considering climate change aspects in the North-West Bangladesh.
- Matrix 7 and matrix 8 assist you in thinking through a result chain (figure 14), developing indicators and discussing sources of data.
- Figures 15 and 16 give indications on how good indicators should be formulated.

7.4 Your task

- Please read exhibit 3. It informs you on the expected impacts on rice production in North-West Bangladesh, its water requirement, etc.
- In matrix 7 note down the desired long-term impacts of the project envisaged by the Ministry of Agriculture for the development of an adapted irrigation system in the North-West of Bangladesh.

- Use matrix 8 to develop a M&E framework:
  - Please consider the selected core target on agriculture of the 7FYP in column A.
  - In column B, brainstorm on potential adaptation measures required in the Boro rice context. These measures need to be in line with the 7FYP core target. Select a few measures your group considers most relevant.
  - In column C think through the outputs and outcomes of the selected measures. Link them to the overall desired result (impact). Figure 14[6] explains the logical framework of a results chain.
  - In column D brainstorm potential indicators for the outputs and outcomes defined. Figure 15 suggests possible criteria for the selection of good indicators. Figure 16 suggest steps towards indicator definition.
  - In column E suggest possible sources of data and information for tracking and measuring each indicator.

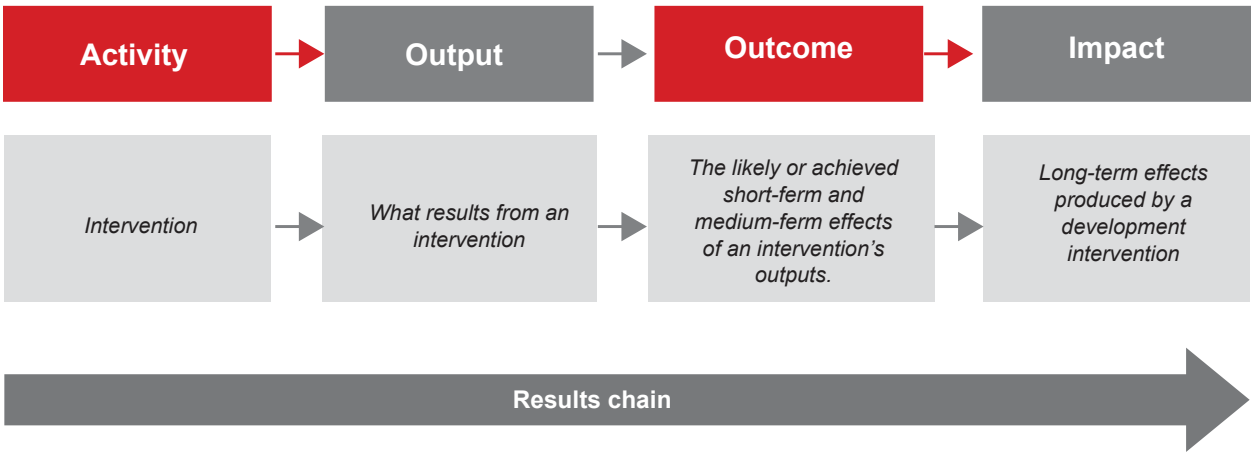


Figure 7.1: Result chain

Criteria for the selection of good indicators
(S) Specific: the indicator is valid and describes the underlying issue.
(M) Measurable, practicability: rely on sound data obtained through reproducible methods independent from the individual collectors of the information
(A) Attainable: the target value and milestones of an indicator should be realistic
(R) Relevant: address issue for the users and related to the objective of M&E
(T) Time-bound: related to time and milestones so that progress can be shown during the course of implementation

Figure 7.2: Criteria for the selection of indicators

[6] *For more information see OECD (DAC) 2002; "Glossary of Key Terms in Evaluation and Results Based Manage- ment"; Evaluation and Aid Effectiveness, No 6 http://www.oecd.org/dataoecd/29/21/2754804.pdf*

1. Define indicator, e.g. qualification of water management staff
2. Specify quantity of change, e.g. 50% of all water managers trained
3. Specify quality of change, e.g. trained in up-to-date water management techniques
4. Define time horizon, e.g. within the next two years
5. If applicable: specify regional aspect, e.g. water management staff within the area of intervention of the project

Figure 7.3: Steps towards output indicator formulation

Matrix 7: Define the desired impacts

What are the desired impacts that the project (Boro rice, Exhibit 3) for the development of an adapted irrigation system in the North-West of Bangladesh aims at?

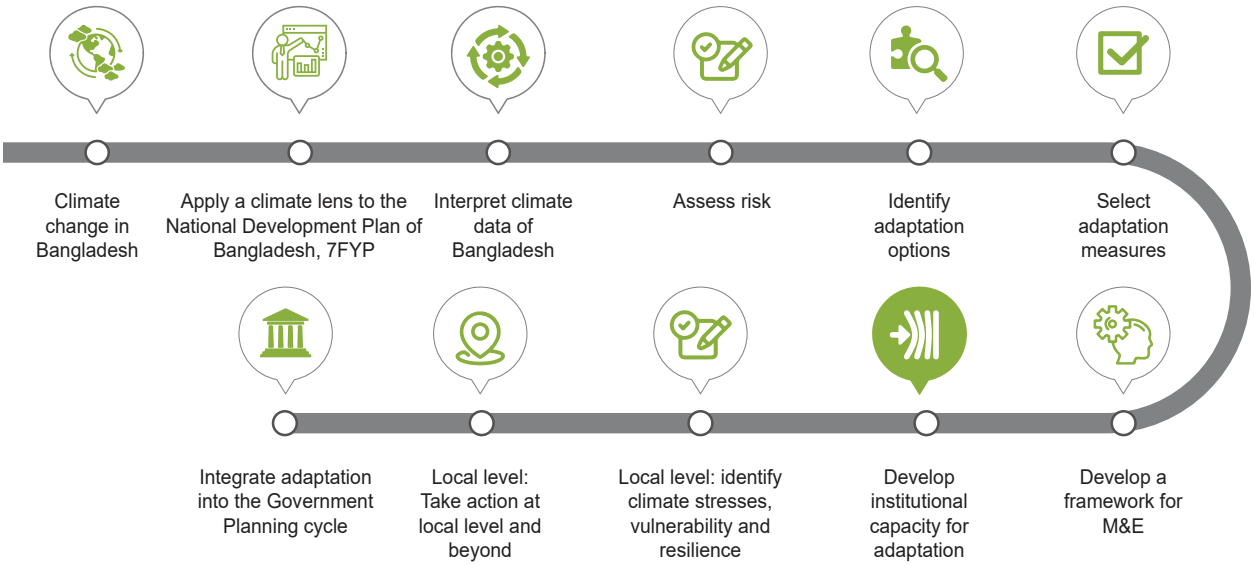
e.g. increased water availability, increased productivity of Boro-rice

Matrix 8: Develop a M&E framework

A Core target (7FYP)	B Adaptation measures (Boro rice example)	C How does the measure link to the overall aim of the project	D Possible indicators	E Sources for the verification of indicators
Significant growth of the agriculture, industry and service sector: Promoting the use of agricultural technology with supportive policies, reforms, regulations and incentives in place for raising productivity and profitability		Output: ■	Output: ■	e.g. internal M&E system of the Ministry of Agriculture (quantitative survey, every year)
		Output: ■	Output: ■	

Module 8:

INSTITUTIONAL CAPACITY FOR ADAPTATION



8.1 Learning objective for the exercise

- Understand that action on adaptation requires adequate institutional capacities
- Learn how to deal with adaptation as an ongoing institutional change process

8.2 Context

Bangladesh recognises that climate change adaptation requires appropriate policies, management structures, administrative processes and activities. The Government therefore, wishes to develop capacity to deal with climate change in a systematic and proactive manner. Capacity development therefore, is a prominent element in the 7FYP as well as in the Bangladesh Delta Plan 2100.

8.3 Instructions for case work

You have the task to support the integration of climate change adaptation into 7 of the strategies identified in the BDP 2100. These strategies and the major issues and challenges foreseen are:

The selected 7 strategies are: (For detail information see Exhibit 2, P-51-63):

Hotspot Specific Strategis

- Combating storm surge and salinity intrusion through effective management of existing polders.
- Ensuring water supply and sanitation in Barind areas.
- Achieving sustainable haor ecosystem and biodiversity managment.
- Developing multi-purporse resources managment system for sustainable growth.
- Providing adequate room for the rivers and increasing conveyance capacity to reduce flood risk.
- Improving water supply, sanitation and waste managment system in urban areas.

Cross Cutting Strategies

- Increasing share of renewable energy in total energy production.

The Government now requests your group's support to provide guidance on building capacity in 5 important policy areas:

- Assessment (of contexts situations, etc.)
- Planning (of projects, activities)
- Information Management
- Coordination (of activities and among actors); and
- Implementation (of projects, activities)

Climate change adaptation is often centered around five key institutional functions (these cannot however be accurately separated):

- **Assessment:** Adaptation requires new information on climate change. its impacts as well as successful management interventions. e.g. climate data by region. risk assessments. climate change impact assessments. evaluation of adaptation practices.
- **Planning:** Climate change adaptation requires strategic and systematic processes in order to define the right priorities. This demands looking into various time horizons. geographical inter-linkages. specific risks and vulnerabilities. etc. e.g. systematic approach to addressing the projected climate change impacts across the society.
- **Coordination:** Adaptation to climate change is neither a one-department-show nor a quick-fix one way top-down road. It cannot be dealt with at one desk. Coordination aims to join forces. to avoid duplication or gaps and create economies of scale in responding to climate change challenges. e.g. horizontal coordination between the Ministries of Water and Agriculture. vertical coordination between National and State level. policy dialogues including civil society representatives.
- **Information management:** Adaptation requires adequate information management. Most Governments and institutions have information management structures. processes and tools in place. These need to be further developed rather than inventing a new information systems.
- **Implementation:** Adaptation also means implementation of climate risk reducing measures. e.g. water retention structures. contingency planning.

Figure 8.1: gives you an explanation on these policy areas

Matrix 9 assists you in reviewing existing capacities in the government in order to define emerging needs for capacity development.

8.4 Your Task

Use matrix 9 to guide your work.

- **Column A** lists the selected strategy that this training course is concerned with.
- **Column B** lists the five important policy areas that are explained in this module (Figure 8.1).
- **Column C**, is a selection of two 'major issues and challenges' that the BDP 2100 identifies in respect to the selected strategiy.
- In **column D**, brainstorm which short to medium term measures are needed to integrate adaptation into Govt. planning procedures.
- In **column E**, identify the long-term measures required to tackle the 'issues and challenges' mentioned in column C.
- In **column F**, identify which capacity development activities are needed to implement the measures identified in column D and E.

A	B	C	D		E	F
Core targets of 7FYP (In your task you need to consider the strategies of BDP)	Important Policy Areas	Selected major issues and challenges for core targets	Which short/medium term measures are needed to integrate adaptation into Govt. planning procedures?		Which long-term measures help tackling the 'issues and challenges' mentioned (column C)?	Which capacity development activities are needed to implement the measures (column D and E)?
			Short to Medium Term	Long Term		
Agriculture: Significant growth of the agriculture, industry and service sector	**Assessment**		■ Promoting the use of agricultural technology for rice production with supportive policies, reforms, regulations and incentives in place for raising productivity and profitability. ■ Such changes will be necessary particularly for rationalisation of water management practices for irrigation and water related hazards including structural and non-structural measures	■ Analyse base line situation regarding rice output, and its climatic, agronomic and economic factors over the last two decades or so, ■ Build CC scenarios for future for specific regions as well as national one Assess future bio-physical and socioeconomic vulnerabilities including natural hazards & risks and impacts on rice production by region and nationally; ■ Possible adaptation in future under various CC scenarios and related vulnerabilities including available technologies and varieties as well as cropping patterns and their region-specific suitability ■ Consult farmers in-depth for the understanding of their vulnerabilities and acceptability of preferred adaptation options	■ Regularly update CC modeling and vulnerability analysis and search for newer types and more cost-effective adaptation options	■ Institutional capacity to be developed and human skill created and nurtured for climate change modeling, modeling of bio-physical and socio-economic vulnerabilities and risks through training as well as investment in bachelor and post-graduate levels in universities Provide research grants to Universities and research organisations to carry out specific modeling tasks; evaluate adaptation options particularly related to rice production
	Planning		■ Development of a concept note detailing project ideas drawing upon Assessment of the problem and the adaptation needs and their time lines as done under the previous set of activities under "Assessment";	■ BRRI and related other organisations to detail out technicalities of each of the adaptation options and the costs of these	■ Relevant officials in Ministry of Agriculture and its constituent agencies to be trained in preparation of adaptation projects based on the assessments above	

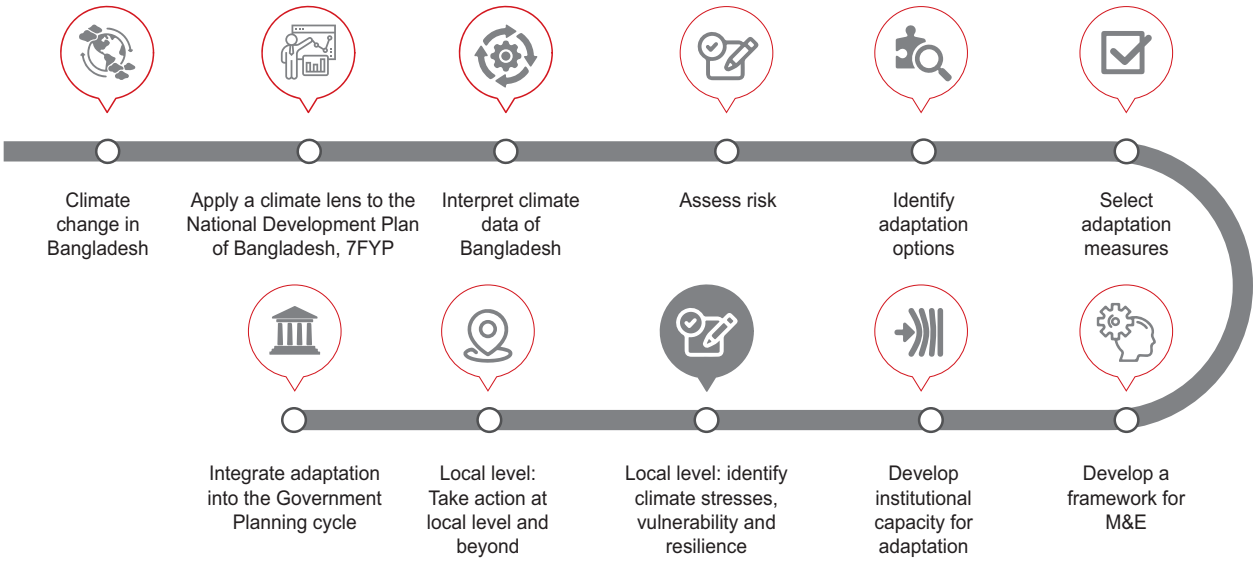
A	B	C	D		E	F
Core targets of 7FYP (In your task you need to consider the strategies of BDP)	Important Policy Areas	Selected major issues and challenges for core targets	Which short/medium term measures are needed to integrate adaptation into Govt. planning procedures?		Which long-term measures help tackling the 'issues and challenges' mentioned (column C)?	Which capacity development activities are needed to implement the measures (column D and E)?
			Short to Medium Term	Long Term		
			■ Preparation of the DPP incl financing issues & other constituent parts of costs, benefits, IRRs of various alternative adaptation options incl ■ Sensitivity analyses due to various RCPs for climate change and environmental issues; ■ Social implications of each of the adaptation options in terms of benefits going to the poorer segments of society and poorer regions with due recognition of gender-based benefits ■ Contingency planning to handle the extreme situations incl proper O&M and adequate funding for them; ■ M&E & scopes for post-project evaluation particularly how far the adaptation option had been able to minimise the specific vulnerability and for the most affected social group incl gender considerations as well for regions	DAE to detail out for each of the chosen adaptation option the required extension plan keeping in mind the needs of poorer farmers and poorer regions Planning sections along with Planning Commission to analyse socio-economic implications based on the base line situation and possible future scenarios Rules to be framed for handling O&M beyond normal present practice to handle contingencies due to extreme conditions in future and financial rules to be framed accordingly	Review to be made for possible new rules for handling extreme situations under climate change and associated financial provisions	

A	B	C	D		E	F
Core targets of 7FYP (In your task you need to consider the strategies of BDP)	Important Policy Areas	Selected major issues and challenges for core targets	Which short/medium term measures are needed to integrate adaptation into Govt. planning procedures?		Which long-term measures help tackling the 'issues and challenges' mentioned (column C)?	Which capacity development activities are needed to implement the measures (column D and E)?
			Short to Medium Term	Long Term		
	Coordination		■ Climate change coordination cell need to be set up in the relevant ministry with focal points specifically in many agencies which may be involved in a major way including organisations analysing base situations as well as doing modeling (bio-physical, socio-economic), planning agencies, monitoring organisations and finally those implementing on the ground including some of those involved in planning	■ Set up a permanent Coordination body among ministries, to be placed under the PM Secretariat to oversee adaptation options under specific ministries and to resolve conflicts among adaptation options advocated by various ministries	■ Training in inter-disciplinary issues related to climate change, not just sectoral issues	
			■ The cell will have the task of deciding what type of analysis, relevant data and modeling to be done for the specific project on adaptation	■ To set up a Task Force to understand the desirability and if suitable decide its working methods, rules and procedures		
			■ Strengthening inter-ministerial coordination particularly among the main stakeholder ministry (Agriculture in this case) and others such as Planning Commission and Finance plus any other relevant ministry depending on the nature of adaptation			
	Knowledge and Information Creation and Management		■ Review of existing knowledge and practices on the ground for rice cultivation	■ To continue on a regular basis new models and analysis based on most recent scientific findings and data	■ Similar to Assessment capacity building	

A	B	C	D		E	F
Core targets of 7FYP (In your task you need to consider the strategies of BDP)	Important Policy Areas	Selected major issues and challenges for core targets	Which short/medium term measures are needed to integrate adaptation into Govt. planning procedures?		Which long-term measures help tackling the 'issues and challenges' mentioned (column C)?	Which capacity development activities are needed to implement the measures (column D and E)?
			Short to Medium Term	Long Term		
			■ KICM is also necessary to understand costs, benefits (incl co-benefits), implementation issues (incl social acceptability) of each of the technical adaptation options including development of new climate resilient varieties, cropping patterns ■ KICM to feed into M&E process and ultimate evaluation ■ KICM to give proper attention to farmers' traditional knowledge and autonomous adaptation practices and integrate then as far as possible with modern scientific practices	■ Collect location and hot-spot based data and run analysis ■ Put all relevant data and analysis in public space for ready access and newer analysis and insights		
	Implementation		■ Sensitise project staff on particularly contingency planning measures and rules and procedures under such conditions	■ Establish local level Climate Change adaptation project coordination unit for coordination of various sectoral adaptation projects and ultimately have an say Upazila CC Adaptation Plan/ Programme	■ Training or Planning Camps may be organized for creating necessary awareness and understanding among various sectoral projects with wider local level participation of stakeholders	

Module 9:

LOCAL CLIMATE HOTSPOTS



9.1 Learning objective for this exercise

- Learn about local information on climate hotspots.
- Learn to relate impacts from climate change to development criteria.

9.2 Context: HOTSPOT: Barind and Drought Prone Areas in Bangladesh [7]

The Barind region with the Barind tracts falls in the North-West region of Bangladesh, and includes 12 districts. It covers roughly an area of some 7,770 sq km. About 5.4 million people live in the hotspot area. The Pleistocene terraces of the Barind tracts experience frequent droughts and water scarcity, which hamper dry season irrigation initiatives. Drought is especially severe in the high Barind (Natore, Bogura, Thakurgoan districts). The area receives some 1,300 mm of rain on an annual basis and is considered the driest region of the country. Rainfall is particularly scarce in the 4-month dry winter period, in which, if water supply can be secured, optimal conditions exist for intensive agriculture. Groundwater development has been extensive over the past 30 years, driven by both public and private sector initiatives. Intensive development activities, exceeding recharge from rainfall, has led to a declining groundwater table, shrinking wetlands and subsequent threats to ecosystems, irrigation and water supply sources.

The hotspot further includes Meander floodplains as the high Ganges River floodplain and the lower Atrai basin. These

Figure 9.1: Identified hotspots, BDP 2100

[7] *For details refer to: Bangladesh Delta Plan 2100. Formulation Project. Bangladesh Delta Scenarios. Process of scenario development and scenario for the BDP 2100. 2015.*

floodplains normally receive enough freshwater for multiple crops within one season. Due to the intense monsoon rainfall, and the interruption of drainage routes by roads, embankments and other infrastructure and high monsoon river levels, drainage congestion is a key issue in Eastern part of the hotspot area, leading to a delayed planting of boro crops. An additional issue is the disconnection of the floodplain from the regional and national river system, related to the development of the Chalan Beel (FCDI) system. A decline of fisheries habitats, biodiversity and livelihoods dependent upon fisheries as well as siltation of regional rivers has been the result.

In summary, the key bottlenecks in the Barind hot spot include:

- agricultural droughts and groundwater depletion.
- clean and safe drinking water supply and sanitation.
- drainage congestion and floods.
- increasing water pollution.
- floodplain connectivity and wetland decline; and
- siltation of regional rivers.

Increased competition for freshwater supplies constitute a further hazard to the environment, in addition to climate change and increasing water pollution, all of which threaten the adequate future development of domestic and agricultural freshwater supply in the region.

Proposed Programs and Measures for the Drought-Prone Areas of the North West include:

- North Rajshahi Irrigation Project.
- Revitalization and Restoration of water bodies of Chalan Beel, including Beel Halti.
- Revitalization and Restoration of Hurasagar and Atrai rivers.
- Enhanced Managed Aquifer Recharge in the Barind.

9.3 Instructions for case work

Given the situation in Barind and other drought-prone areas in Bangladesh, your task is to assess linkages to climate change. Please identify for each of the key development criteria: **impacts from climate change potentially having a positive / negative influence on the key development criteria**. These key development criteria are outlined and briefly described here below:

Economic Productivity & Loss

The criterion Economic Productivity & Loss is related to changes in *Sector Productivity* of the key sectors Agriculture, Livestock, Fisheries, Industry, Transport, Human Resources and Energy and *Economic* Loss related to the above sectors as well as Housing, (Critical) Infrastructure and Health.

Livelihood Security

The criterion 'Livelihood Security' consists of two main categories: *i) Food Security; and ii) Water Security.* Whereas Food security is mostly related to caloric sufficiency as well as food variety, water security is related to safe drinking water and sanitation as well as security from disasters such as floods, droughts and erosion.

Equity & Gender

Equity & Gender are crosscutting assessment criteria related to Income Distribution and the Livelihood Security criterion described above.

Environmental Sustainability

Environmental Sustainability is a key criterion to assess the impact on ecosystem sustainability, both in protected areas and in the ecosystem services provided through wetlands, floodplains, soils, rivers and intertidal areas.

Governance

Governance is also a cross-cutting criterion including aspects such as institutional capacity, O&M and water service adequacy for different functions and stakeholders and transparency.

9.4 Your task

Use matrix 10 to guide your work.

Your task is to advise your Government in formulating sector development and planning policies taking into consideration projected climate change impacts for the rice production in Bangladesh.

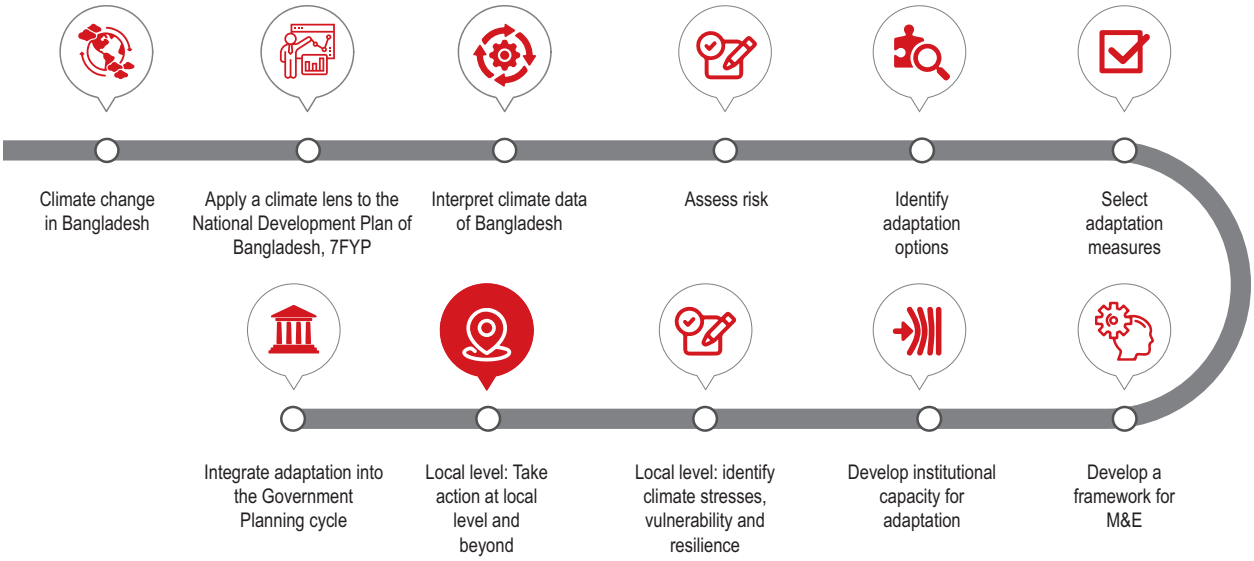
- In column A please identify elements of climate change which may have a positive influence on each key development criteria (refer to examples in the matrix).
- In column B please identify elements of climate change which may have a negative influence on each key development criteria (refer to examples in the matrix).

Matrix 10: Climate change impact on key development criteria

Key development criteria	A Elements of climate change having a positive influence on the key development criteria Example	B Elements of climate change having a negative influence on the key development criteria Examples
Economic Productivity & Loss	Shifting of production zones opens new livelihood opportunities	New disease patterns in rice production challenge HYV
Livelihood Security	Changing precipitation and temperature patterns offer new agricultural opportunities	
Equity & Gender	New income opportunities may include women specifically	Reduction of groundwater availability increases womens' workload of fetching water
Environmental Sustainability	New government policy with a climate change focus	
Governance	New government policy with a climate change focus	

Module 10:

ACTION AT THE LOCAL LEVEL AND BEYOND



10.1 Learning objective for this exercise

- Understand what can be done at the local level and how local action links to regional and national governance and actors.

10.2 Context

Recent evidence is indicating that rising temperature has severe consequences for economic growth, since some results point out two key issues: first, higher temperature substantially reduces economic growth in poor countries; and second, higher temperature has wide-ranging effects, reducing agricultural output, industrial output, and political stability. In addition, internal development factors also worsen the possible climate change impact. These include population density, high poverty and inequality, weak infrastructure, limited integration of disaster into planning and low human development progress.

The primary challenge for Bangladesh is to scale up investments to create a suitable environment for the economic and social development of the country and to secure the well-being of people, especially the poorest and most vulnerable groups, including women and children. The Government of Bangladesh's vision is to eradicate poverty and achieve economic and social prosperity for all people. This will be achieved through a pro-poor Climate Change Management Strategy, which prioritizes adaptation and disaster risk reduction, and also follow the path of low-carbon development, mitigation, technology transfer and the mobilization and international provision for investments in coping mechanisms and green technology.

As in the Sixth Plan, Climate Change Management under the 7FYP will be addressed on two fronts: Adaptation and Mitigation. The adaptation strategy will encompass various measures which can be taken to adequately prepare for the inevitable consequences of climate change, whereas mitigation efforts will cover activities aimed at reducing our carbon footprint.

Climate change leads to environmental effects (impacts and vulnerabilities) such as sea surface warming, natural disasters and disruptions of precipitation rain patterns. Food security is threatened along with the livelihood of people affected by climate change.

10.3 Instructions for case work

Some of the vulnerabilities (matrix 11) projected for the country are described :

- **Gender sensitivity to disasters and climate change**

  The extreme poor and women will be faced with the most serious challenges due to adverse impacts of climate change. Poverty eradication for the poor will be hindered as they are disproportionately affected by the events of climate change.

- **Loss of livelihoods leading to migration**

  In many remote areas affected by climate change, the inhabitants, especially the poor and the marginalized will find it extremely difficult to maintain livelihoods, especially those based on fragile natural ecosystems. This may lead to migration into dense urban regions, worsening living conditions in the process.

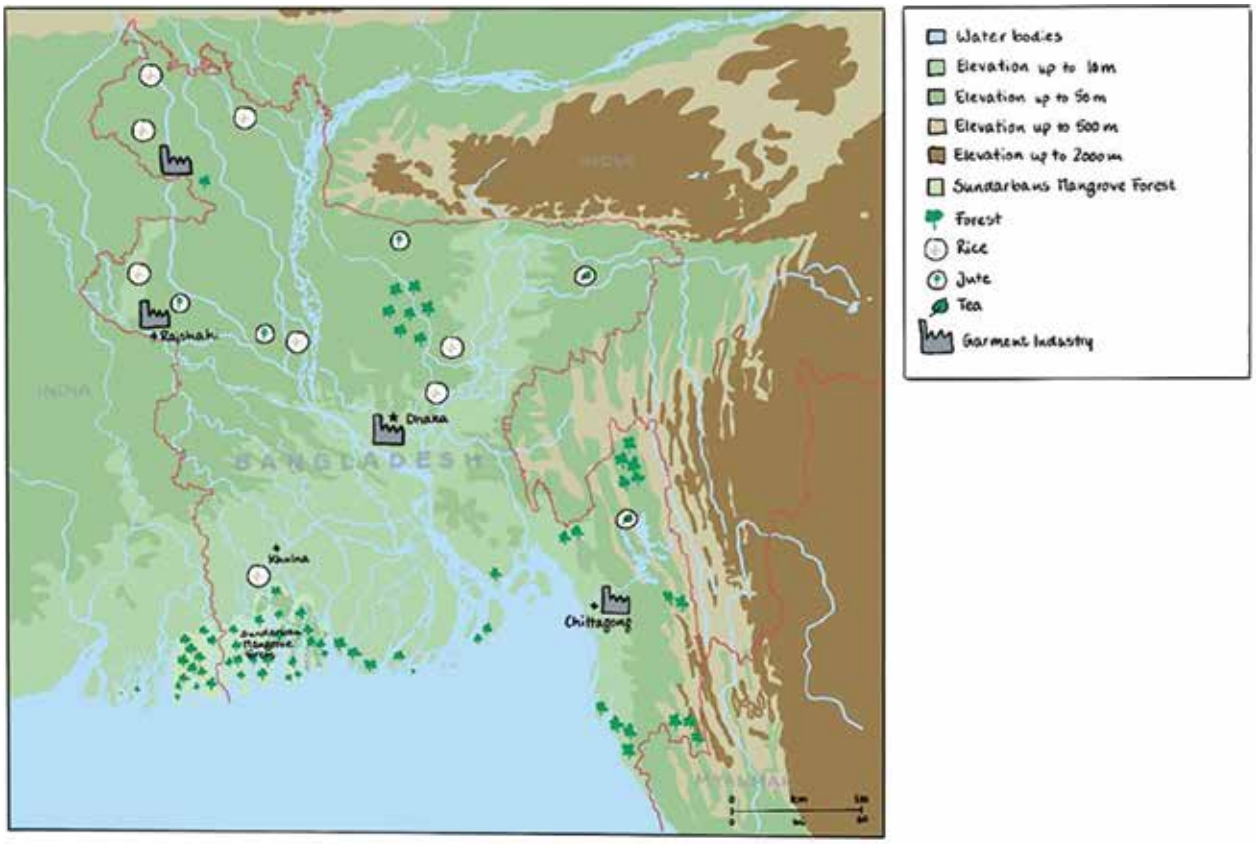
- **Food insecurity**

  Changes in rainfall patterns increase the likelihood of a drought, and an increase in peak monsoon may lead to frequent floods as well. Greater tidal interaction can also cause frequent embankment failures, which will increase salinity in coastal areas. This will create significant difficulties in maintenance of food security amongst poor smallholders and women. Production potential, despite advancement of new varieties and other inputs, will tend to be diminished with increasing temperature, particularly beyond a threshold of 2˚C.

10.4 Your task

Use matrix 11 to guide your work. Please choose, from the Bangladesh map a local area that your group is particularly familiar to work on in this module.

[8] *Bangladesh 7. Five-Year-Plan. FY2016-FY2020. Accelerating Growth, Empowering Citizens. 2015. General Economics Division (GED). Planning Commission. Government of the People's Republic of Bangladesh. Chapter 8.5.1., p. 412.*



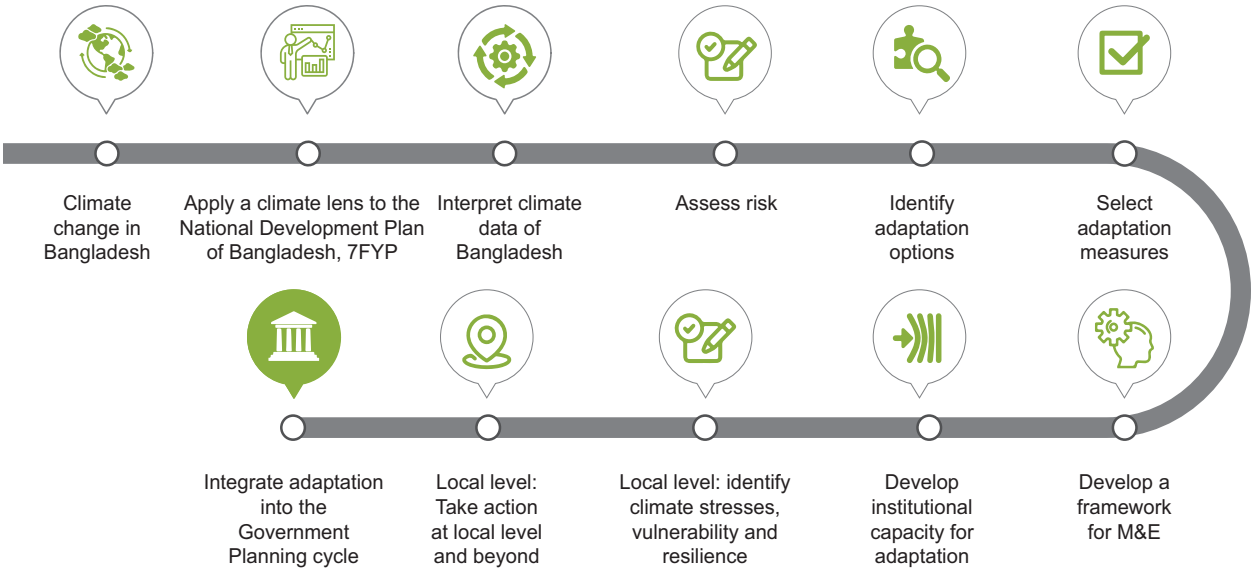
- **Column A** in matrix 11 shows the 3 vulnerabilities which have been identified in the 7FYP.
- In **column B** discuss what adaptation measures you consider possible, based on your professional experience, your knowledge of the local context and your information on projected climate change impacts (exhibit 2). First brainstorm broadly and then select the most relevant adaptation measures.
- In **column C**, identify which steps are necessary to put the options you considered into practice.
- In **column D** specify the actors with capacities to take action and establish links between important actors. Think of synergies with, and support needed from actors at state and national level as well as non-state actors.

Matrix 11: Assess vulnerabilities and adaptation options at local level

A Vulnerabilities to climate change (as identified in the Bangladesh 7FYP)	B Adaptation measures considered	C Next steps	D Who has the capacity to take action and establish links
Disasters and climate change impacts affect women and men differently			
Loss of livelihoods leading to migration			
Food insecurity			

Module 11:

INTEGRATE ADAPTATION INTO THE GOVERNMENT PLANNING CYCLE



11.1 Learning objective for this exercise

- Understand how to integrate adaptation into the various steps of the planning cycle in order to avoid maladaptation and ensure that the future project/programmes of the Government address priority development needs
- Learn how to integrate adaptation into specific sectoral projects

11.2 Context

The Government of Bangladesh, often in cooperation with bilateral and multilateral agencies, is implementing several sustainable development projects in different sectors. As climate change becomes a more and more pressing issue, imagine that the Government has asked your expert group for methodological support on how to integrate climate change adaptation into the planning cycle into consideration of existing and future infrastructure projects. This will help to avoid misguided investments and ensure that the projects address priority development needs under climate change.

The design of new infrastructure projects for each sector may refer to different planning horizons. The longer the planning horizon, the more crucial it becomes to take account of climate issues in the planning cycle. According to each scenario, a specific adaptation measure needs to be considered in the infrastructure planning, ranging from basic solutions (low regret / no regret) to complex measures, which are dependent on further analysis.

The appropriate pathway for developing projects needs to be in line with the country's economic growth and national revenues. Besides the economic and financial feasibility, the projects depend on the functional institutions having a long-term vision.

Part 1: Important aspects for the planning cycle

As an expert group you need to be able to give insightful advice. The Planning Commission aims at understanding future changes in the context of climate change and the resulting implications for the planning process.

Various information help you in executing your task:

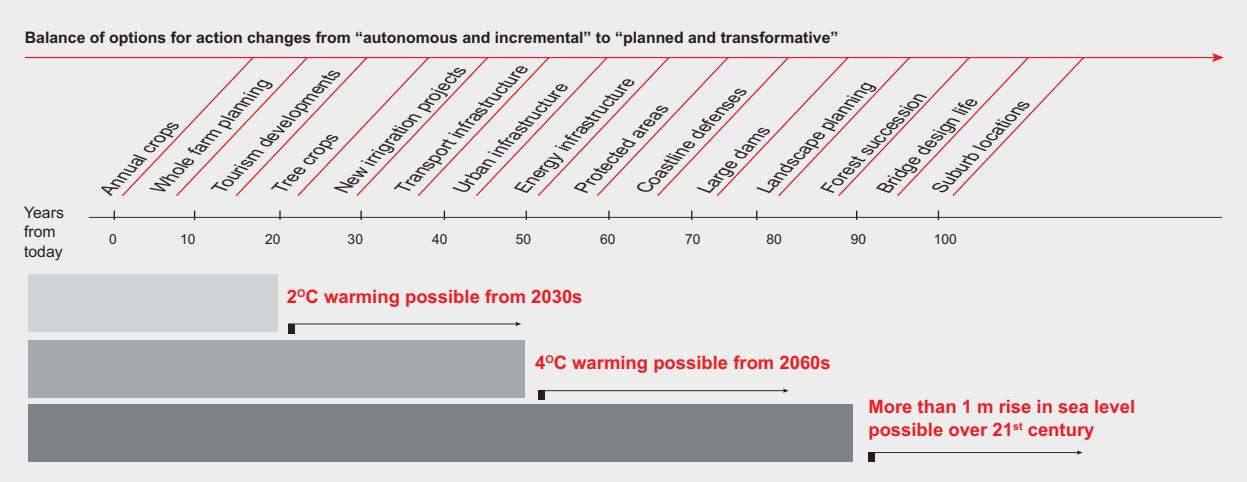
- Figure 11.1 informs on the planning horizons of various sectors, illustrating how far our planning decisions reach into the future.
- Matrix 12 A informs on sectoral impacts as planning bases for the future.
- Matrix 12 B informs on sectoral project planning for future.

Your task

Please read exhibit 2. The exhibit informs on the expected impact on selected hotspot specific and cross cutting strategies.

Please fill up the columns A to E in Matrix 12 A and transfer the 'Entry points into existing planning procedure' into column F. You may also use the climate information given to you during your work on Module 1 and Exhibit 2. Please see the examples in the Matrix 12 A which shows the sectoral impacts as planning bases for the future.

Use Figure 11.1 to guide your group discussions, considering various planning horizons as required by climate change projections.



Source: Stafford Smith et al. (2010). Rethinking Adaptation in a 4 Degree World.

Figure11.1: Planning horizons - Today's decisions shape the future

Figure 11.1 argues that, depending on projected impacts from climate change, these impacts need to be integrated into planning at all levels. If, for example, a 2 degree warming from 2030 onwards is projected, all those planning sectors with a reach beyond 2030 will have to be considered. A reforestation programme needs to consider climate change impacts and possibly adjust the selection of tree species or the composition of various tree species in view of the 2 degree warming projected for 2030. The same argument applies to irrigations systems, transport infrastructure or urban infrastructure, etc.

Part 2: Integrating climate change into specific projects

Your task

Please fill up the columns A to E in Matrix 12 B and transfer the 'Entry points to be build into existing planning procedure' into column F. Position the entry points in such a manner that they appear beside the relevant and corresponding step in the Govt. Planning Procedure (in column G). Please see the examples in the Matrix 12 B which shows the sectoral project planning for future.

Matrix 12 A: Sectoral impacts as planning bases for the future

A	B	C	D	E	F
Climate signals* **	**Sector and sub sector**	**Bio-physical impact**	**Socio-economic impact**	**Relevance for planning (please consider fig. 19)**	**Entry points into existing planning procedure**
Example Rising temperature and uncertain rainfall	**Example** Agriculture/ Food crop production e,.g. rice	**Example** Phenological changes; impacts of drought; excessive at critical life stages of plants; rainfall anomalies leading to consequential flood damage or higher demand for irrigation leading to reduced aquifer recharge and lower water table; lower yield; initial rising evaportranspiration; Nutritional content changes	**Example** Lower output of crop (rice) Food and nutrition security threats particularly for women in specific cases Higher demand for imports of fodo staff putting pressure on foreign exchange balance	**Example** Policy intervention related to research for development of climate resilient varieties and cropping patterns and their extension; Necessary infrastructure development to withstand flood and drought challenge; changes in agronomic practices to minimize crop losses	**Example** Prioritise various adaptation options based on the imemediate and ultimate outcomes of CC impacts (bio-physical and socio-economic)
Task: Need to identify climate signals	**Task:** Need to identify sector and sub sector	**Task:** Need to identify bio-physical impacts	**Task:** Need to identify socio-economic impacts	**Task:** Need to identify relevance for planning	**Task:** Need to identify entry points

A Note on Climate Signals***

Climate signal is the variation in the state of the climate system which is identifiable and statistically perceptible in space or time. The variation is the fingerprint of climate change. Some major examples of climate signal is sea–level rise, extreme precipitation, warming of sea surface temperature, the increase of frequency and intensity of cyclone, etc.

Matrix 12 B: Sectoral project planning for future

A Climate signals	B Specific project	C Bio-physical impact	D Socio-economic impact	E Relevance for planning (please consider fig. 19)	F Entry points to be built into existing planning procedure	G Steps to additionally built into current government planning structure (goes beyond present considerations of environmental impacts)
Example Rising temperature and uncertain rainfall	**Example** Irrigation system in North-West Bangladesh	**Example** Falling aquifer recharge and lower water table; lower yield due to phonological changes and rising evaportranspiration; Nutritional content deteriorates (Zn, Fe, protein contents fall)	**Example** Lower output of rice Rising price of rice Food and nutrition security threats	**Example** Policy intervention related to water pricing; PES; water saving technology such as AWD; From nutrition point of view, biofortication research and development of fortified	**Example** CC impact modelling based on various RCPs and SSPs and their immediate and ultimate possible outcomes; effect of various adaptation measures; prioritise and decide which exact intervention to be projectised	**Example** 1. Biophysical impacts of climate change under clearly defined assumptions as downscaled model from GCMs under various emission and socio-economic scenarios 2. Technical feasibility of adaptation options 3. Costs and benefits identified, quantified and financial and economic values estimated incl co-benefits wherever applicable 4. DPP prepared with Biophysical impact model details annexed
Task: Need to identify climate signals	**Task:** Need to identify sector and sub sector	**Task:** Need to identify bio-physical impacts	**Task:** Need to identify socio-economic impacts	**Task:** Need to identify relevance for planning	**Task:** Need to identify entry points	**Task:** Need to identify the steps

REFERENCES

All information for different modules have been extracted from different national, international documents and resources developed in CEGIS and C3ER, BRAC University over the years. Various sources are:

Annex 1

The United Nations Sustainable Development Goals

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