CLIMATE CHANGE, IMPACTS AND ADAPTATION POLICY FOR BANGLADESH

Md. Mafizur Rahman
Professor
Department of Civil Engineering
BUET
mafiz@agni.com

2nd GEOSS Asia-Pacific Symposium on the role of Earth observations in tackling climate change
Tokyo, Japan, 14-16 April 2008

Presentation Organization

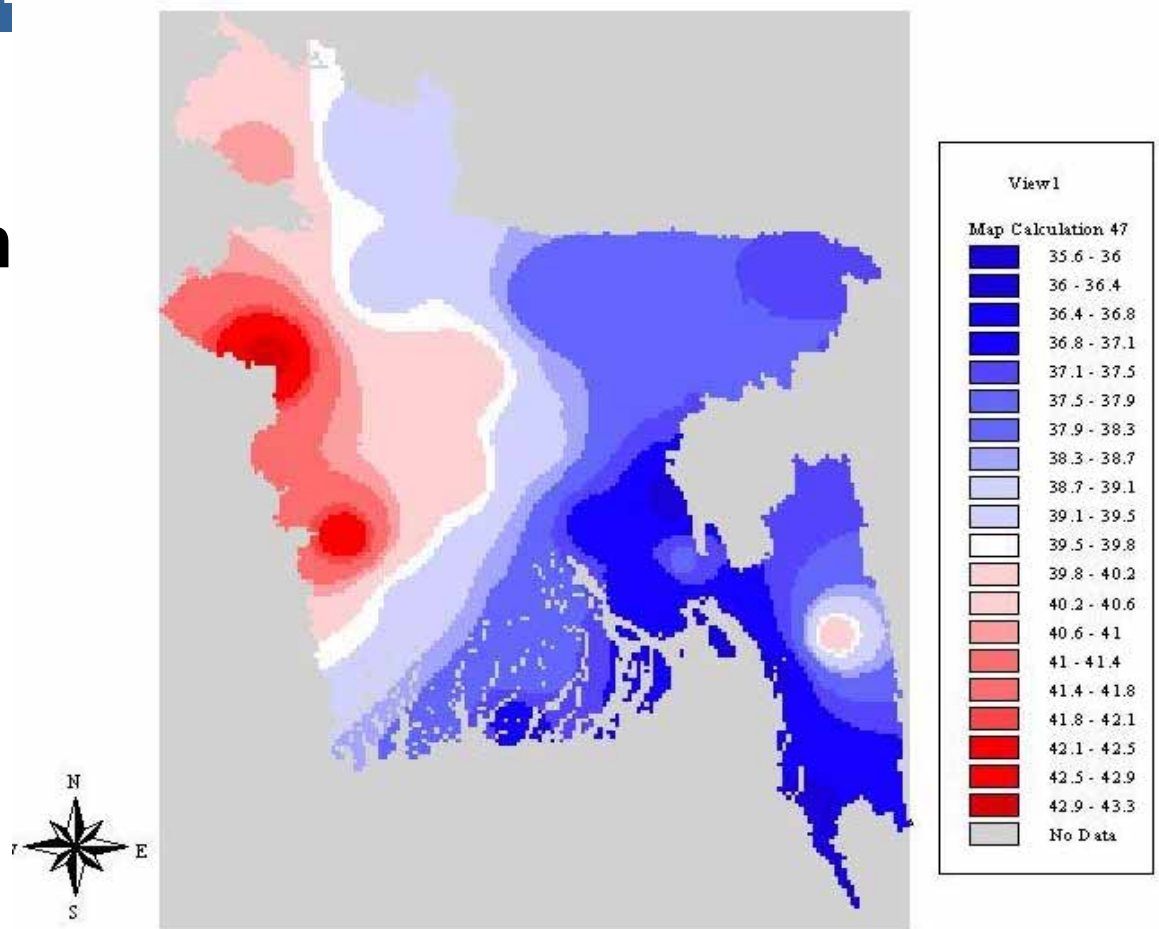
- Assessment of Climatological changes (Rainfall, Temperature, spatial, temporal)
- Drought analysis (Temporal, Spatial)- Bangladesh perspective
- Flood damage, risk mapping (Flood control infrastructure, Road network)
- SIDR damage
- Crop water requirement and water budget
- Vulnerability sectors
- Priority areas
- Adaptation measures
- National policies, projects
- Expectations from GEOSS

❑ Climatic condition

- **Bangladesh is situated at the Tropic of Cancer.**
- **It lies between 20 ° 34’ and 26 ° 38’north, between 88 ° 01’ and 92 ° 41’ east.**
- **Its climate is tropical with a mild winter from October to March, a hot, humid summer from March to June. A warm and humid monsoon season lasts from June to October and supplies most of the country's rainfall.**
- **Natural calamities, such as floods, tropical cyclones, tornadoes, and tidal bores occur almost every year.**

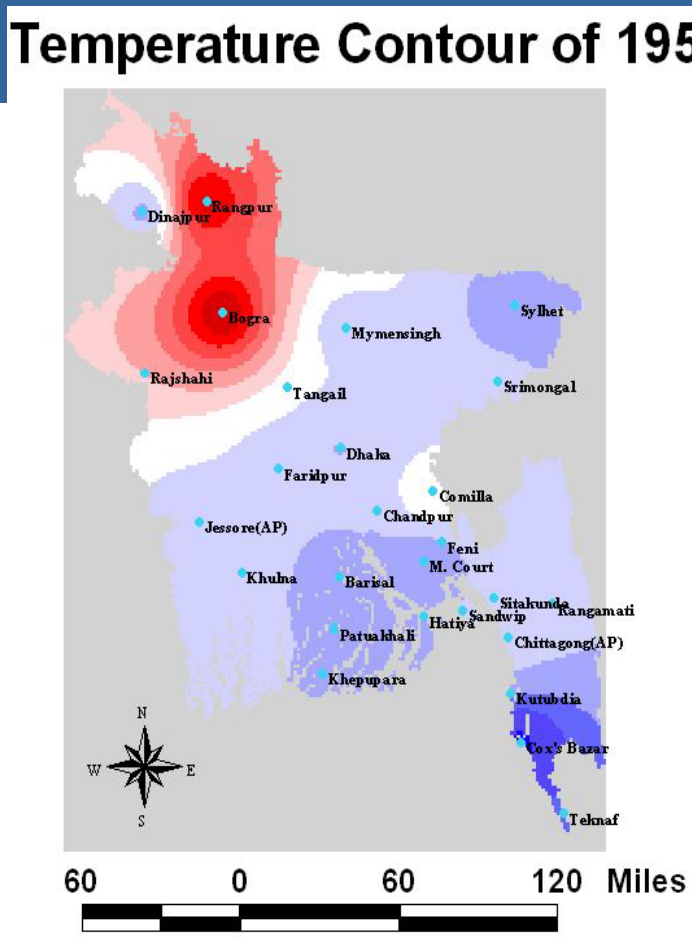
❑ Temperature and rainfall characteristics in Bangladesh

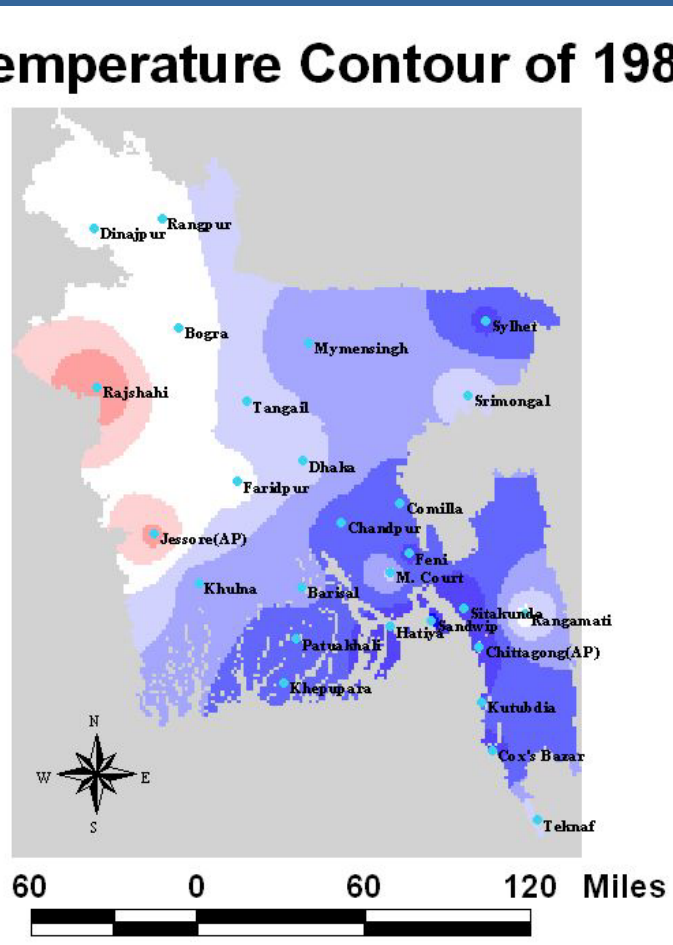
- **North western and mid western area are the high temperature zone of Bangladesh**



Yearly temperature (°C) distribution over Bangladesh

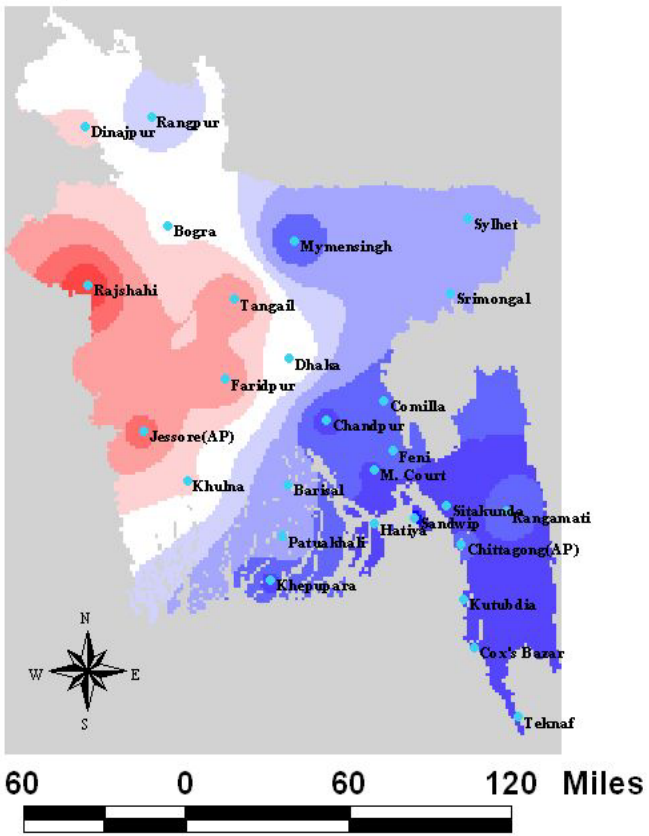
Shift of high temperature zone.



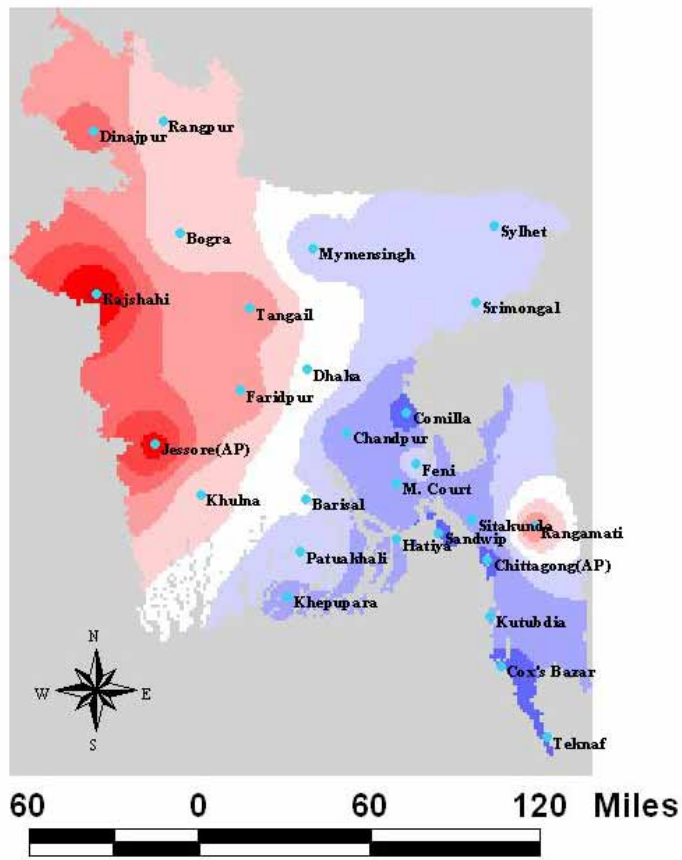


-In the ninety decade the high temperature zone has occupied the whole western region of Bangladesh.

Temperature Contour of 1988



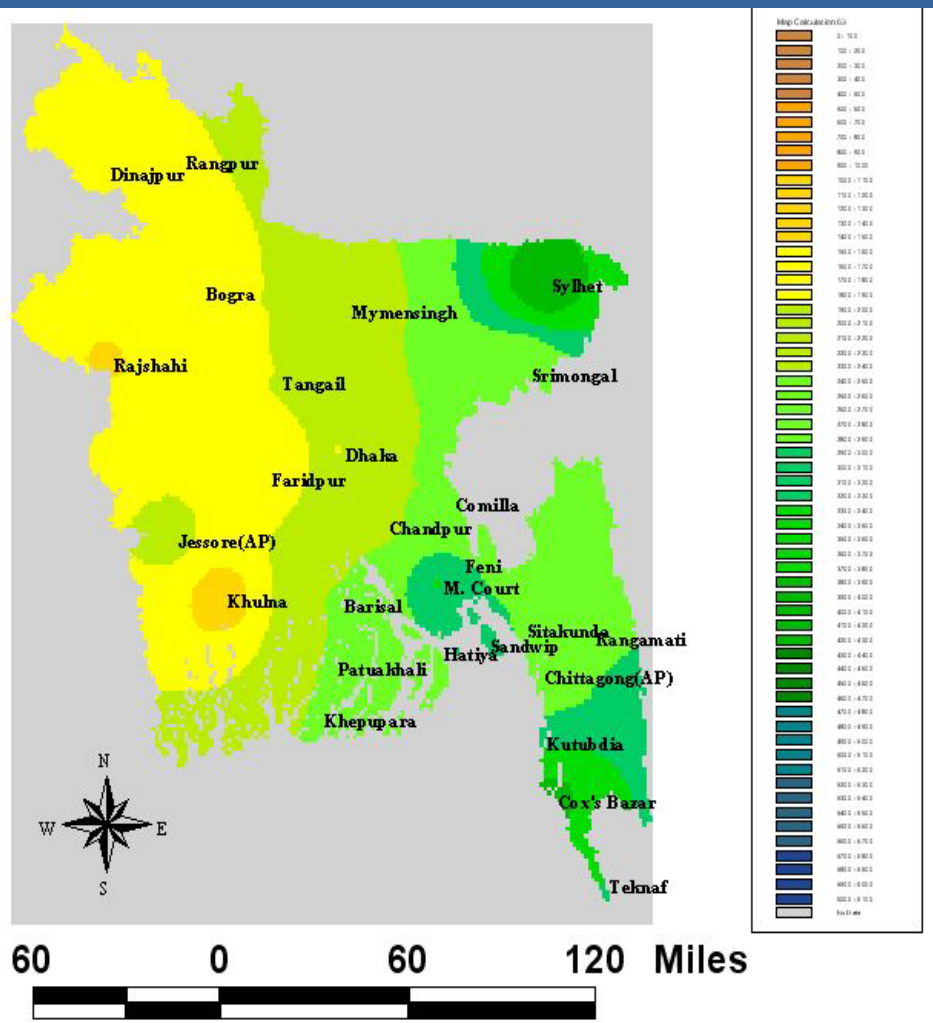
Temperature Contour of 1995



RAINFALL PATTERN

- **Southeastern, Eastern and Northeastern area are the heavy rainfall zone of Bangladesh**

- **Western area are the least rainfall zone**



DATA ANALYSIS

SPATIAL DISTRIBUTION OF RAINFALL

Obtain the spatial distribution of deviations of annual rainfall from Long Period Average (1951-2006)

Three windows (1951-1980, 1961-1990 & 1971-2006)

Five decades (1951-1960, 1961-1970, 1971-1980, 1981-1990 & 1991-2006).

LINEAR TREND OF RAINFALL

#Time series of yearly rainfall of each station as well as for country was analyzed and fitted linear trend line. Trend line also projected for 15 years future.

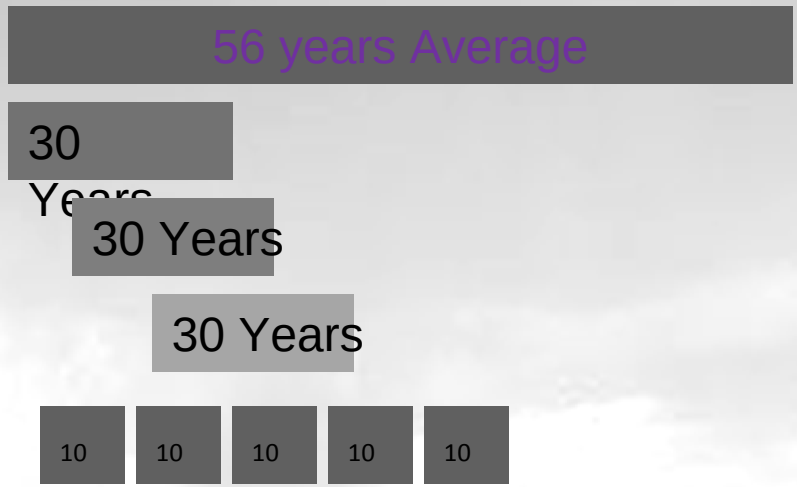
YIELD OF RICE WITH TIME

The trend line of rice yield with time

Spatial distribution of seasonal and annual rainfall

Spatial distribution of deviation of rainfall from **LPA (1951-2006)** obtained for seasonal and annual basis during last three windows (30 years) and decades.

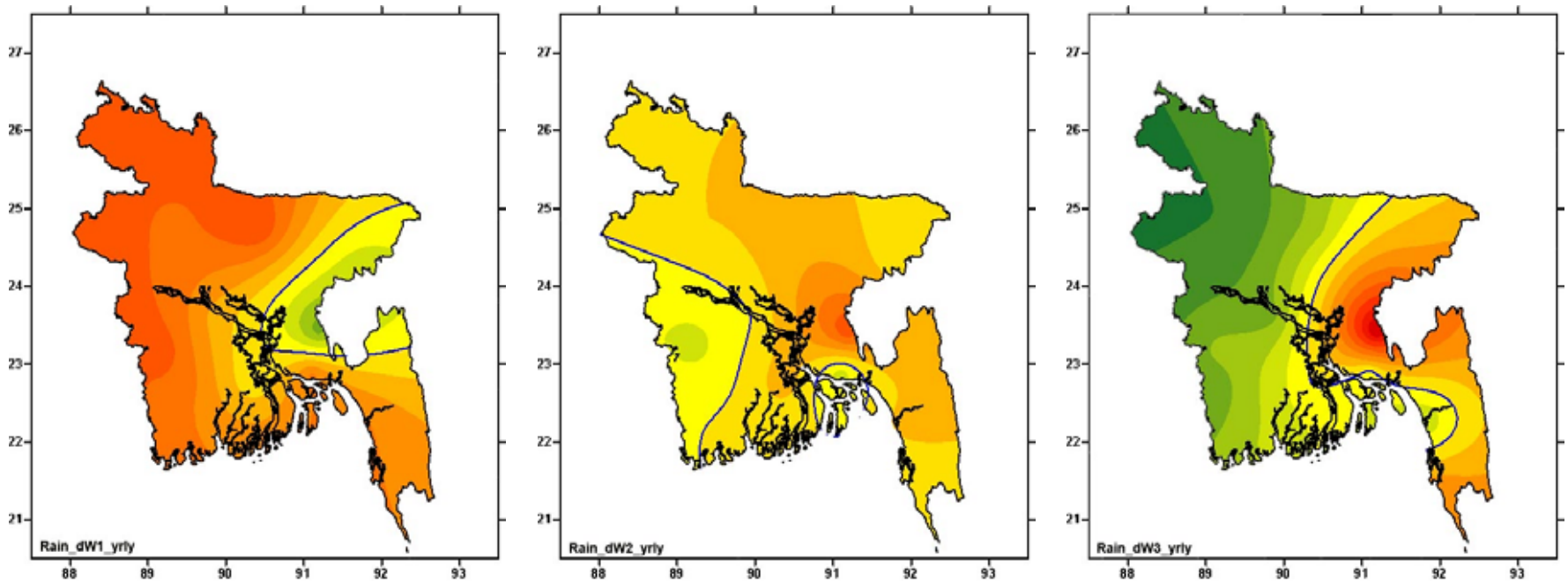
- Window-(1)-- 1951-1980
- Window-(2)-- 1961-1990
- Window-(3)-- 1971-2006
- First Decade -- 1951-1960
- Second Decade -- 1961-1970
- Third Decade -- 1971-1980
- Fourth Decade -- 1981-1990
- Fifth Decade -- 1991-2000



- Pre-monsoon(Mar→May)
  - * 3 Windows
  - * 5 Decades
- Monsoon(Jun→Sep)
  - * 3 Windows
  - * 5 Decades
- Post-monsoon(Oct→Nov)
  - * 3 Windows
  - * 5 Decades

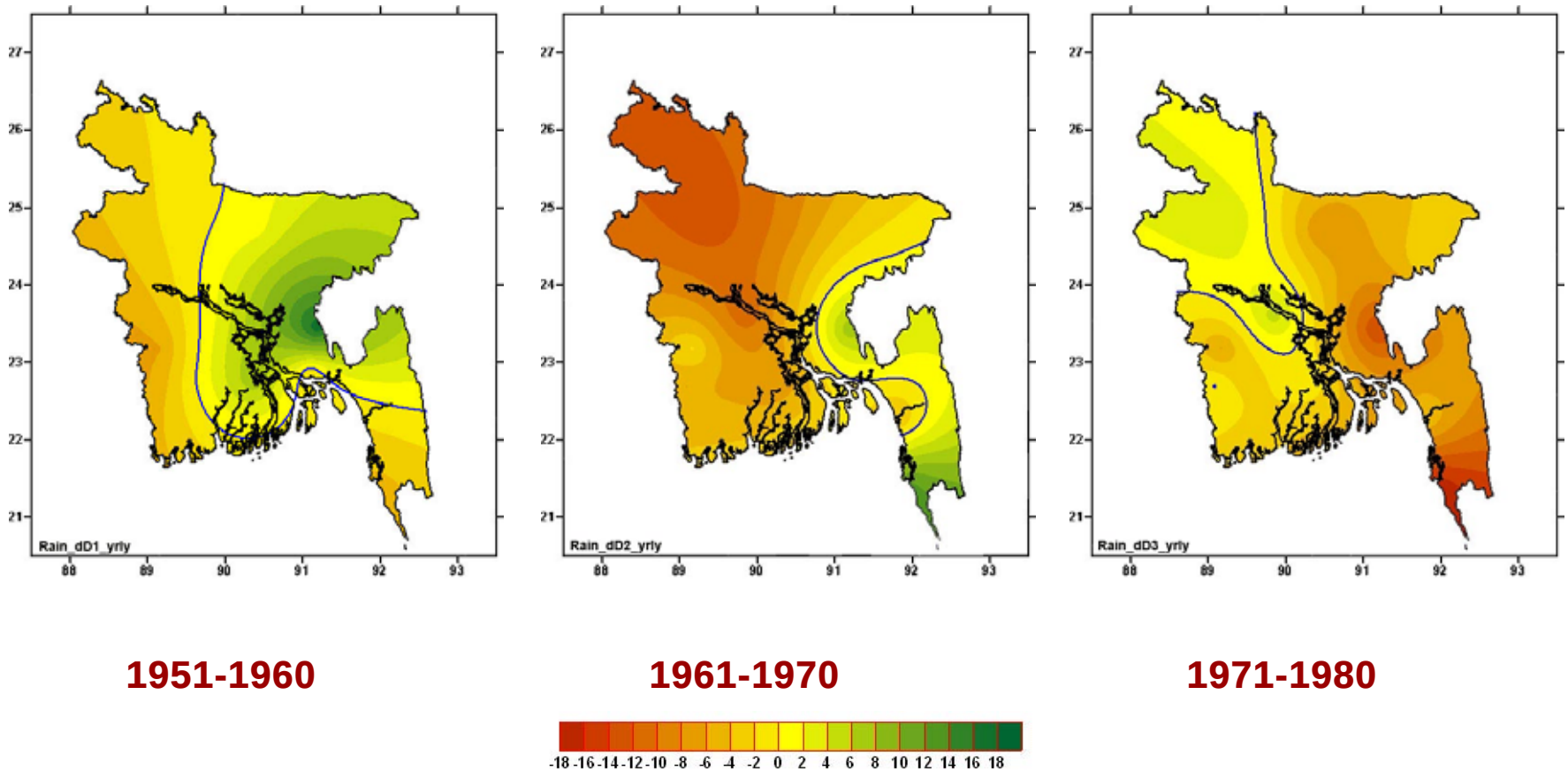
- Winter(Dec→Feb)
  - * 3 Windows
  - * 5 Decades
- Yearly(Jan→Dec)
  - * 3 Windows
  - * 5 Decades

Deviation (%) of Yearly Rainfall from LPA over Bangladesh in different Windows (30 years)



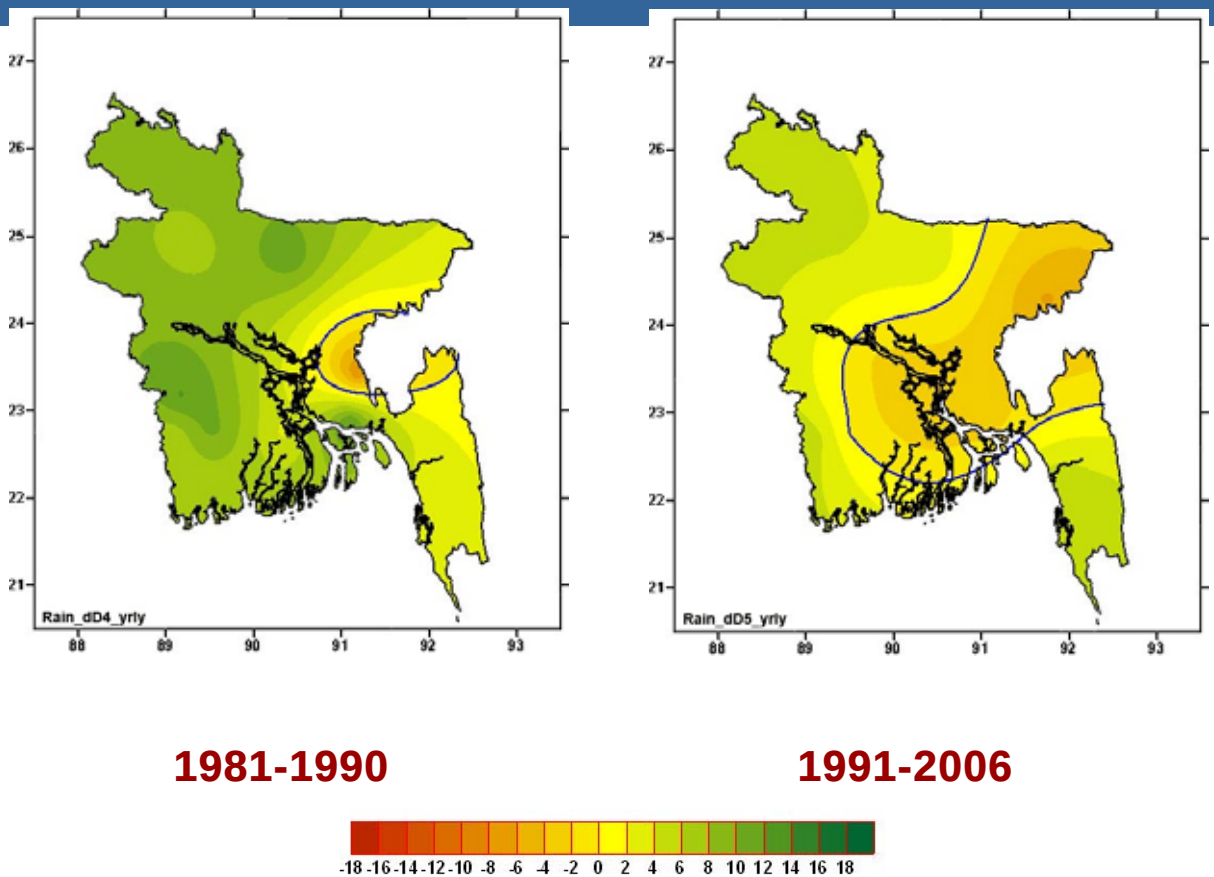
1951-1980 **1961-1990** **1971-2006**

Deviation (%) of Yearly Rainfall from Normal over Bangladesh in different Decades



1951-1960 **1961-1970** **1971-1980**

Deviation (%) of Yearly Rainfall from Normal over Bangladesh in different Decades

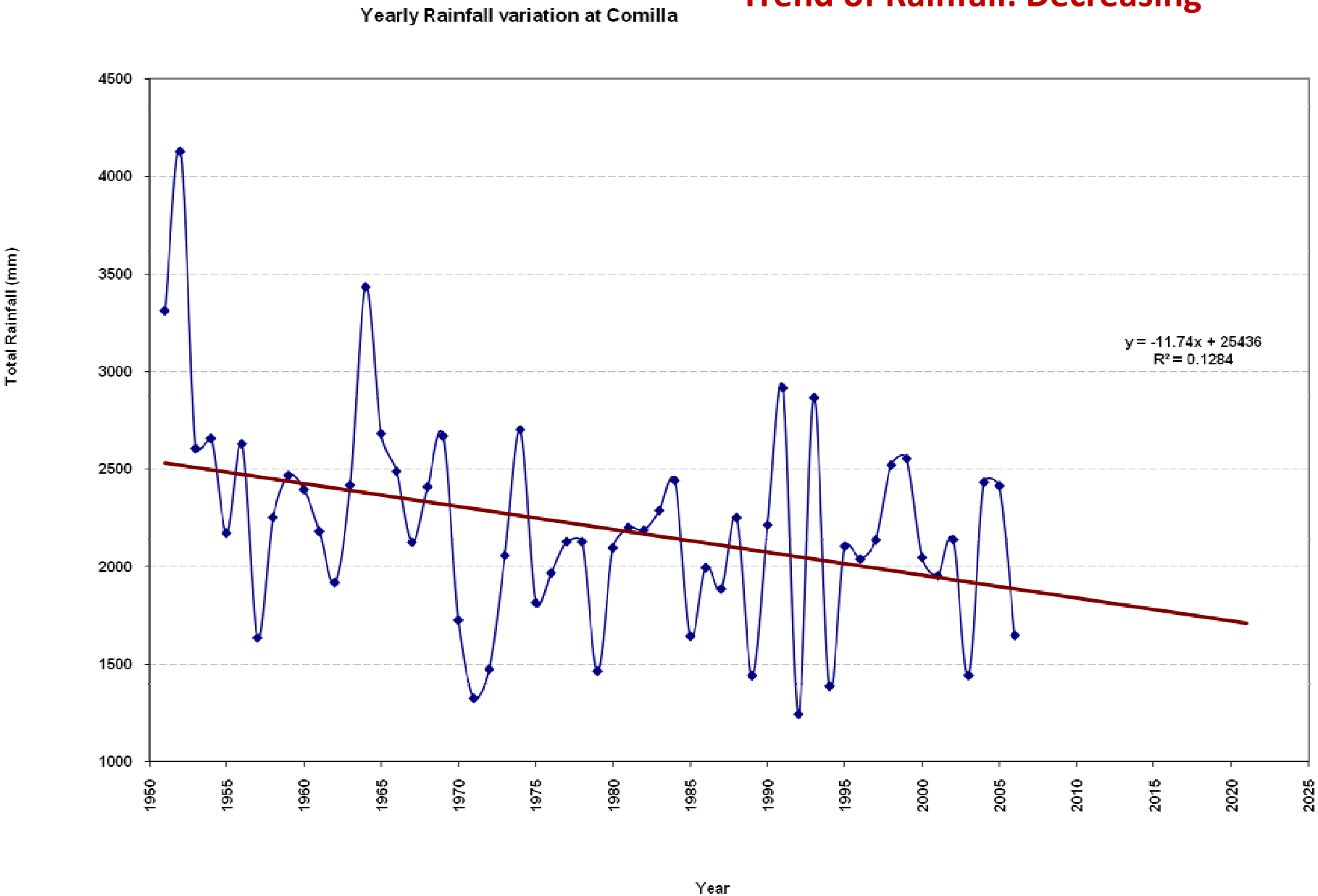


1981-1990 **1991-2006**

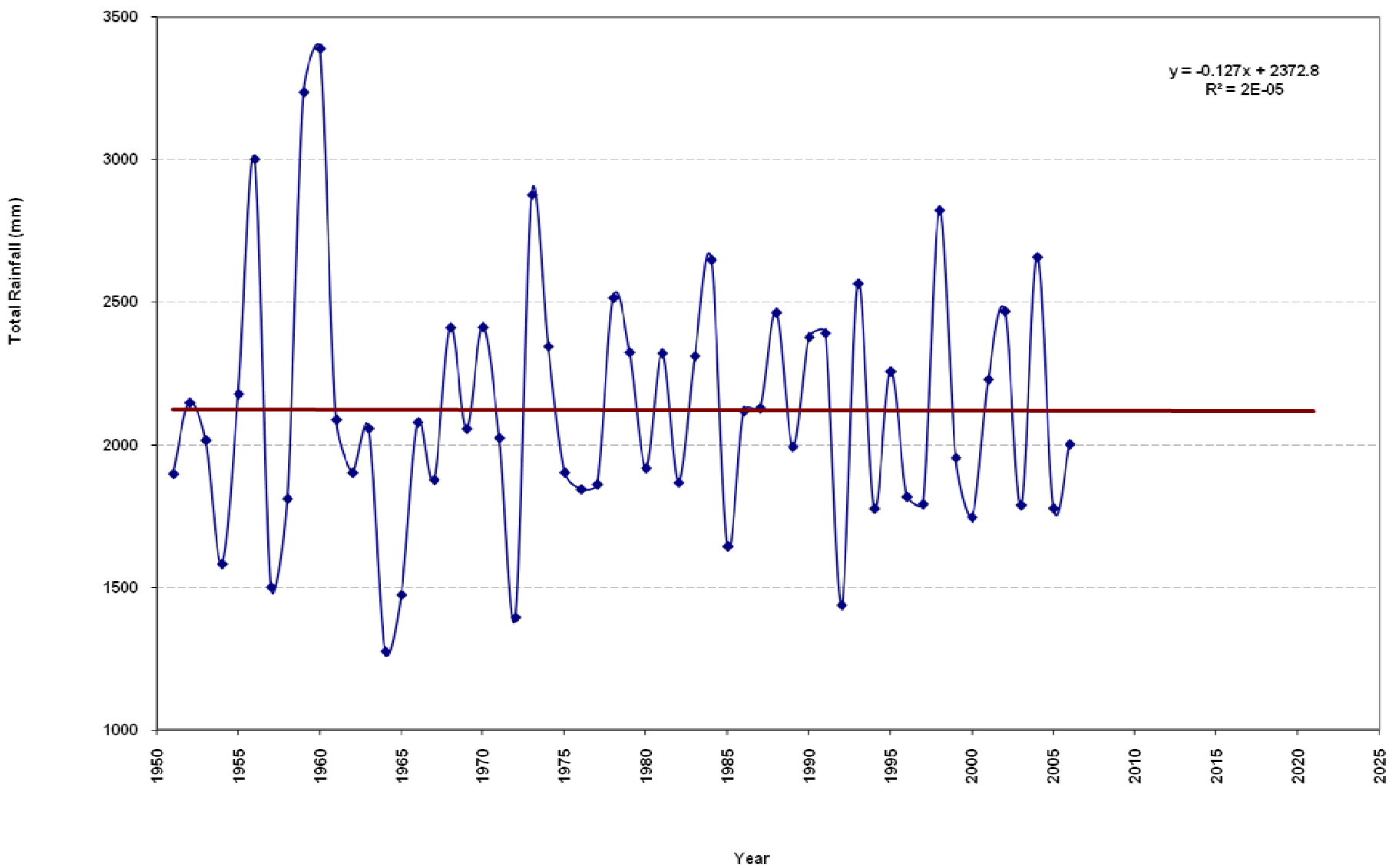
Data Sample

Station	Yr	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Pre_mon	Mon	Post_mon	Winter	Yearly
Mymensingh	1948	0	21	35	211	529	327	564	322	530	241	26	0	775.0	1743.0	267.0		2806.0
Mymensingh	1949													0.0	0.0	0.0	0.0	0.0
Mymensingh	1950	0	30	64	28	133	496	112	468	70	31	41	0	225.0	1146.0	72.0	30.0	1473.0
Mymensingh	1951	0	0	12	42	123	444	240	159	151	355	77	0	177.0	994.0	432.0	0.0	1603.0
Mymensingh	2003	0	27	120	96	266	395	213	124	190	345	0	10	482.0	922.0	345.0	####	1786.0
Mymensingh	2004	6	2	14	244	145	337	791	254	272	487	0	0	403.0	1654.0	487.0	18.0	2552.0
Mymensingh	2005	0	0	84	153	454	247	454	511	408	361	0	0	691.0	1620.0	361.0	0.0	2672.0
Mymensingh	2006	0	0	0	173	300	278	308	365	429	27	0	0	473.0	1380.0	27.0	0.0	1880.0

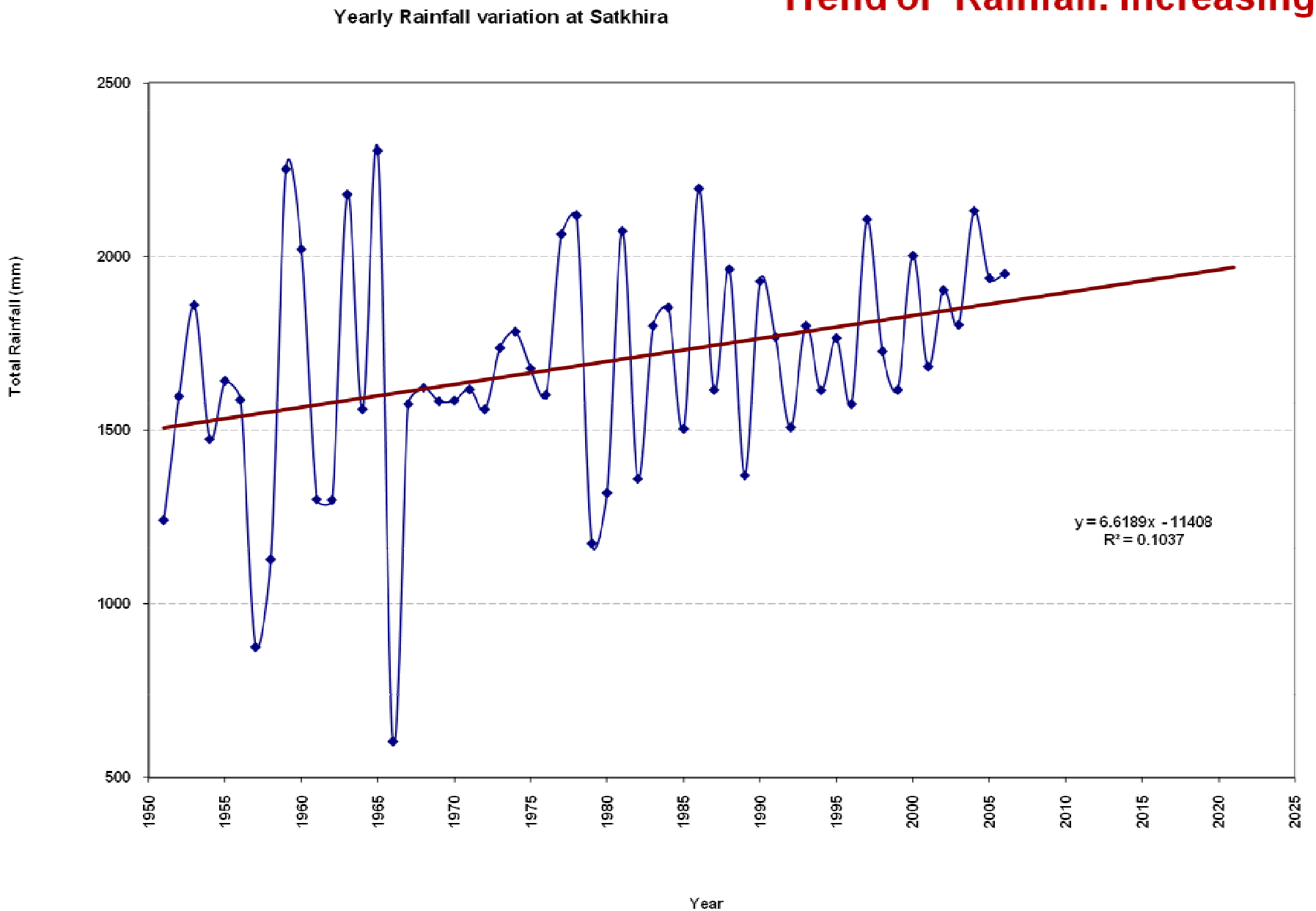
Trend of Rainfall: Decreasing



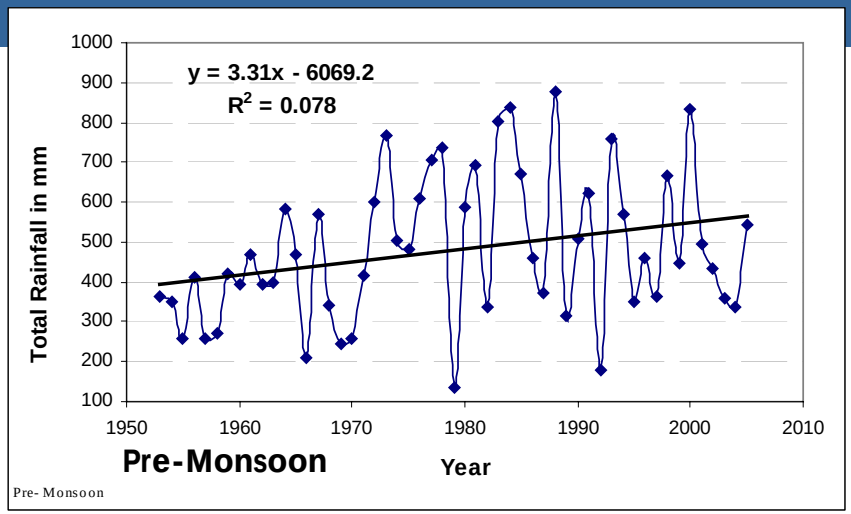
Trend of Rainfall: No Significant change

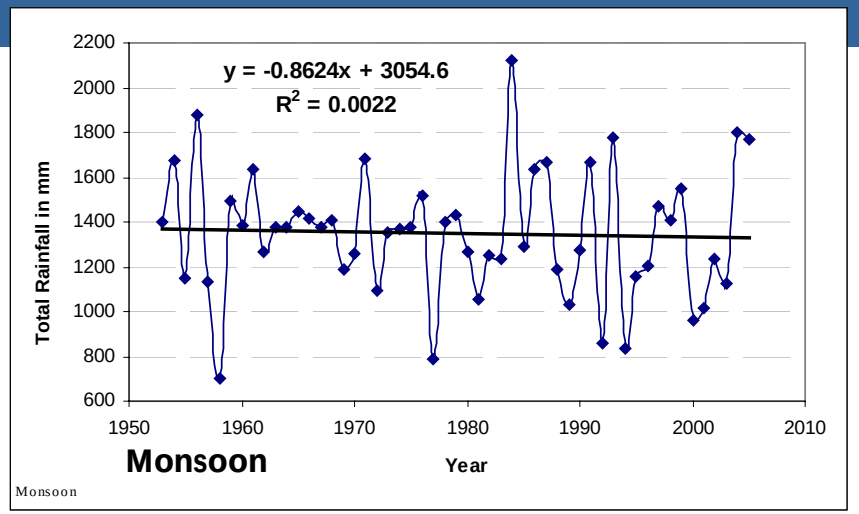


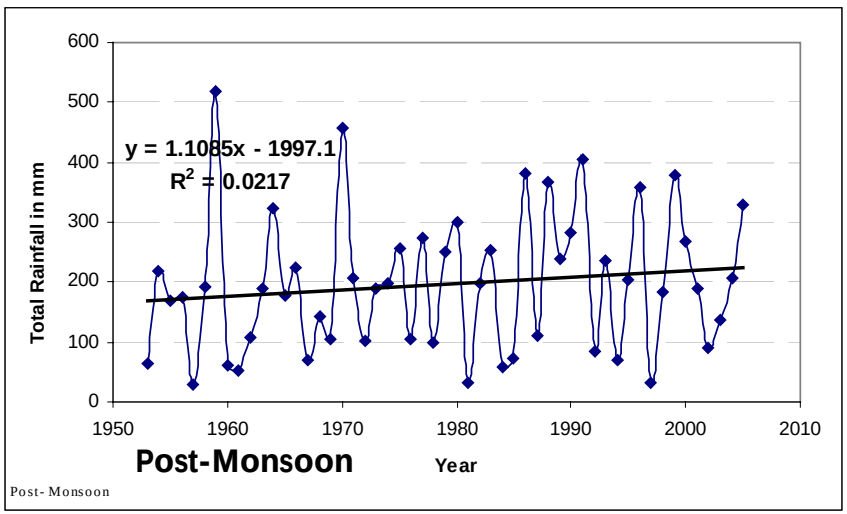
Trend of Rainfall: Increasing

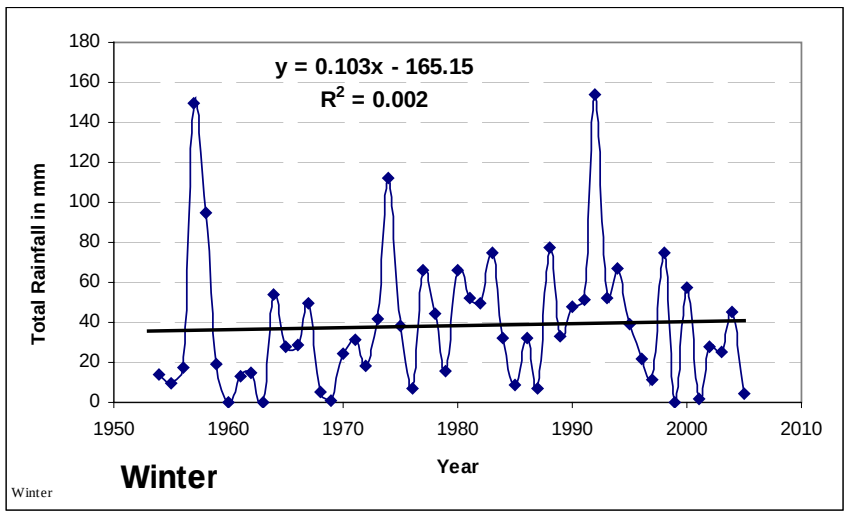


Seasonal Variation of Rainfall in Dhaka

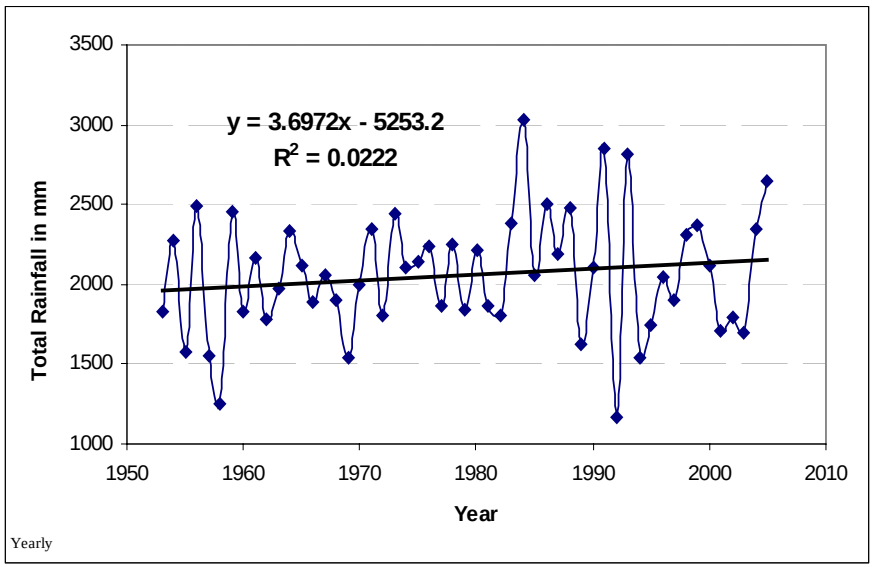




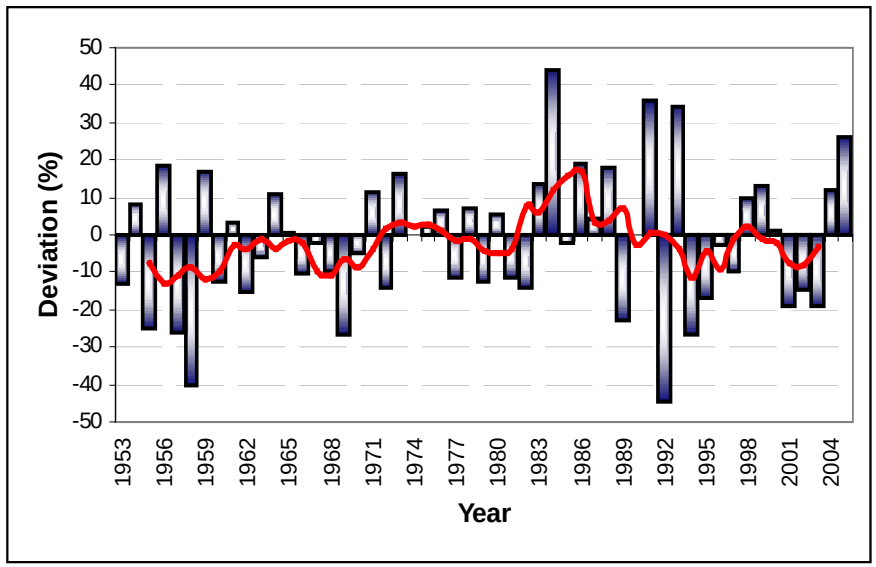




Variation / Deviation of Yearly Rainfall in Dhaka

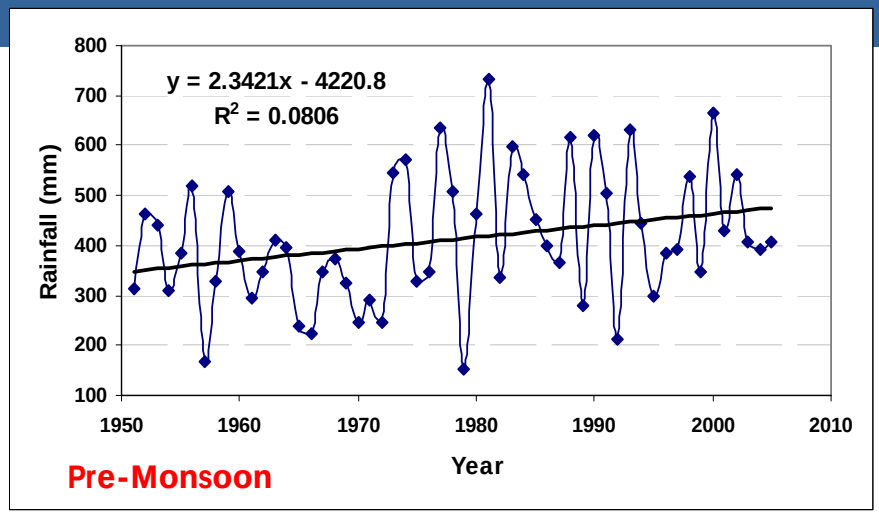


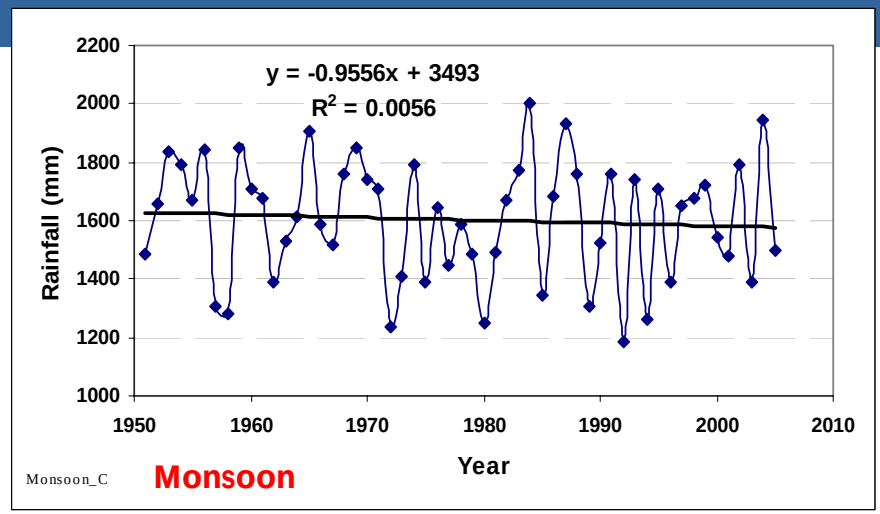
Variation of Yearly Rainfall

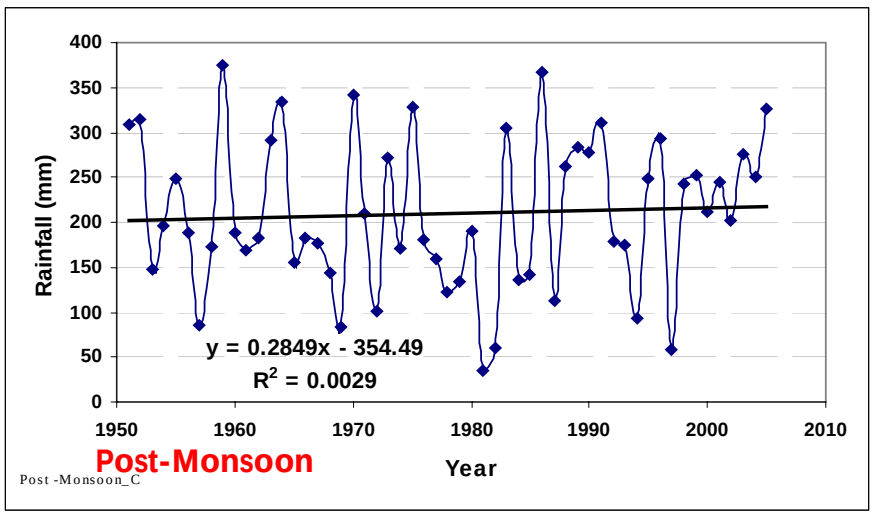


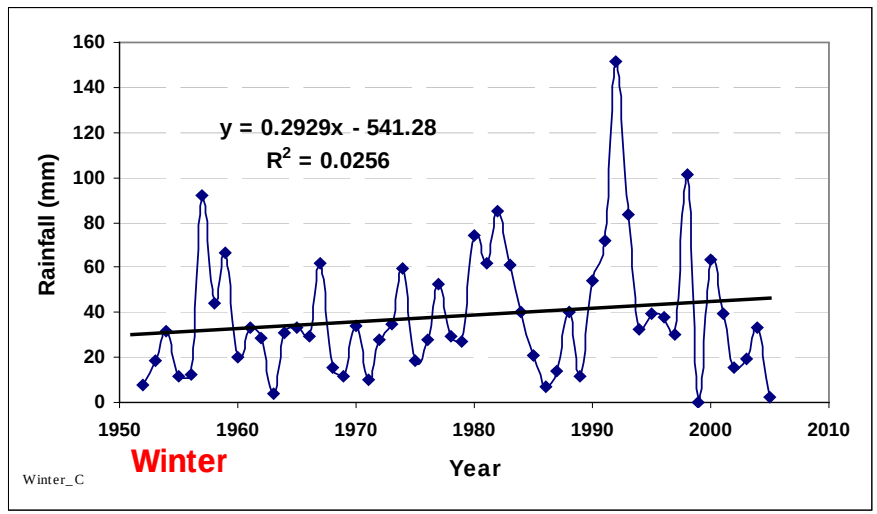
Deviation of Yearly Rainfall from Normal

Seasonal Variation of Rainfall in Bangladesh

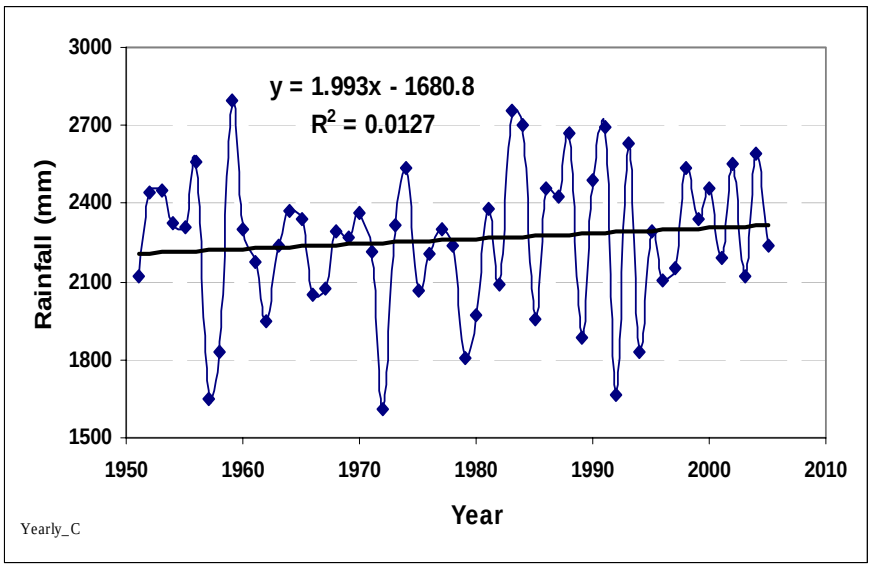




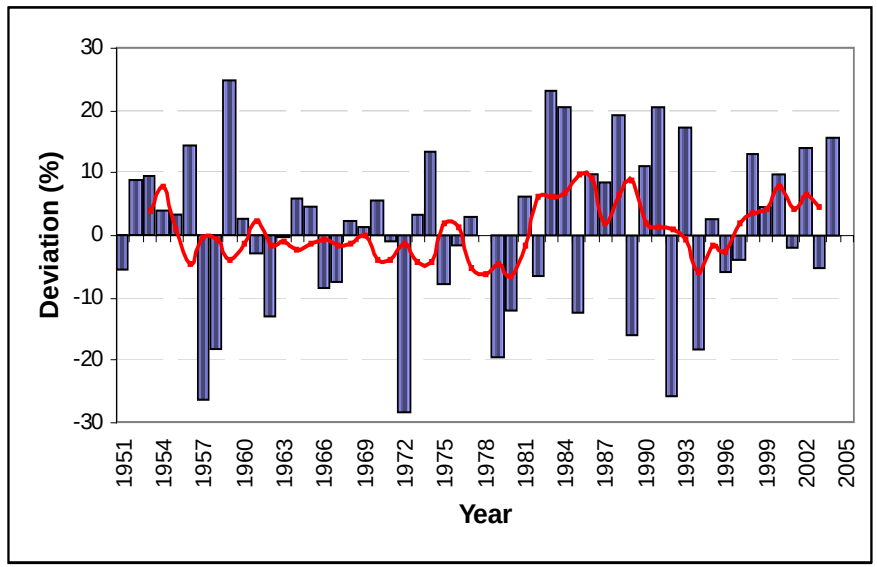




Over All Bangladesh

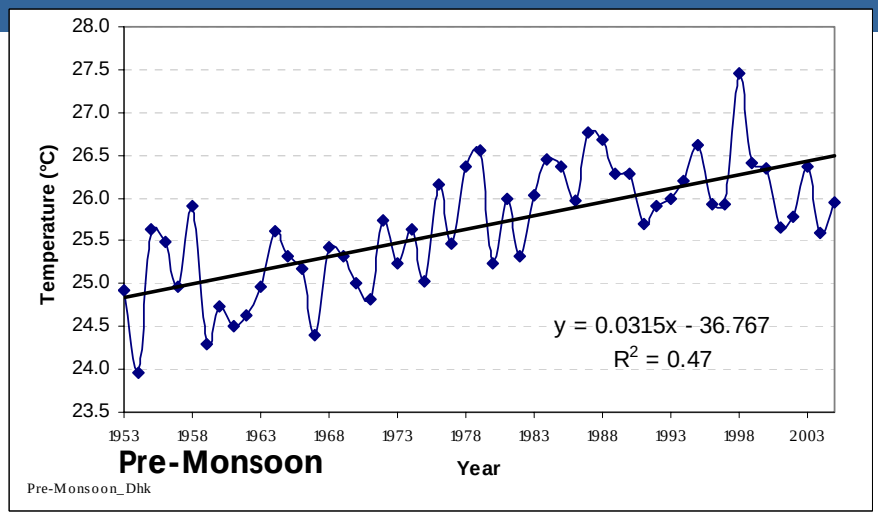


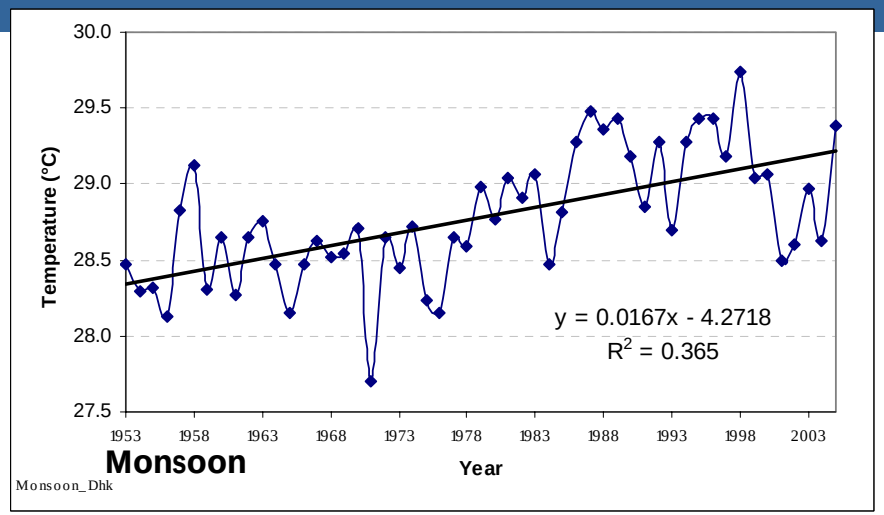
Variation of Yearly Rainfall

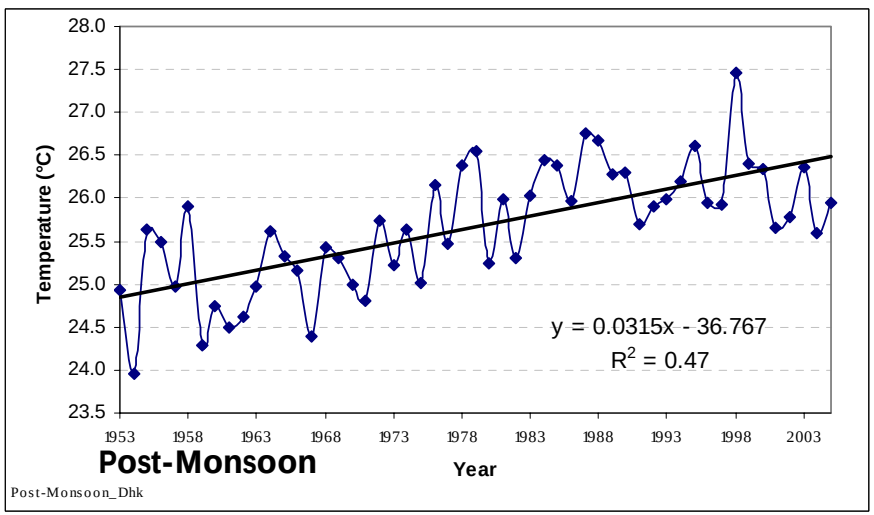


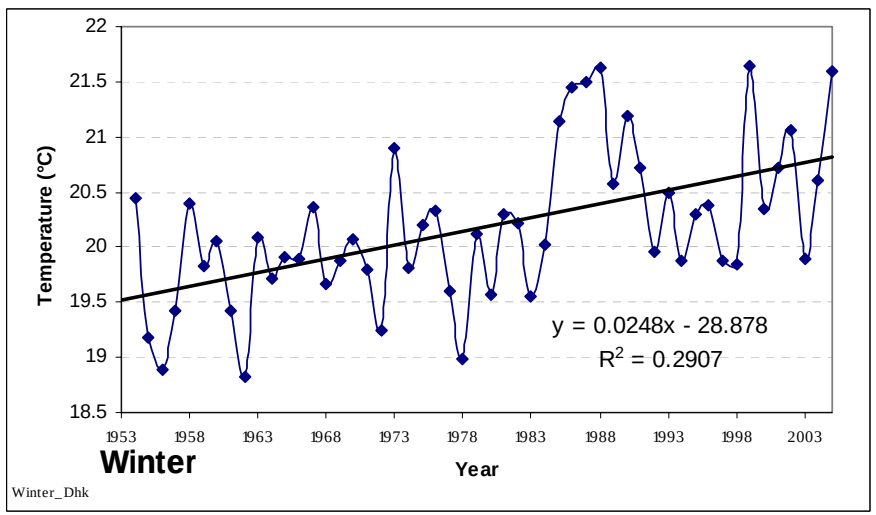
Deviation of Yearly Rainfall from Normal

Seasonal Variation of Mean Temperature in Dhaka









Yield analysis of Rice with time

Barind Area

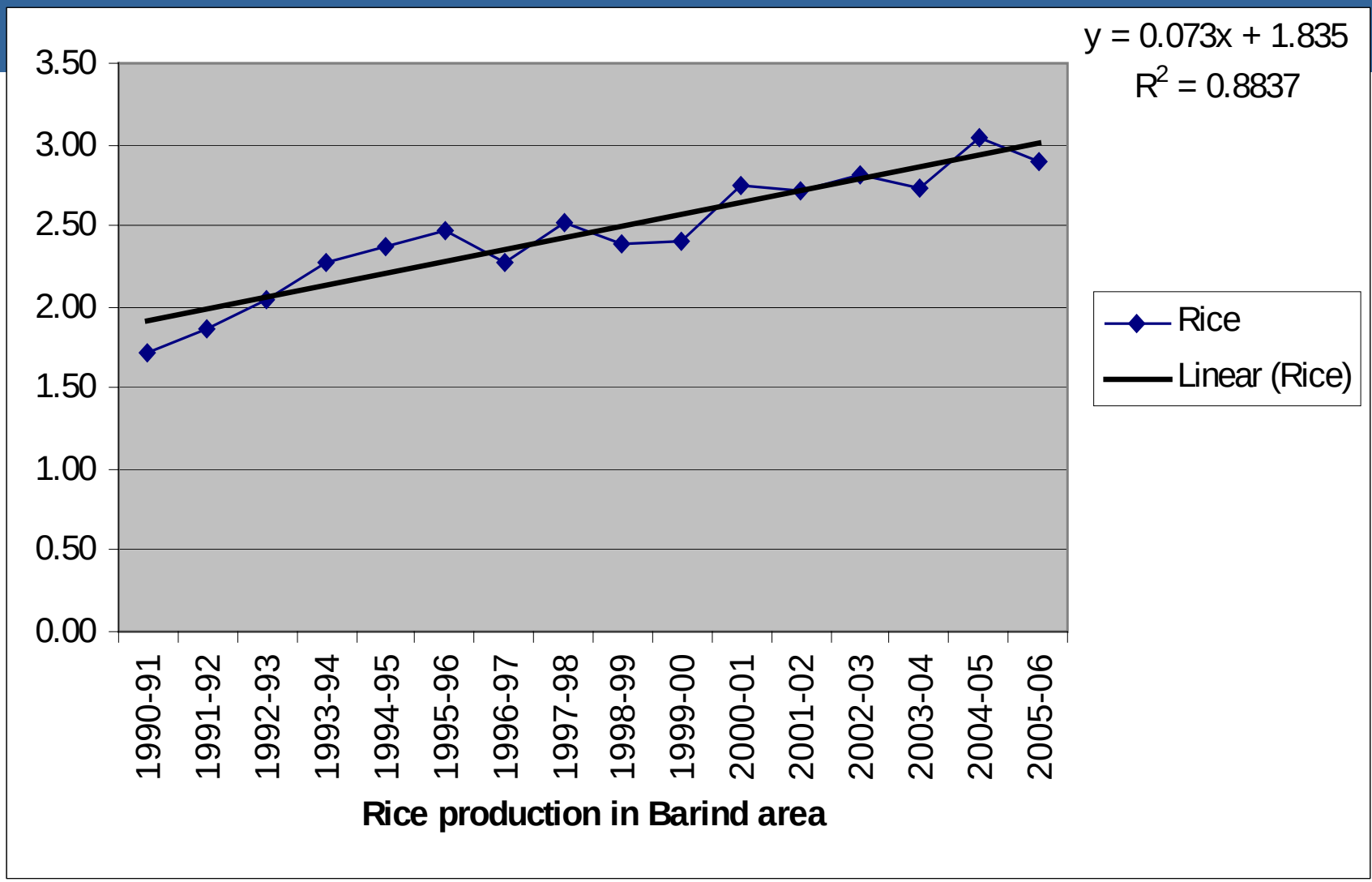
Sample Data

Average Rice Production in Barind Area

M-ton/Hect

	Rajshahi			Naogaon			Chapai Nawabganj			Average Production of Brind Area			
Year	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro	**Rice**
1990-91	1.05	2.11	1.87	1.50	1.90	1.65	1.21	2.11	2.00	1.25	2.04	1.84	1.71
1991-92	1.11	2.15	2.22	1.58	2.10	1.75	1.32	2.15	2.40	1.34	2.13	2.12	1.86
1992-93	1.08	2.20	2.80	1.61	2.15	2.05	1.35	2.22	3.00	1.35	2.19	2.62	2.05
1993-94	1.22	2.27	3.12	1.63	2.27	2.86	1.43	2.27	3.35	1.43	2.27	3.11	2.27
1994-95	1.18	2.38	3.28	1.92	2.26	3.35	1.38	2.38	3.22	1.49	2.34	3.28	2.37
1995-96	1.08	2.60	3.40	2.20	2.39	3.29	1.41	2.36	3.45	1.56	2.45	3.38	2.46
1996-97	0.77	1.40	3.57	1.86	2.50	3.00	1.65	2.48	3.30	1.43	2.13	3.29	2.28
2001-02	1.00	2.24	3.50	2.45	2.50	3.67	2.40	2.62	4.12	1.95	2.45	3.76	2.72
2002-03	1.40	2.32	4.25	2.24	2.60	3.50	2.42	2.40	4.25	2.02	2.44	4.00	2.82
2003-04	1.03	2.54	4.15	1.80	2.48	3.60	2.62	2.43	4.00	1.82	2.48	3.92	2.74
2004-05	1.47	3.65	4.46	2.00	2.45	3.70	2.73	2.69	4.16	2.07	2.93	4.11	3.03
2005-06	1.24	2.16	5.05	2.40	2.48	3.72	2.81	2.71	3.53	2.15	2.45	4.10	2.90

Yield analysis of Rice with time



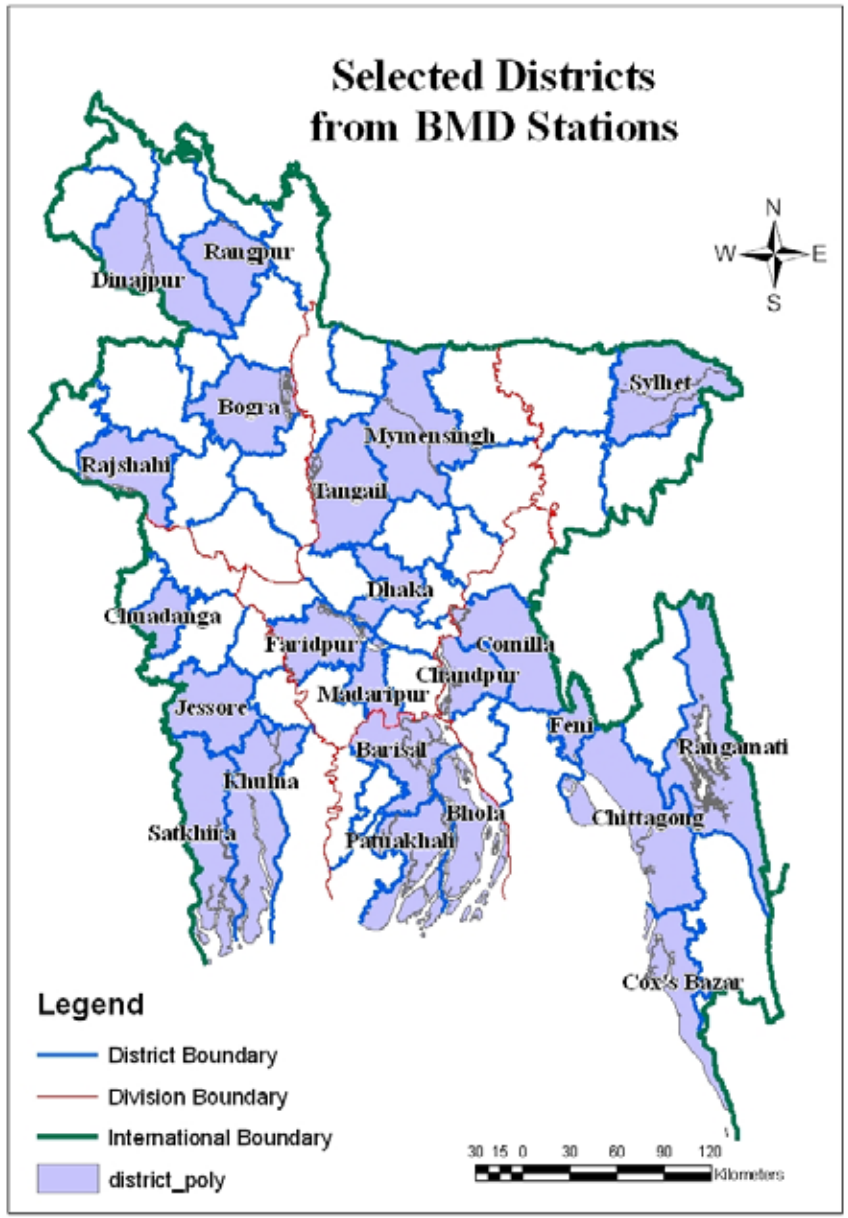
DEFINING

DROUGHT:

BANGLADESH

PERSPECTIVES

MAP OF STUDY AREA



DROUGHT MAP (Considering Rainfall)

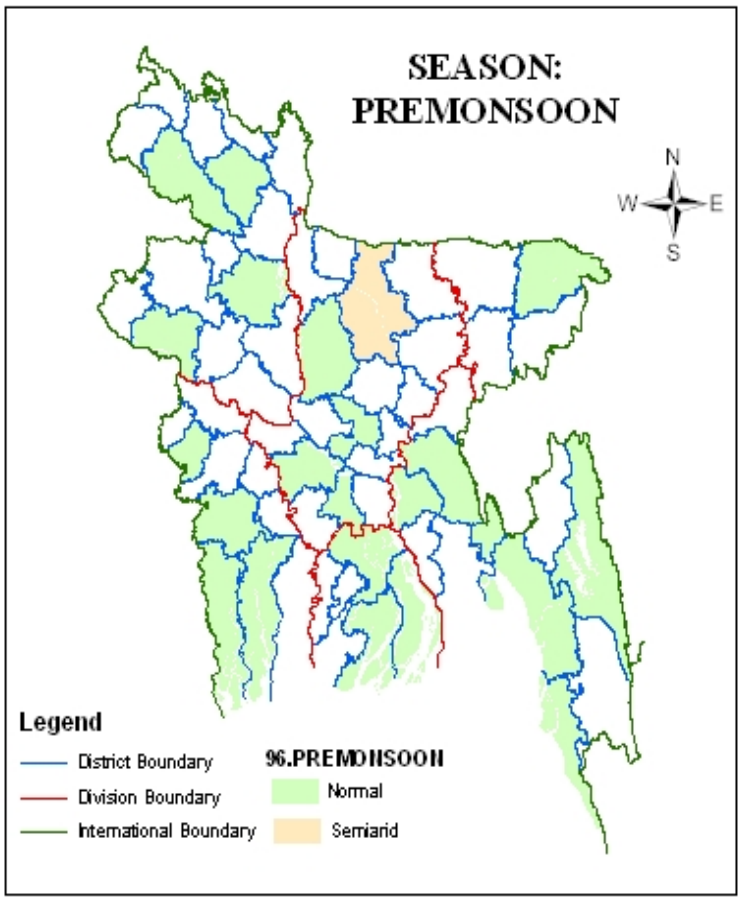


Fig: for year 1996

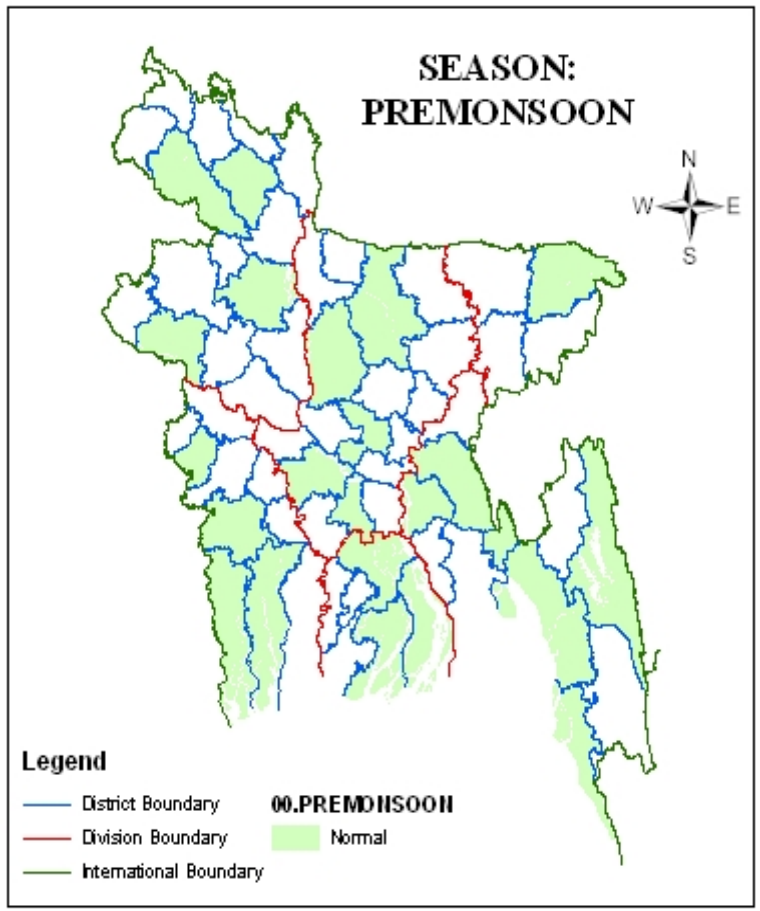


Fig: for year 2000

DROUGHT MAP (Considering Rainfall)

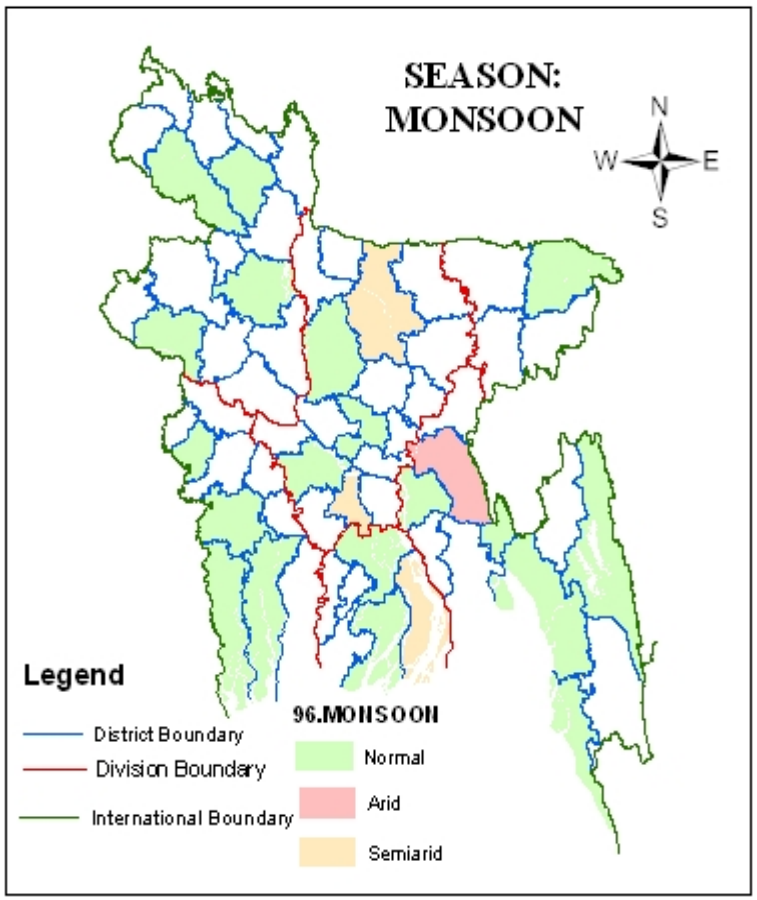


Fig: for year 1996

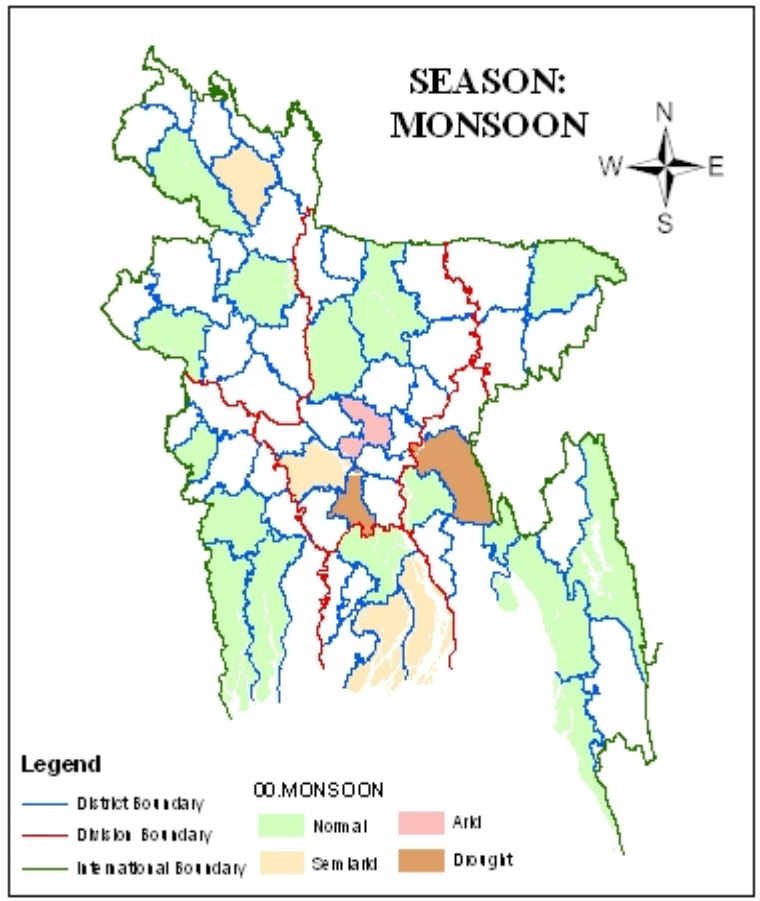


Fig: for year 2000

DROUGHT MAP (Considering Rainfall)

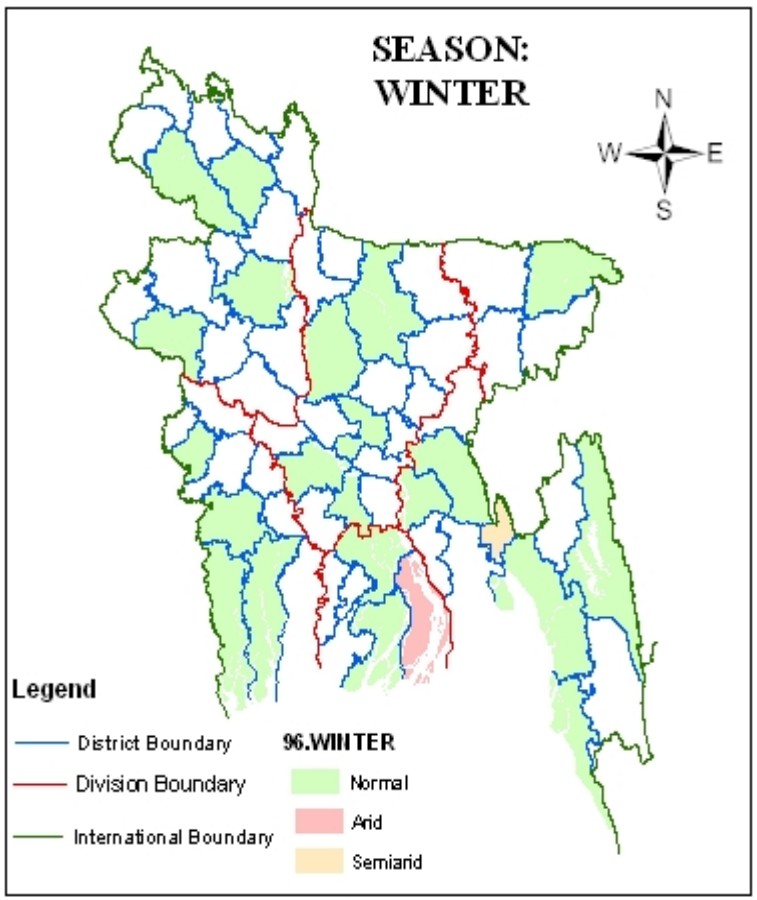


Fig: for year 1996

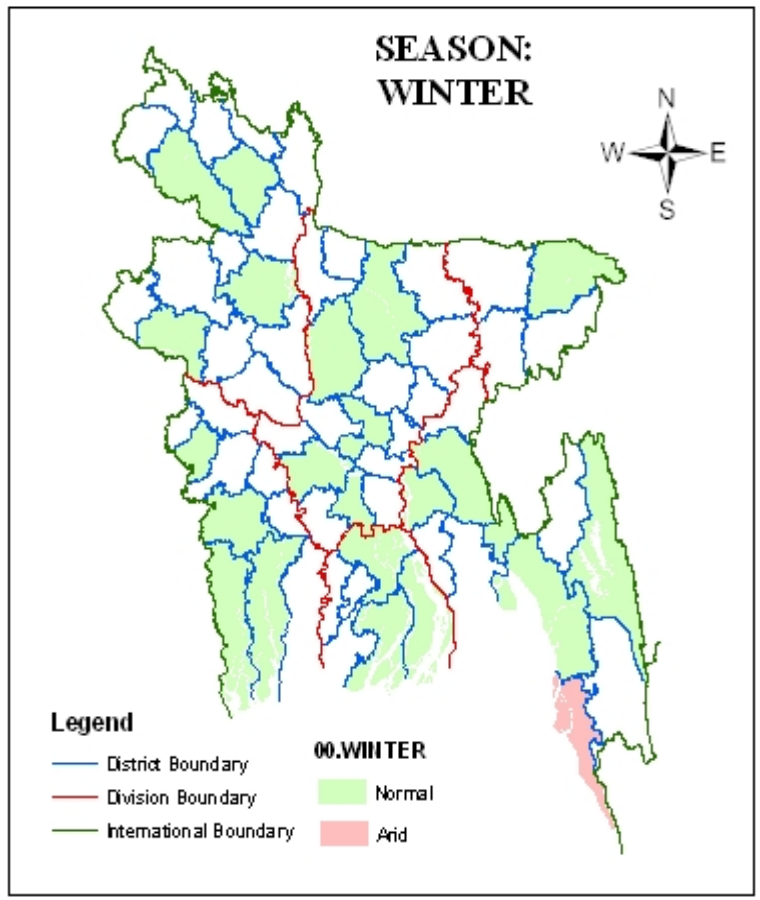


Fig: for year 2000

DROUGHT MAP
(Considering Temperature)

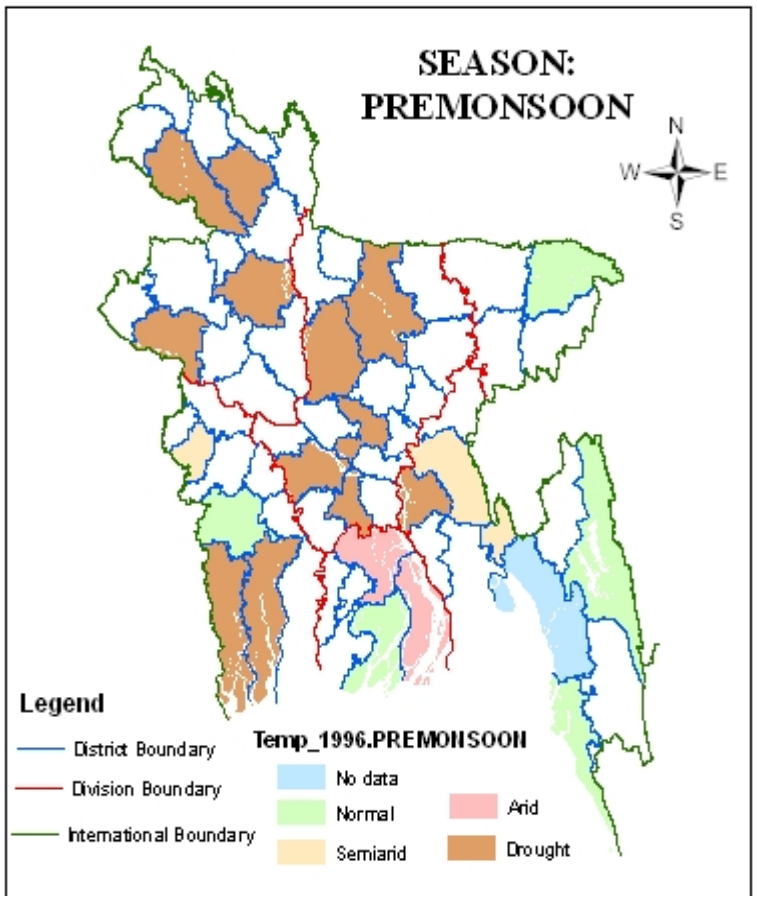


Fig: for year 1996

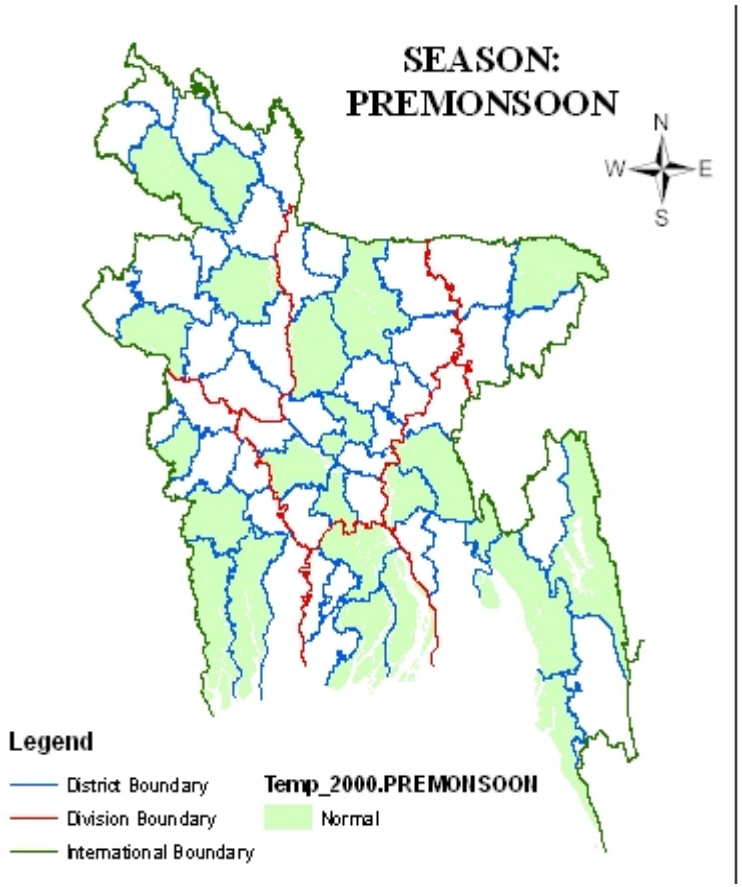


Fig: for year 2000

DROUGHT MAP
(Considering Temperature)

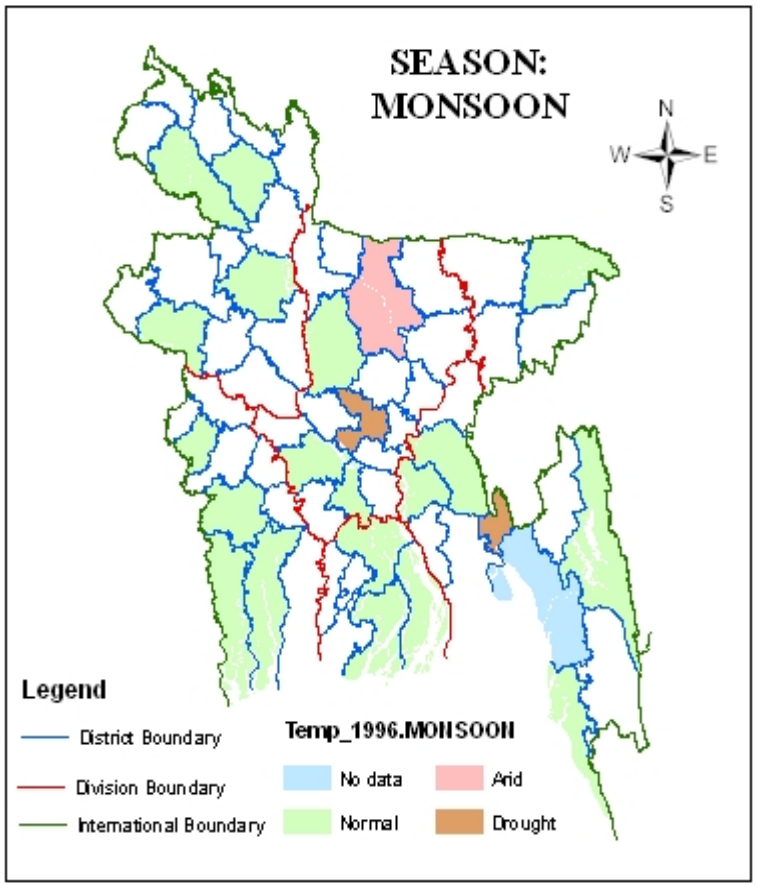


Fig: for year 1996

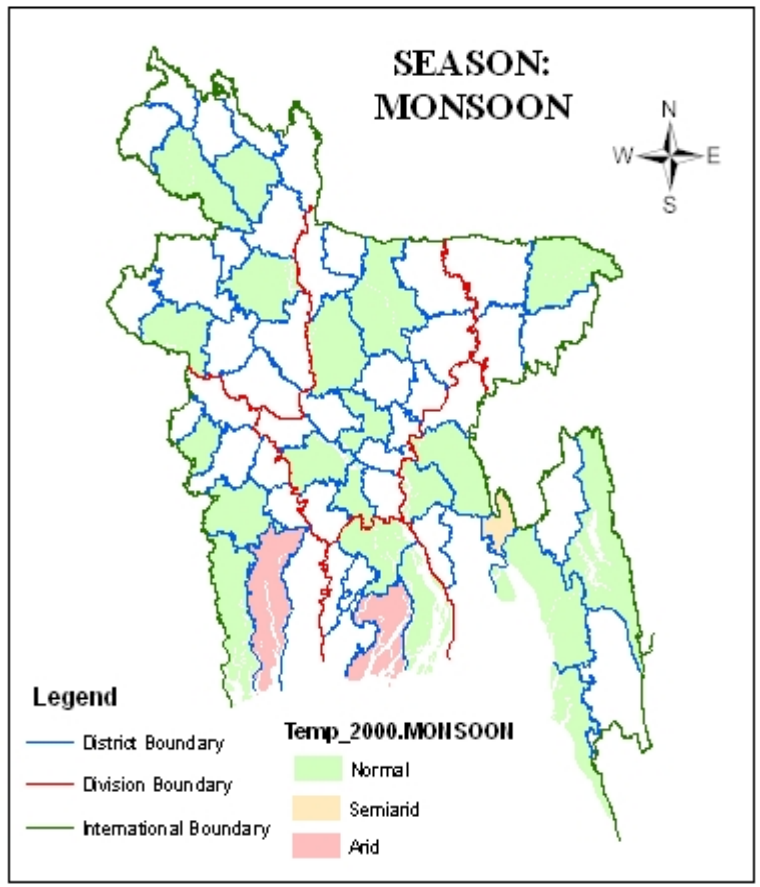


Fig: for year 2000

DROUGHT MAP
(Considering Temperature)

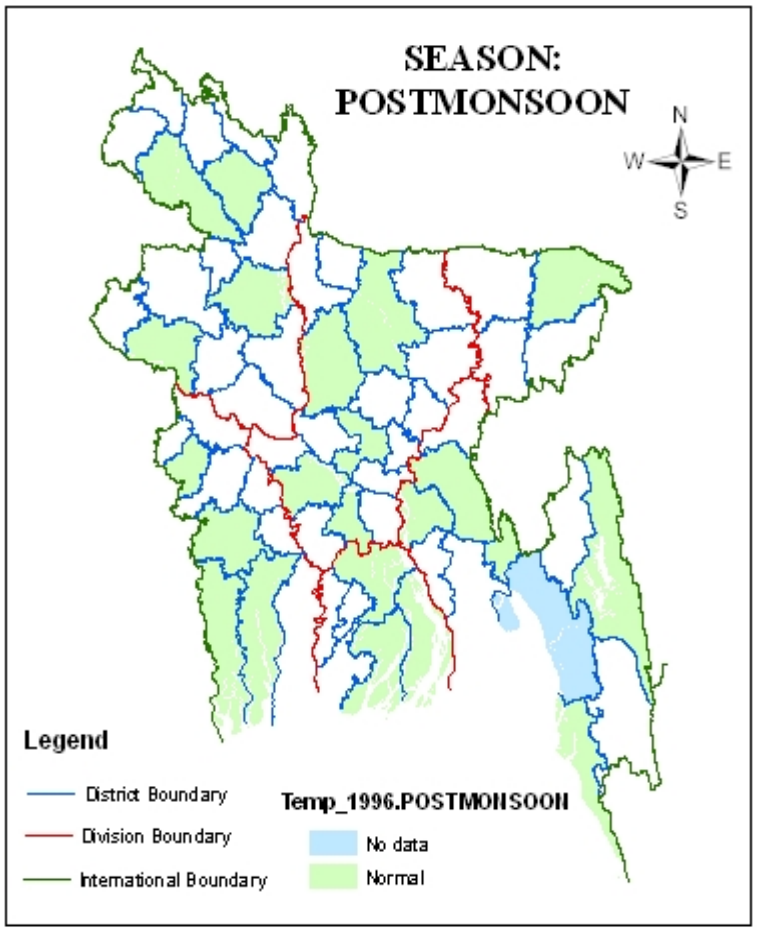


Fig: for year 1996

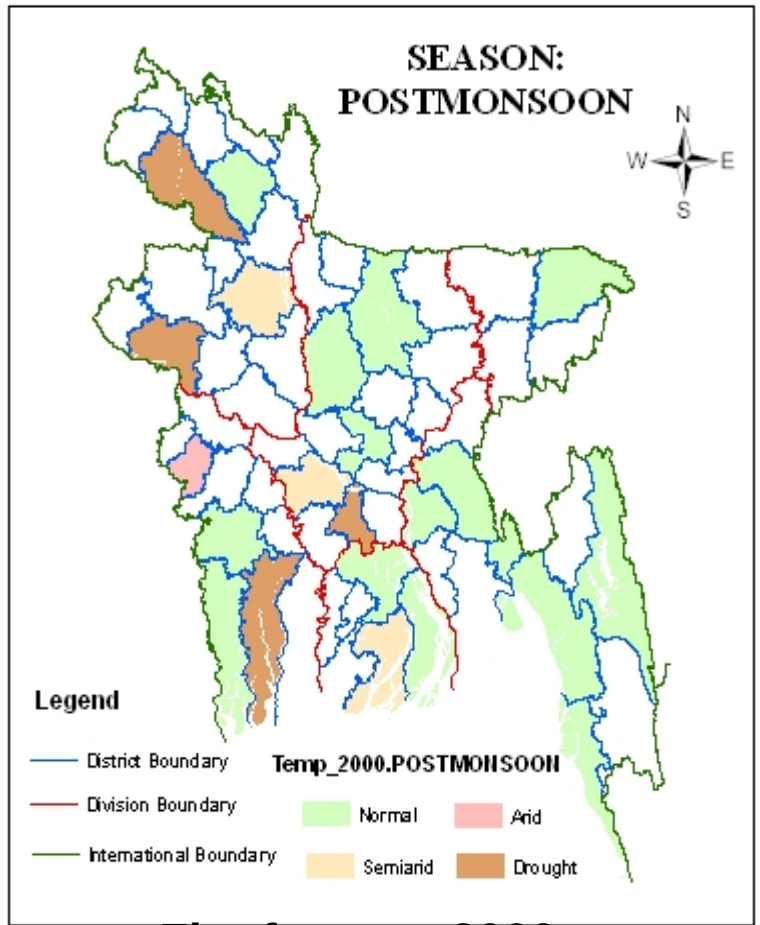


Fig: for year 2000

DROUGHT MAP
(Considering Temperature)

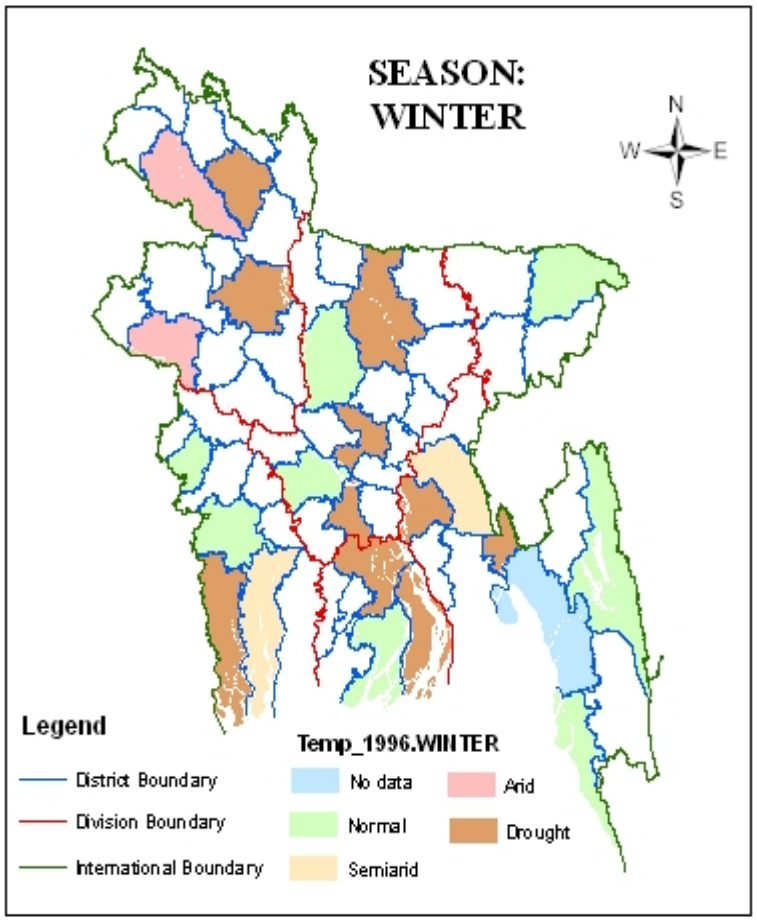


Fig: for year 1996

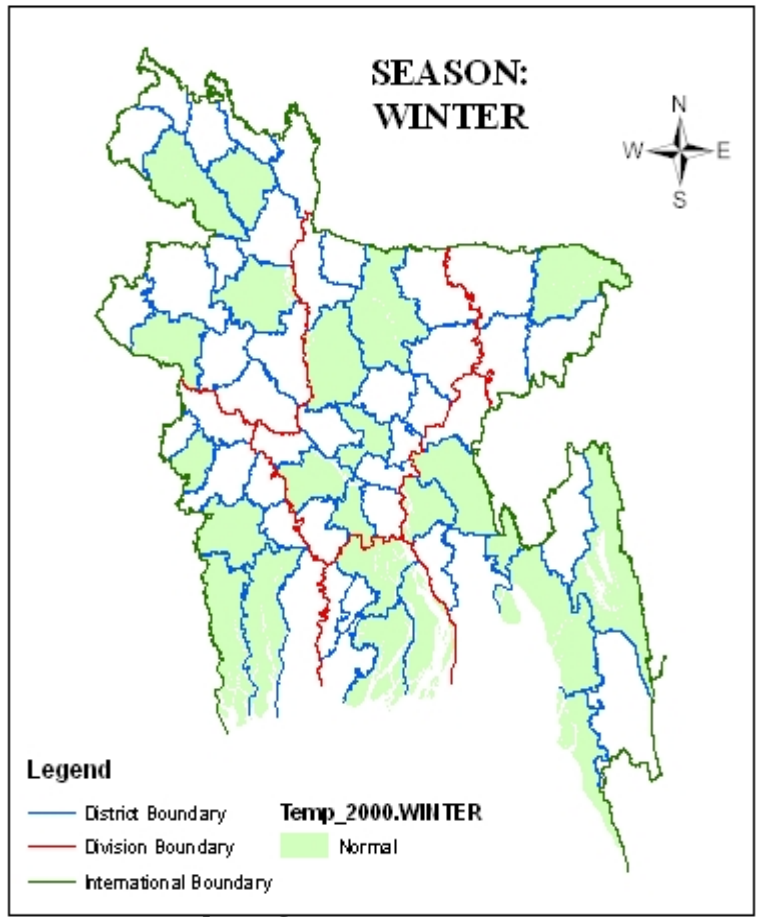


Fig: for year 2000

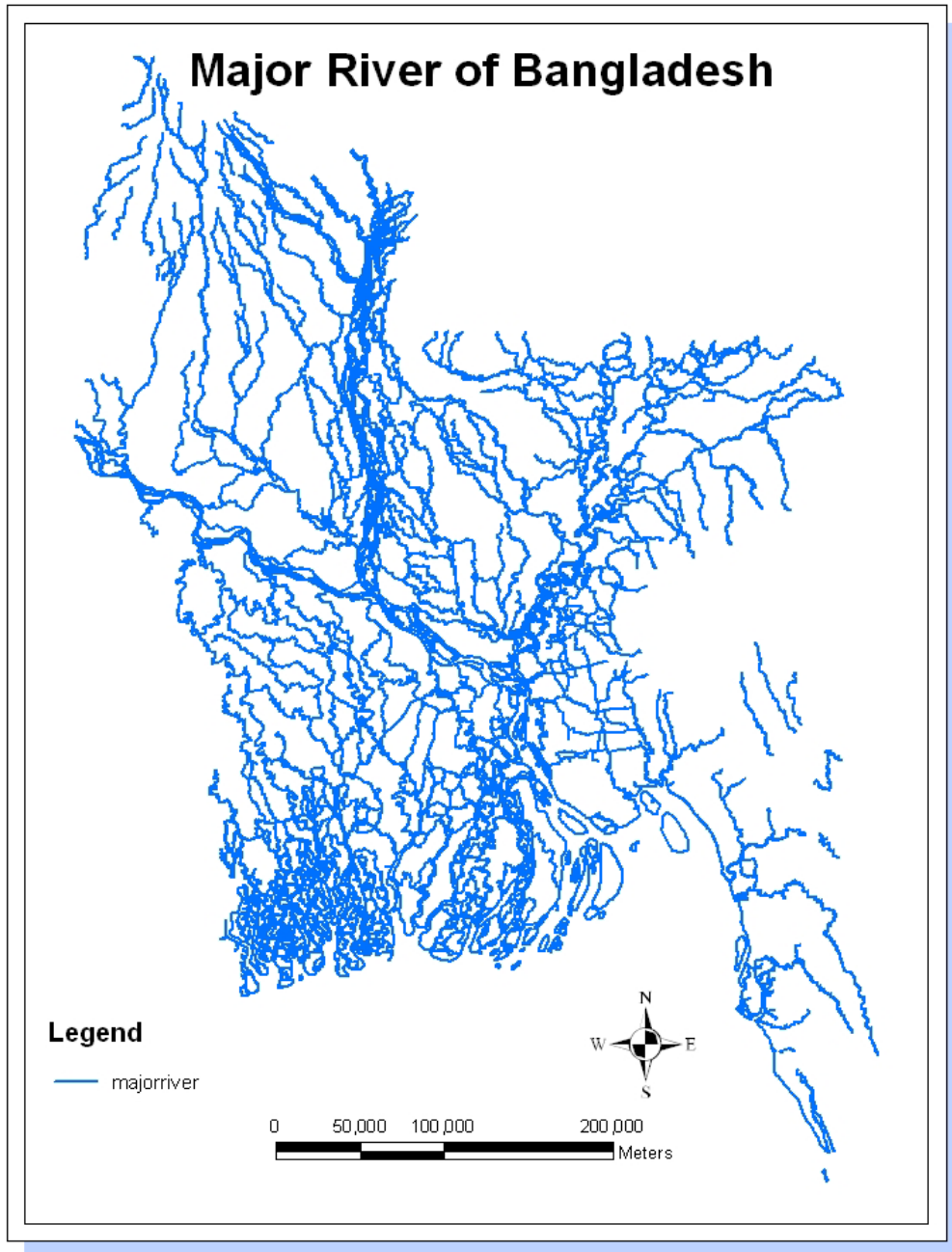
DROUGHT MAP SUMMARY

Seasons	Rainfall		Temperature	
	1996	2000	1996	2000
Pre-monsoon	Semiarid exit	No dryness	Dryness up to drought	No dryness
Monsoon	No Drought	Drought exist	Drought exist	No Drought
Post-monsoon	No dryness	Dryness upto drought	No dryness	Dryness upto drought
Winter	No significant change		Drought exists	No dryness

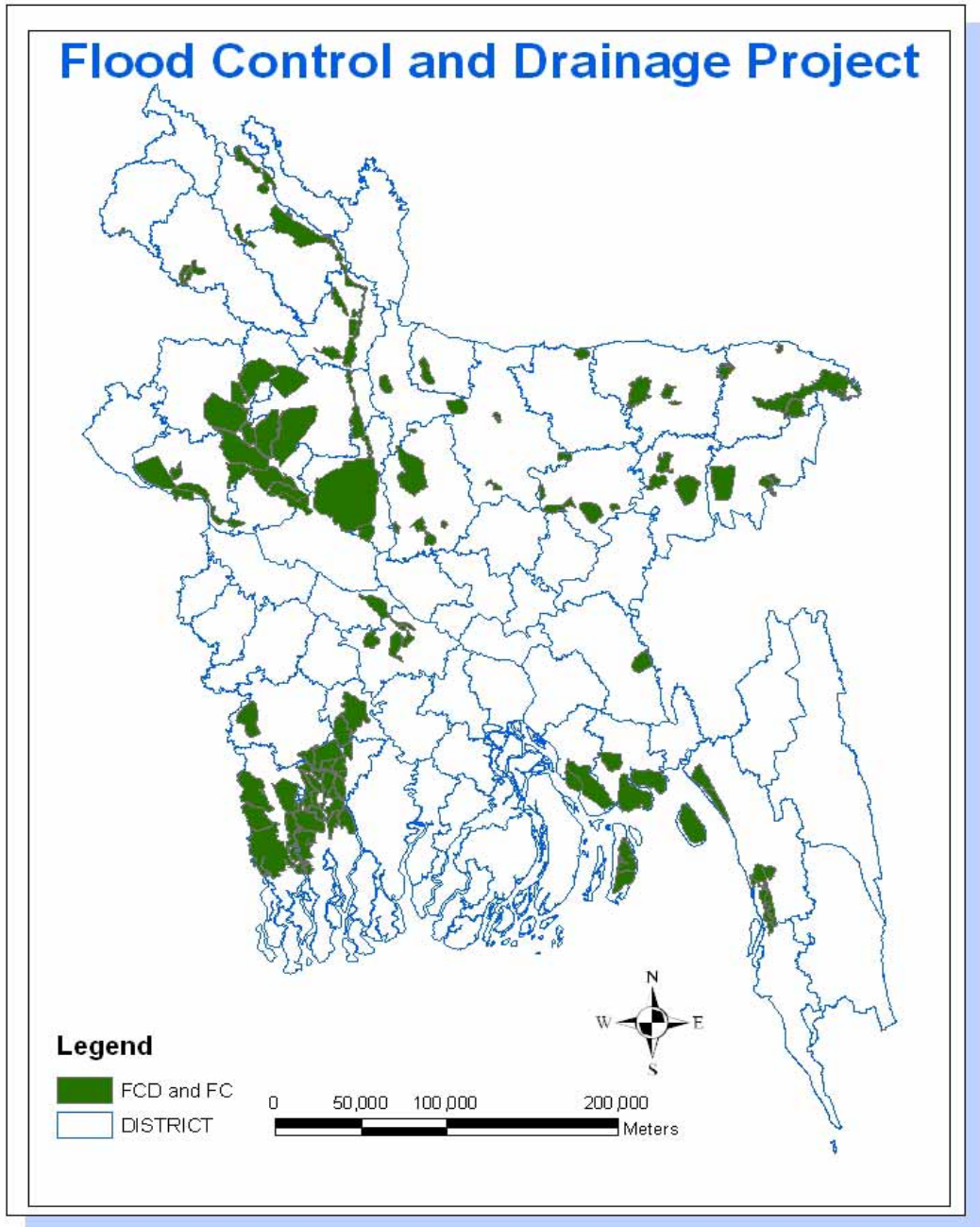
Project Title:

- Assessment of Flood Damage, Rehabilitation & Risk calculation for the year 2007 in Bangladesh (Agriculture, Highway, Embankment Network)

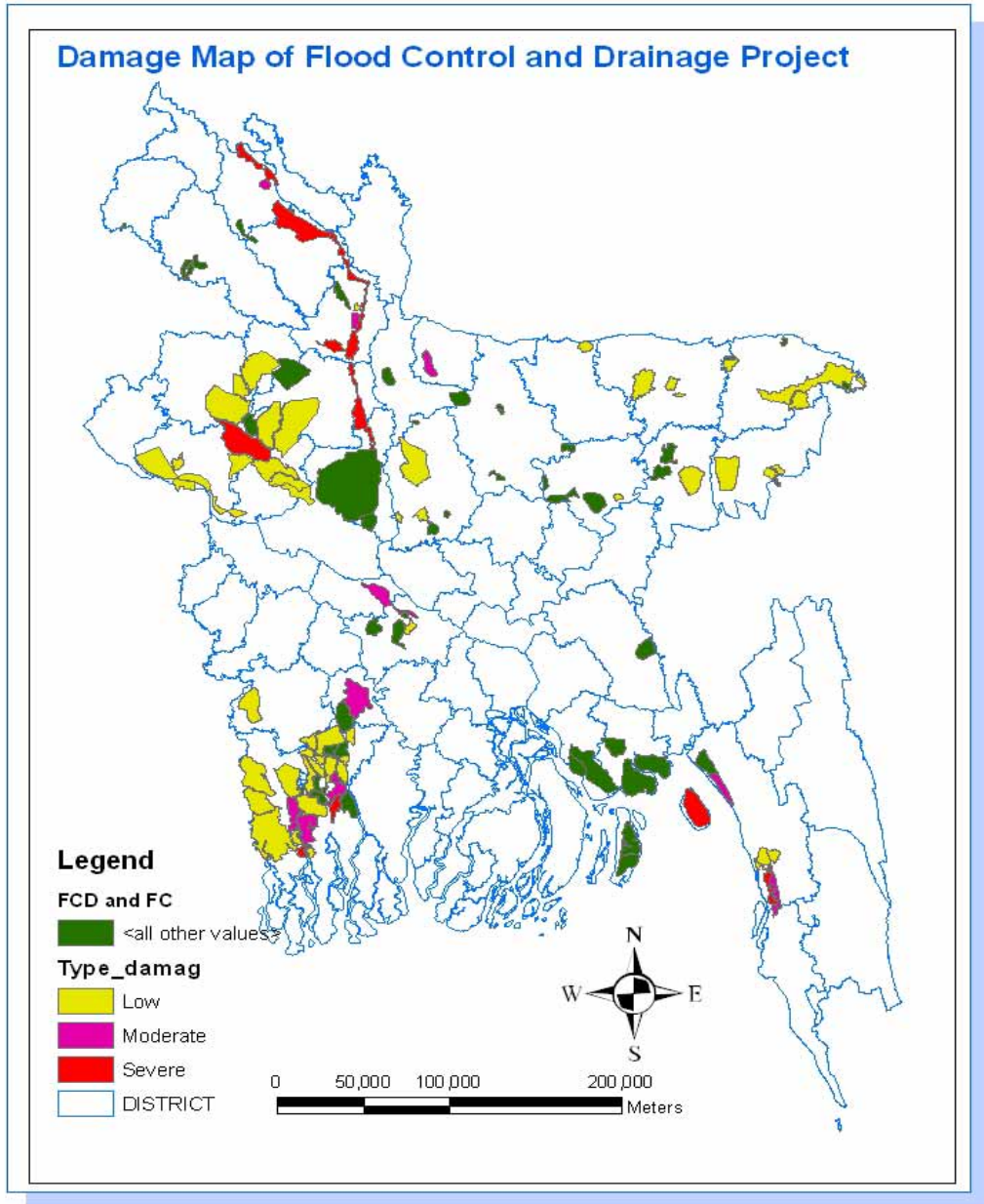
Major River Network of Bangladesh



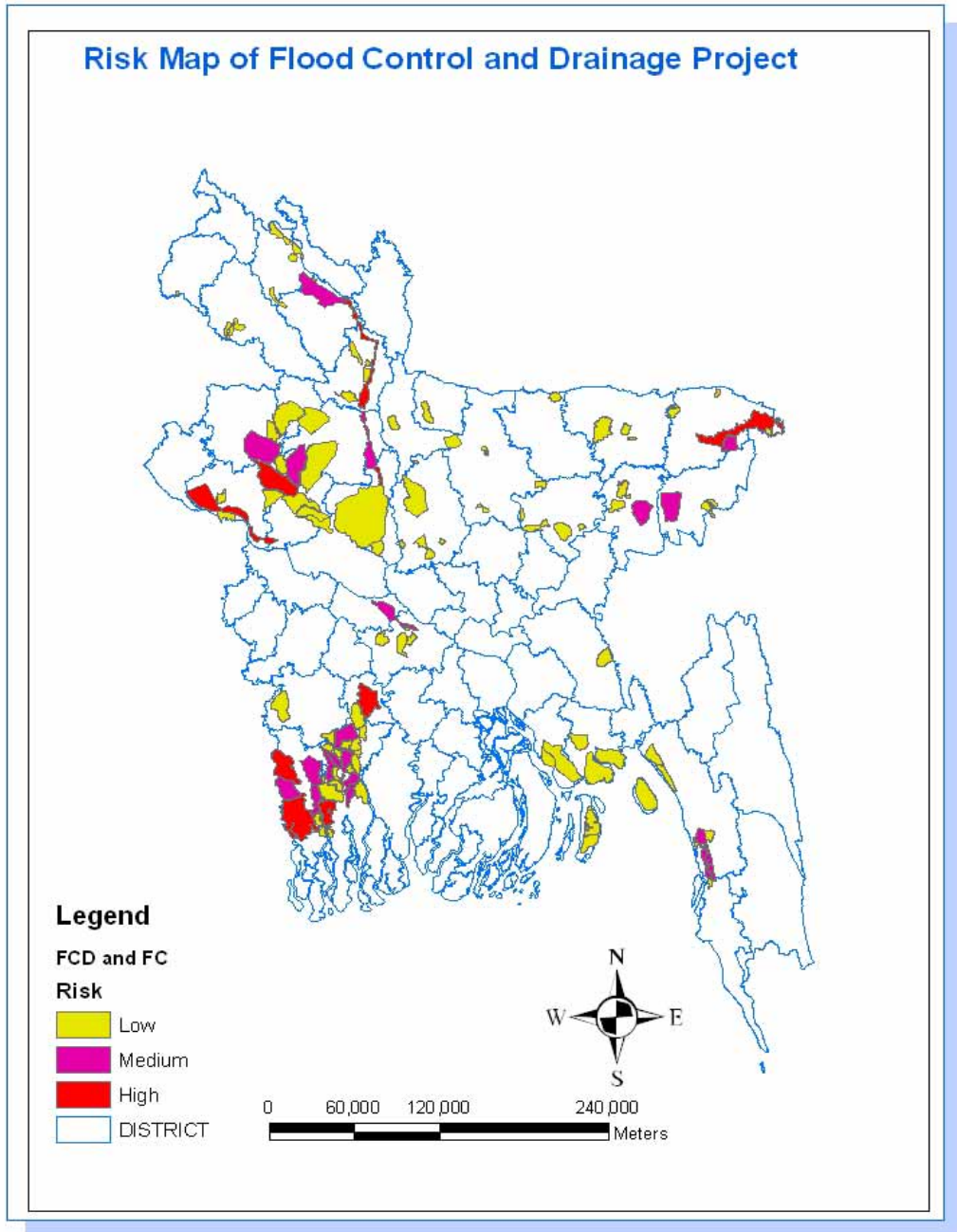
Flood Control
and
Drainage Project



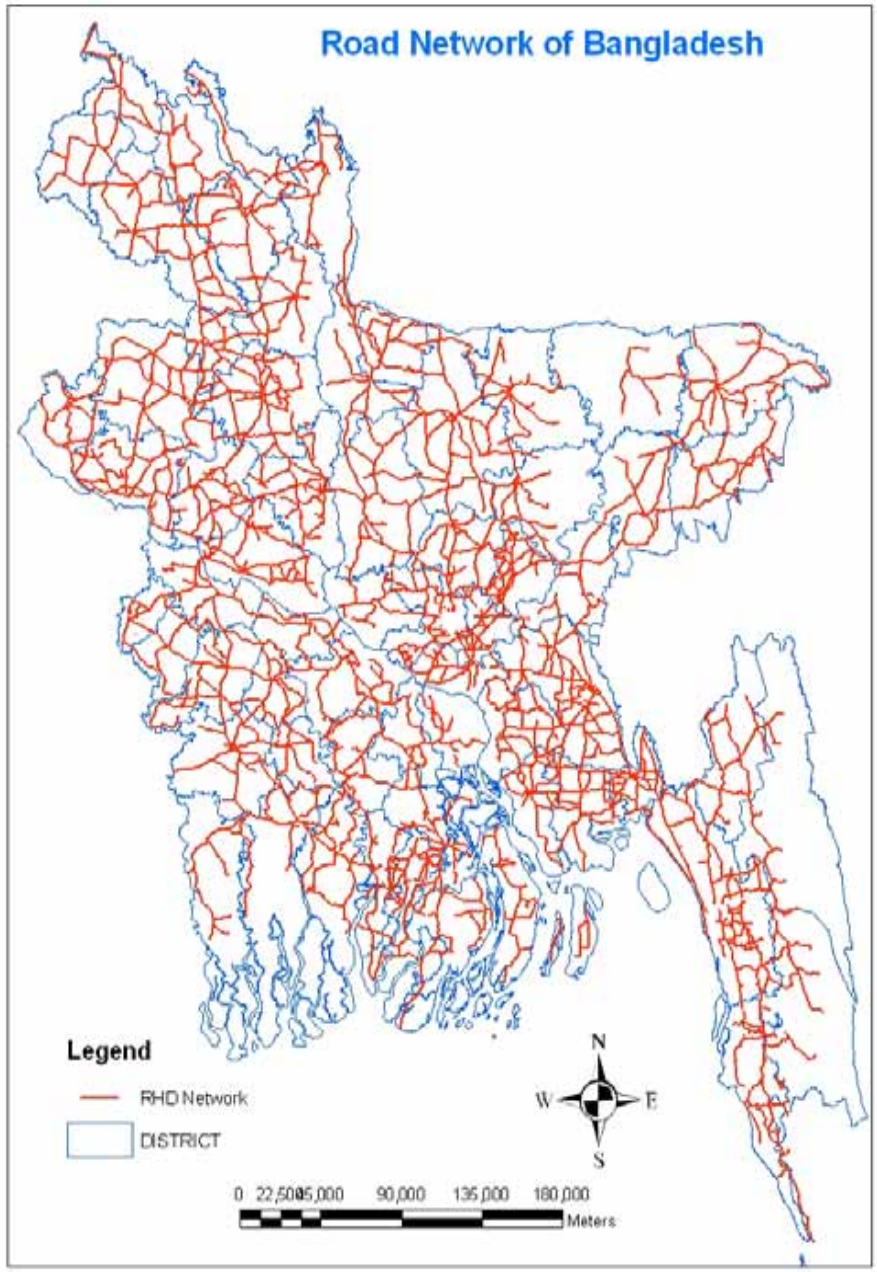
Damage Map


Damage Map of Flood Control and Drainage Project
Legend
FCD and FC
<all other values>
Type_damag
Low
Moderate
Severe
DISTRICT
N
W
E
S
0
50,000
100,000
200,000
Meters

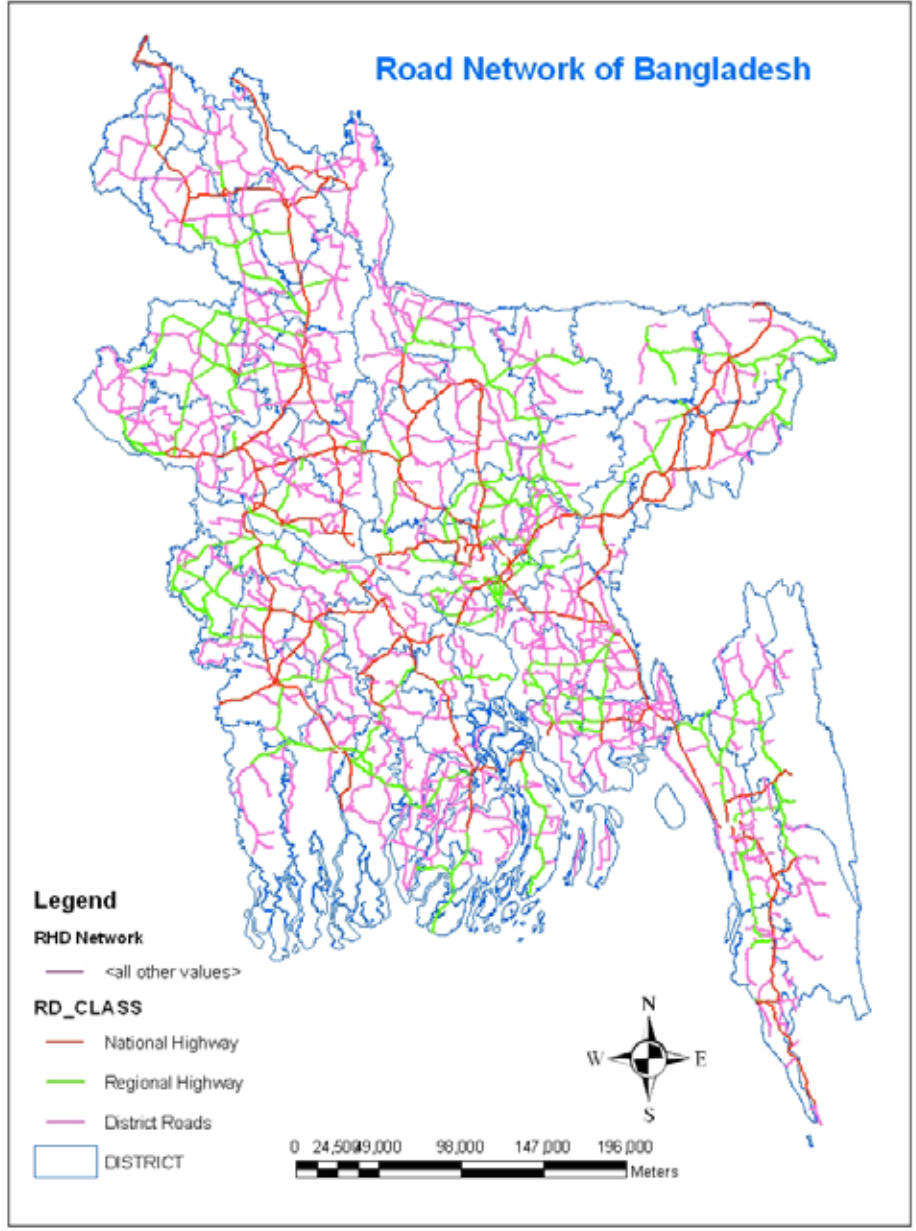
Risk Map


Risk Map of Flood Control and Drainage Project
Legend
FCD and FC
Risk
Low
Medium
High
DISTRICT
N
W
E
S
0
60,000
120,000
240,000
Meters

Road Network of Bangladesh



Major Road Network of Bangladesh



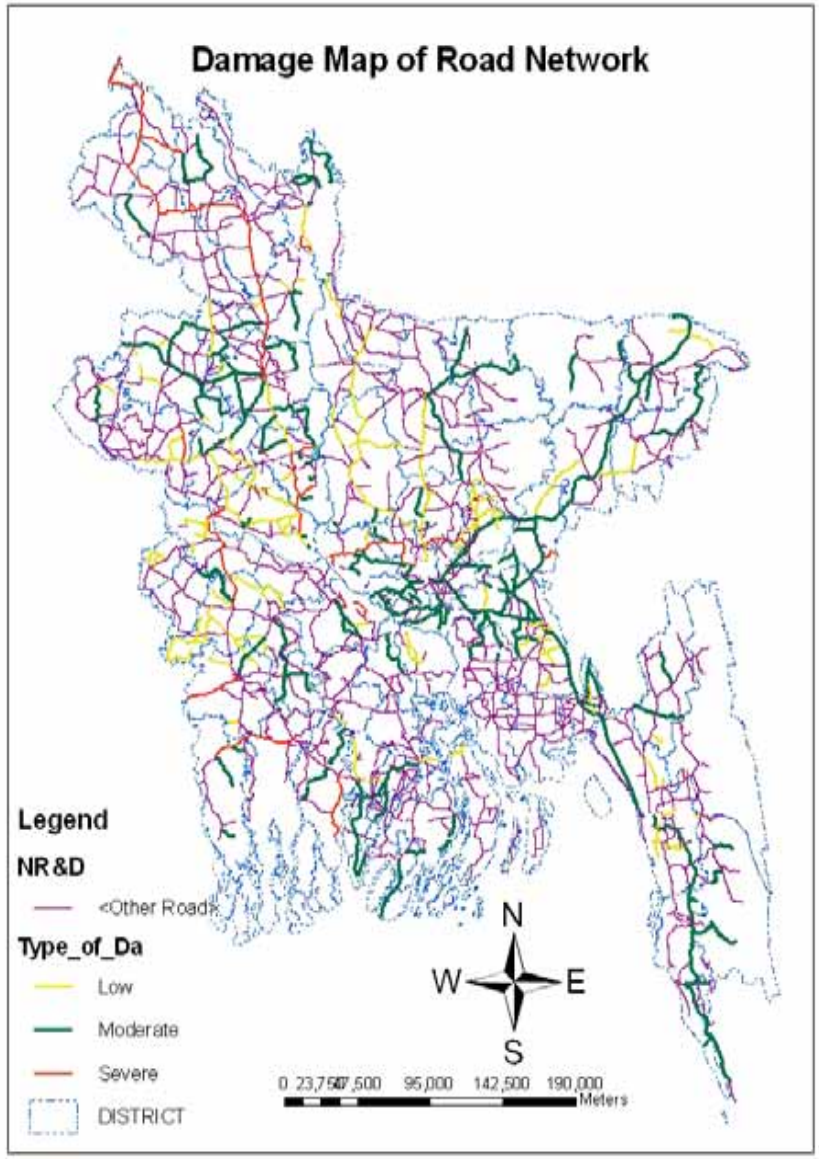
Damage Map of Road Network

- Legend

Low

Moderate

Severe



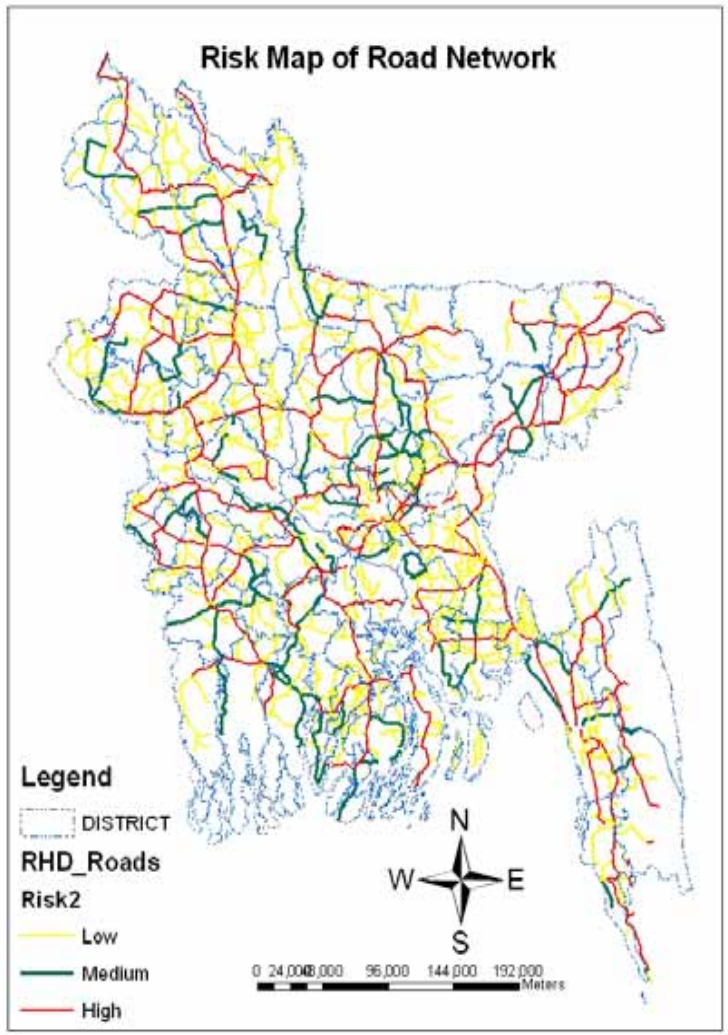
Risk Map of Road Network

Legend

Low

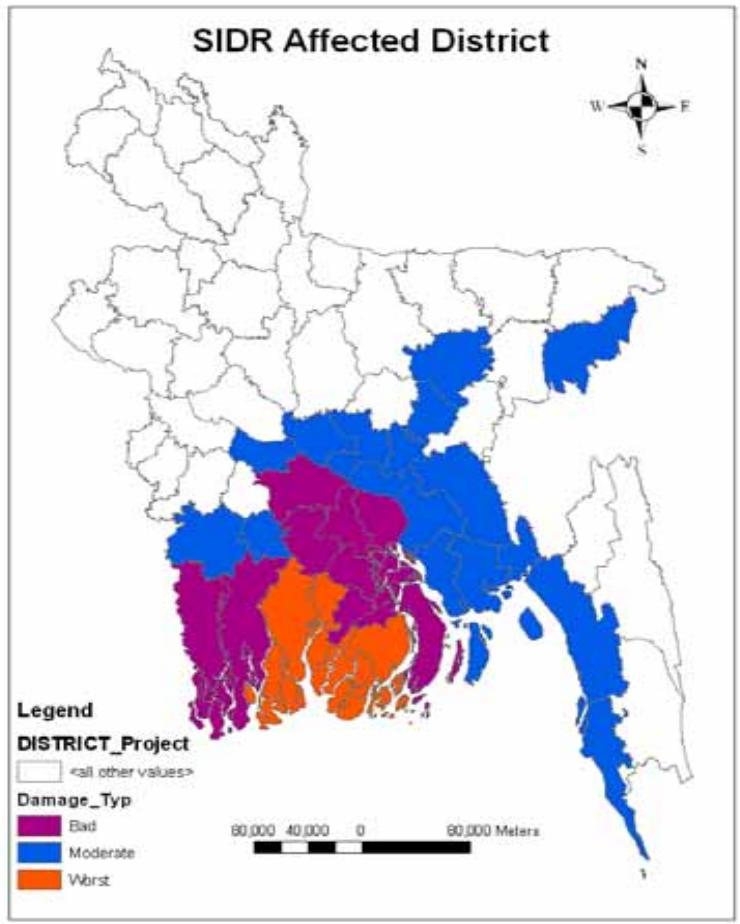
Medium

High

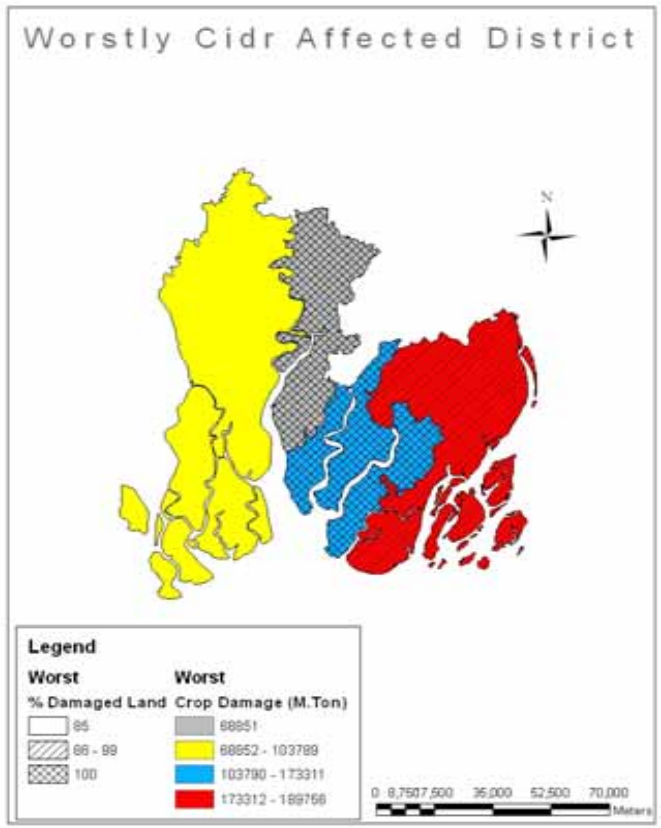


SIDR affected District

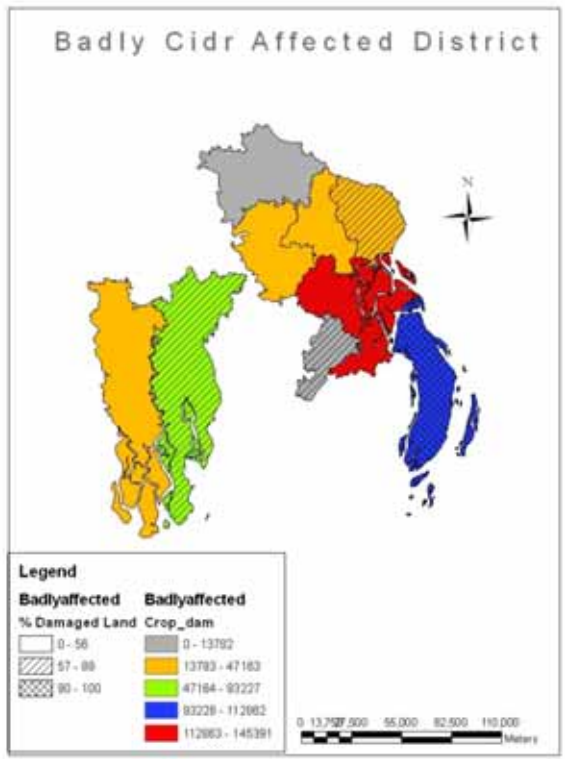
Total 30 District Affected
4 Worst
9 Badly
17 Moderate



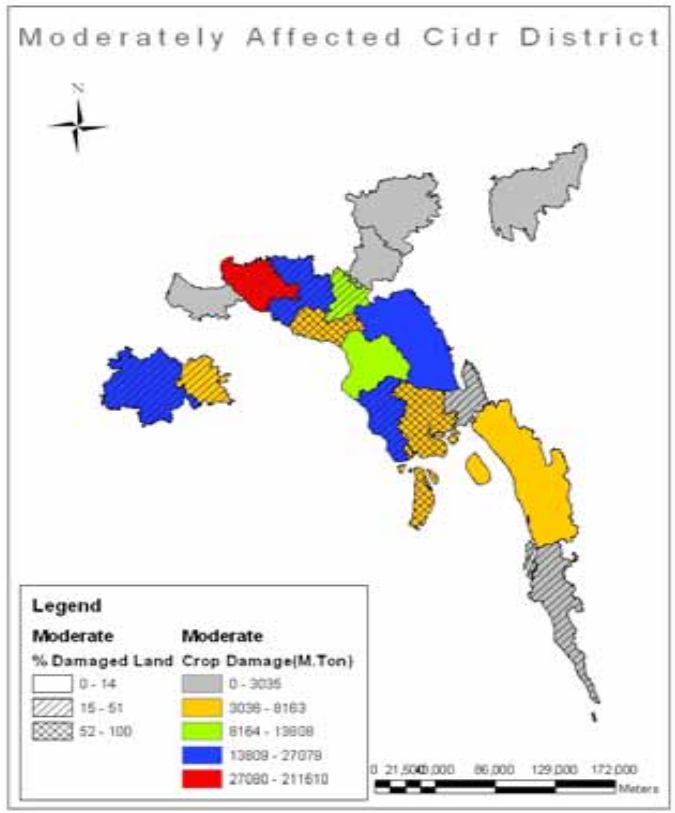
Worst Affected



Badly Affected



Moderately Affected



Recommendation

- **Risk based analysis of flood protection project and infrastructure is very important to find flood vulnerability area. This will help in minimizing flood damage. Lesson learnt from this study will be used in detail study of Risk based analysis of flood protection project, infrastructure.**
- **1. Risk zone classification for infrastructure will be done.**
- **2. Economic evaluation of infrastructure will be considered.**
- **3. For Return period calculation discharge of Major River will be used.**
- **4. Comparative study of major road and embankment network for flood proofing is necessary. Because from our study, it is observed that where embankment damage is high, road network damage is also high.**
- **5. Dem should be integrated in connection with risk analysis.**

Project

Crop water requirement and assessment of water budget under the climate change Scenario

- Forecasting the future crop pattern from the trend in the past and consideration of cost of crop production and climatic changes
- Crop water demand under the changed scenario
- Forecast the water budget and availability of water available for different sectors

Vulnerability of Bangladesh to climate stimuli

- Low economic strength,
- Inadequate infrastructure,
- Low level of social development,
- Lack of institutional capacity,
- Higher dependency on the natural resource base

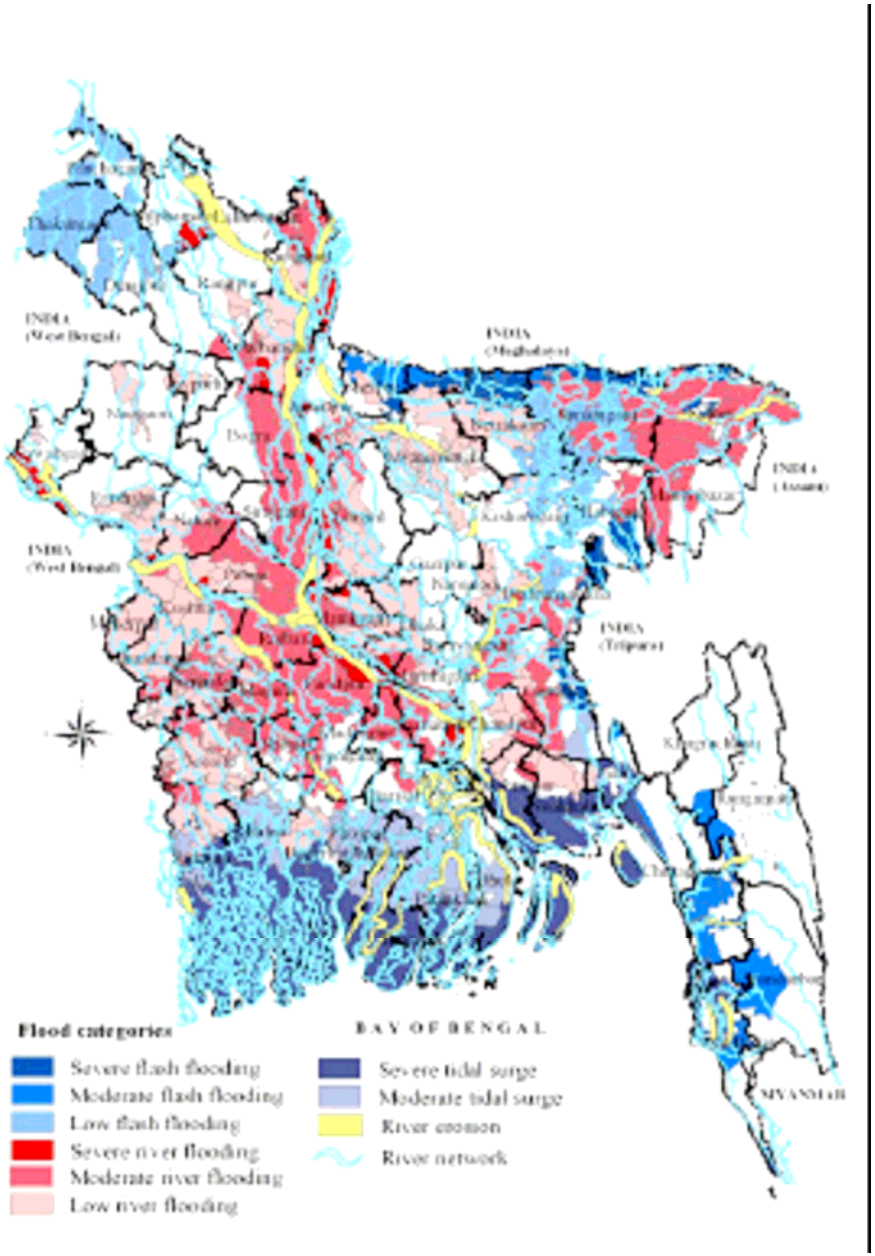
Major problems

- Early and untimely floods,
- Localized inundation and flash floods
- Salinity intrusion far from the sea,
- Continuous and prolonged droughts,
- Increased cyclone and storm surges
- Extreme temperature
- Delayed rainfall
- Water logging and drainage congestion
- Fogs in places where these were never heard of during summer time

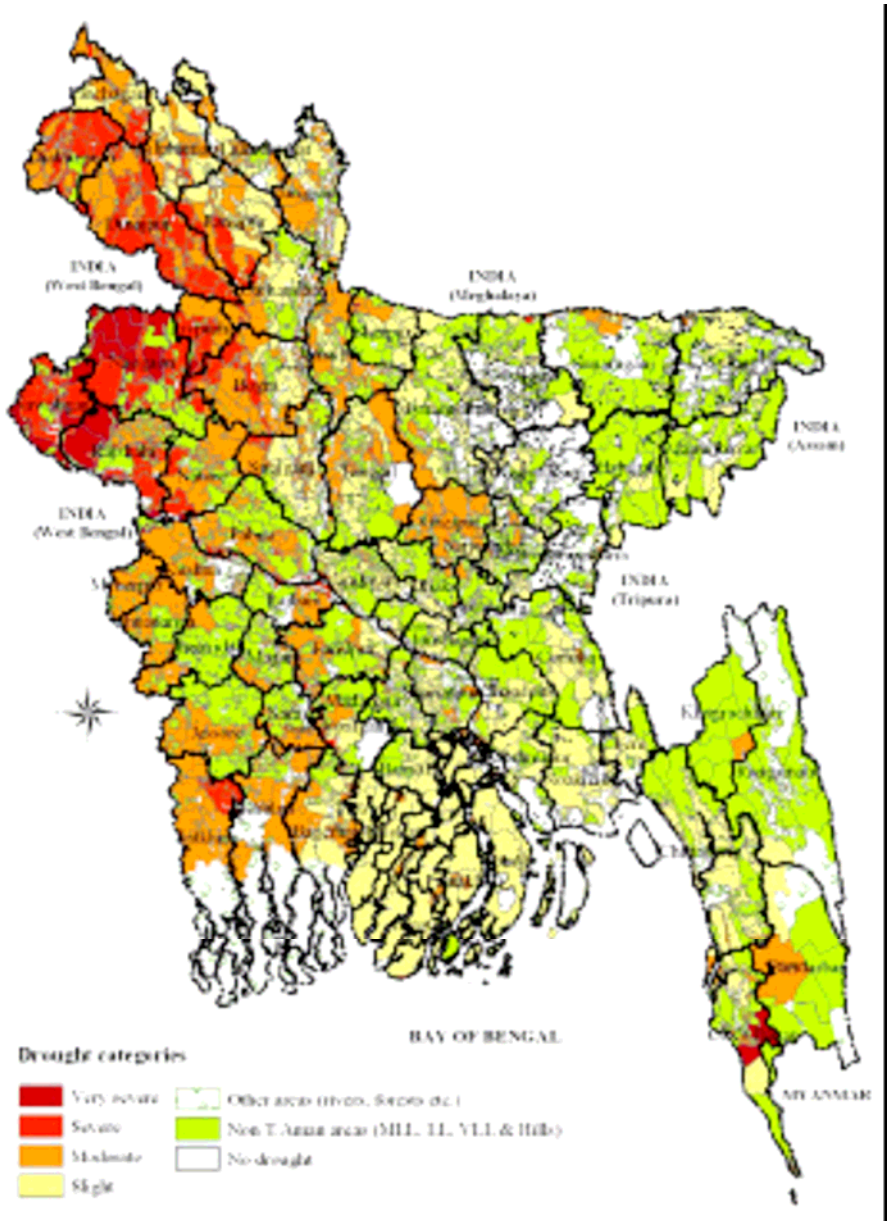
Climate change induced challenges are

- scarcity of fresh water due to less rain and higher evapo-transpiration in the dry season,
- drainage congestion due to higher water levels in the confluence with the rise of sea level,
- river bank erosion,
- frequent floods and prolonged and widespread drought,
- wider salinity in the surface, ground and soil in the coastal zone

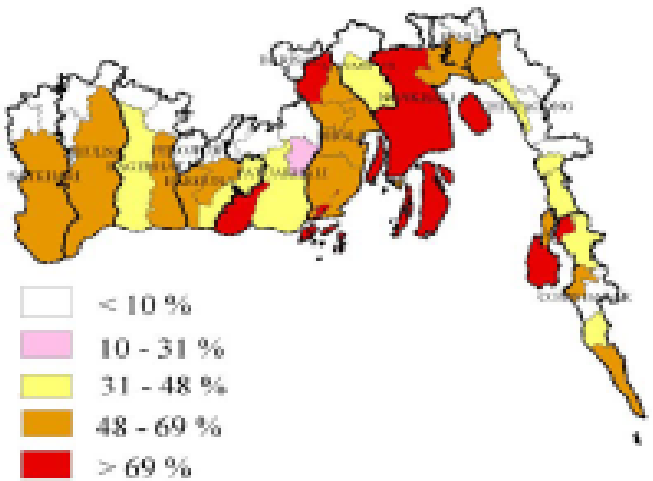
FLOOD AND RIVER EROSION

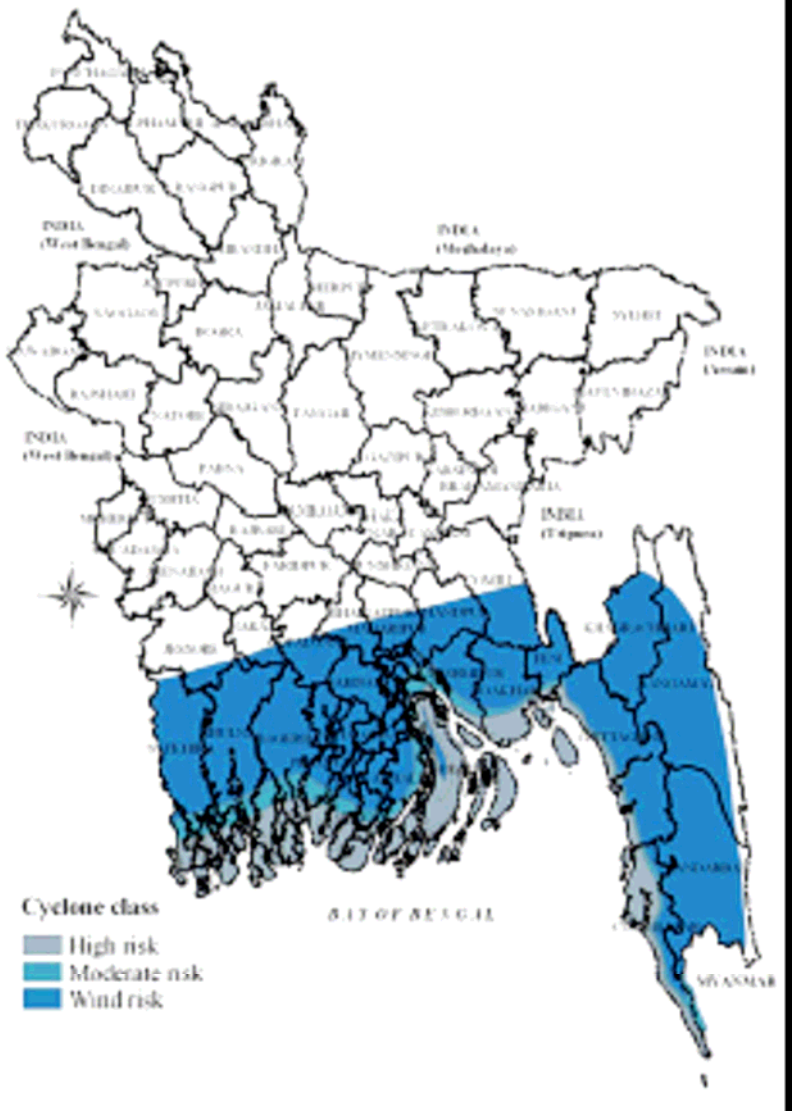


DROUGHT AFFECTED AREAS



CYCLONE AFFECTED AREAS



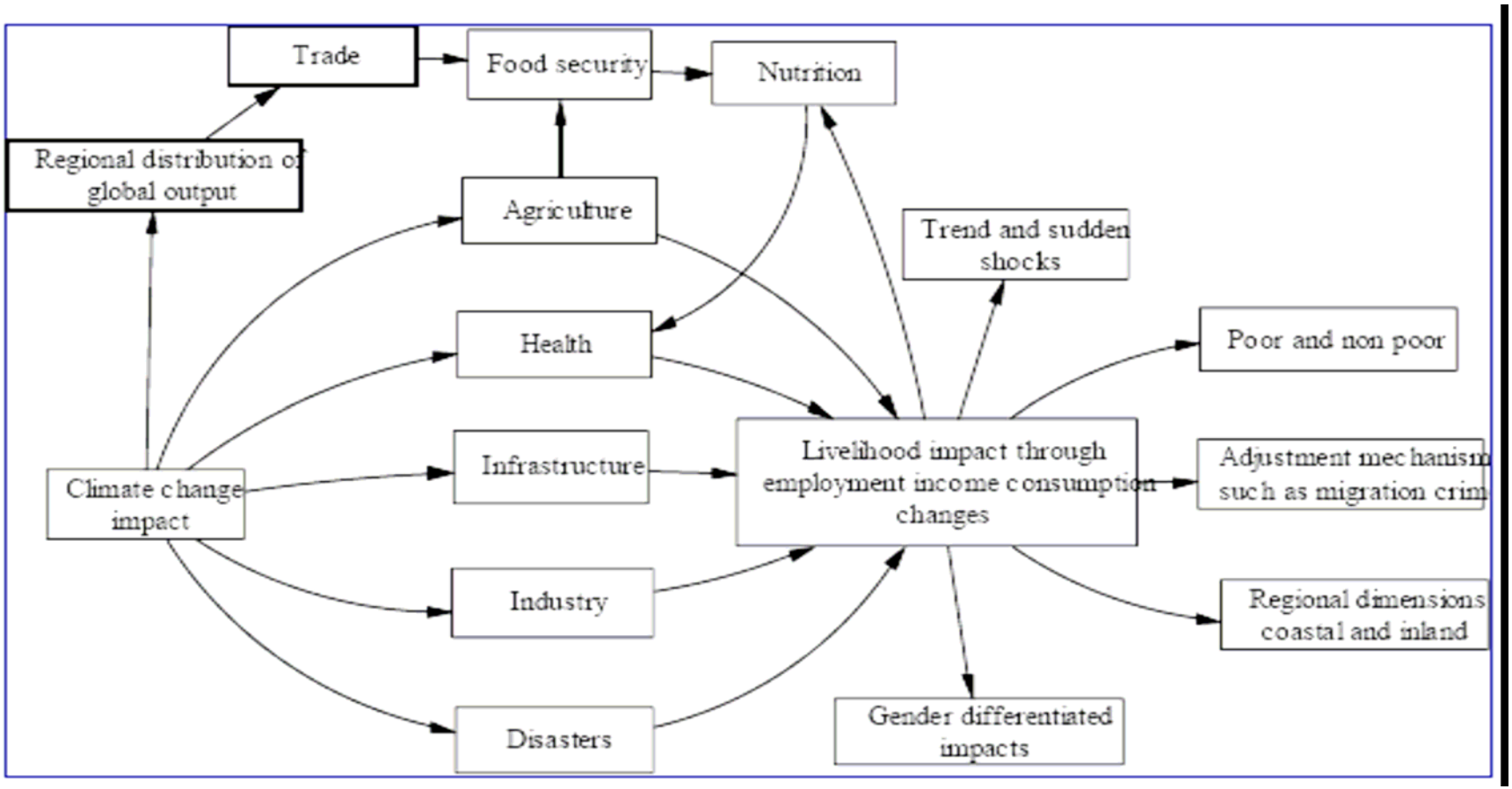


Relation between agents of change and primary physical effects in the coastal zone of Bangladesh.

Climate Change					Climate Variability			
Increase average temperature	Increase average rainfall	Decrease average rainfall	Sea level rise	Erratic temperature (extreme heat or cold)	Erratic rainfall (excessive rainfall and lack of timely rainfall, untimely rainfall)	Erratic tidal Wave	Cyclone and storm surges	Physical Vulnerability Context
+	++		++		+	+	+	Inundation
+		++			+			Low Flow
			++			++	++	Salt Water Intrusion
	++				++			Flash Flood
++		++ +		++	+			Drought
	+		++			++		River Morphology

+++ refers to high, ++ refers to moderate, and + refers to low level of relationship

Intensity of Impacts on Different Sectors due to Climate Change



Intensity of impacts on different sectors due to Climate Change

Physical Vulnerability Context								Sectoral Vulnerability Context
Extreme Temperature	Sea Level Rise		Drought	Flood		Cyclone and Storm Surges	Erosion and Accretion	
	Coastal Inundation	Salinity Intrusion		River Flood	Flash Flood			
+++	++	+++	+++	+	++	+++	-	Crop Agriculture
++	+	+	++	++	+	+	-	Fisheries
++	++	+++	-	-	+	+++	-	Livestock
+	++		-	++	+	+	+++	Infrastructure
++	+++	++	-	++	+	+	-	Industries
++	+++	+++	-	++	-	+	-	Biodiversity
+++	+	+++	-	++	-	++	-	Health
-	-	-	-	-	-	+++	+++	Human Settlement
++	+	-	-	+	-	+	-	Energy

Causes of Impacts, vulnerable areas and impacted sectors

Climate and Related Elements	Critical Vulnerable Areas	Most Impacted Sectors
Temperature rise and drought	• North-west	• Agriculture (crop, livestock, fisheries) • Water • Energy • Health
Sea Level Rise and Salinity Intrusion	• Coastal Area • Island	• Agriculture (crop, fisheries, livestock) • Water (water logging, drinking water, urban) • Human settlement • Energy • Health
Floods	• Central Region • North East Region • Char land	• Agriculture (crop, fisheries, livestock) • Water (urban, industry) • Infrastructure • Human settlement • Health • Disaster • Energy
Cyclone and Storm Surge[1]	• Coastal and Marine Zone	• Marine Fishing • Infrastructure • Human settlement • Life and property
Drainage congestion	• Coastal Area • Urban • South West	• Water (Navigation) • Agriculture (crop)

Examples of changes coastal communities have to cope with vulnerability context

Vulnerability Context	Accentuated by Climate Change		
	Exposed Upazilas	Inland Upazilas	Buffer Zone
Shocks			
Cyclones and storm surges	+++	+	-
Floods	++	+++	++
Droughts	-	++	+++
Fluctuations			
Employment	+	++	+
Hydrology/water balance	+	++	+
Food availability	+	+	+
Market prices	+	+	+
Trends			
Increase siltation and drainage congestion	+	+++	++
Increase salinization SW and GW	+++	++	+
Increase bank erosion	+++	+++	+++
Decrease dry season river flows	+	+	++
Increase resource degradation	+	+	+
Change in land use	+++	++	+
Increase GW extraction	+	++	+++
Increase law and order problems	++	+	-
Increase unemployment: (men and women)	+	++	+
Increase water borne diseases	+	++	++
Growth food shortage	+	+	+
Growth migration patterns	++	+	
Reduction fresh water supply	++	+	

Existing Knowledge on Coping Strategies

- Cyclone Shelters
- Flood Shelters
- Coastal Embankment
- Digging of drainage channel
- Creation of green belt through Coastal Afforestation
- Rain Water Harvesting
- Floating Agriculture
- Saline Tolerant Species
- Shallow Tube-well for irrigation
- Supplementary Irrigation
- Drainage Control
- Short duration Crop variety based on situation (Depth and Duration of Flood, Timing of flood, recession of flood, etc.)
- Artificial Management of Temperature for Poultry and Livestock (Use of Wet Jute bags, Use of Exhaust fan, electricity bulbs for heating rooms)

Future Coping Strategies and Mechanisms

- Development of Techniques for Transferring Knowledge and experiences from one area/ecosystem to another.
- Communication of adaptation measures to community Level
- Monitoring of actual impacts of climate change (Then, we can target the problems for solution)
- Research to study problems and to find coping strategies.
- Strengthening of insurance mechanism for crop failures, losses due to cyclones, storm surges and natural hazards.
- An integrated system approach (Integration among Production system, Human System and Physical System) to deal with SLR

ADAPTATION AIM

- Reducing the vulnerability context
- Increasing the resilience through increasing assets

Reducing the vulnerability context

Key focus is on the following issues:

- drainage congestion
- salt water intrusion
- morphologic dynamics
- natural disasters

Drainage congestion

- Physical adaptations aim at
  - ➢ improving the run-off from land after flooding
- requires mainly two steps:
  - ➢ bringing water from the land into the main drainage system; and
  - ➢ draining water to the sea. At present,
- ✓ low feasibility and effectiveness.
- ✓ So require better possibility

Salt-water intrusion

- Specific physical adaptations for the salinity problem should focus on
  - ➢ increasing surface water flows from upstream,
  - ➢ increasing local storage capacity of fresh surface or groundwater, and
  - ➢ desalinization plants and equipment.

✓ Effectiveness of such measures is high, but feasibility is low because of high cost

Morphological dynamics

- Physical adaptations to the threat of increased erosion would include
  - ➢ mangrove greenbelts
  - ➢ cross dams and/or river training works

✓ high effectiveness and feasibility

Natural disasters

- Physical adaptations include the
  - construction of new infrastructure such as cyclone shelters and /or coastal embankments and landfills
  - modification of existing infrastructure combined with improved warming systems
  - mangrove greenbelts

✓ effective, but they do not score high on feasibility because of costs and organization needed to maintain them

Effectiveness of possible adaptation measures to reduce the vulnerability context

Primary Physical Effects / Adaptations Measures	Salt-water Intrusion	Drainage Congestion	Coastal Morphology	Cyclone and Storm Surges
Increasing drainage capacity	-	+++	++	-
New regulator and tidal basin	+++	+++	+	-
Proper operation and maintenance	++	++	+	-
Desalinization plant	++	-	-	-
Effective landuse planning	++	+	++	+
Coastal Afforestation and greenbelt plantation	-		+	+++
River training	-	++	+++	-
Increase cyclone centers	-	-	-	+++
Improve warning system	-	-	-	+++
Design and build new infrastructure incorporating CC and sea level rise.	+	++	++	+++
Improvement of Coastal Livelihoods System and Well-being				
Education	-	+	-	+
Health	+	++	-	+
Income	+++	+++	++	++
Housing	-	+	+++	+++
Food Security	++	+++	++	++

Priority Sectors

- Agriculture and Food Security
- Terrestrial and Freshwater Ecosystem
- Coastal Zone and Marine Ecosystem
- Disaster Control (floods and drought)
- Human Health, and
- Human Settlement and Infrastructure (as result of urbanization).

The Final List of the Projects

Sl. No.	Project Title	Type of Project	Primary Implementing Agency	Total Cost
1	Reduction of climate change hazards thro ugh Coastal afforestration with community participation.	Interventio n	Forest Department (FD)	Full project: USD23 million Project design: 100,000
2	Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise.	Interventio n	Department of Public Health Engineering (DPHE)	Full project: USD1.5 million Project design: USD 25,000
3	Capacity building for integrating Climate Change in planning, designing of infrastructure, conflict management and land-water zoning for water management institutions.	Capacity building	Water Resource Planning Organization (WARPO)	USD2.0 million Project design: USD 25,000

The Final List of the Projects (continuation-1)

Si. No	Project Title	Type of Project	Primary implementing Agencies	Total Cost
4	Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disasters.	Awareness and Capacity Building	Ministry of Environment and Forest (MoEF)	Full project: USD7 million Project design: USD 50,000
5	Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains.	Intervention	Disaster Management Bureau (DMB) and Local Government Engineering Department (LGED)	Full project: USD5 million Project design: USD: 50,000
6	Mainstreaming adaptation to climate change into policies and programs in different sectors (focusing on disaster management, water, agriculture, health and industry).	Capacity building	Department of Environment (DOE)	Full project: USD1 million Design phase: USD 25,000

The Final List of the Projects (continuation-2)

Si No	Project Title	Type of Project	Primary Implementing Agencies	Total Cost
7	Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.	Awareness raising	Board of Education	Full Project: USD0.5 million Project design: USD 25,000
8	Enhancing resilience of urban infrastructure and industries to impacts of climate change	Capacity building	Department of Environment (DOE)	Full project: USD2 million Design phase: USD 25,000
9	Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.	Intervention	NGO consortium	Full project: USD 5 million Design phase: USD 50,000

The Final List of the Projects (continuation-3)

Si no	Project Title	Type of Project	Primary Implementing Agencies	Total Cost
10	Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.	Research	Bangladesh Agricultural Research Council (BARC)	Full project: USD5 million Design phase: USD 50,000
11	Promoting adaptation to coastal crop agriculture to combat increased salinity.	Intervention	Bangladesh Agricultural Research Institute (BARI)	Full Project: USD:6.5 million Project design: USD 50,000
12	Adaptation to agriculture systems in areas prone to enhanced flash flooding– North East and Central Region.	Intervention	Bangladesh Agricultural Research Institute (BARI)	Full project:USD6.5 million Project design: USD 50,000

The Final List of the Projects (continuation-4)

Si. no	Project Title	Type of Project	Primary Implementing Agencies	Total Cost
13	Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.	Intervention	Department of Fisheries (DOF)	Full Project: USD4.5 million Project design: USD 50,000
14	Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh	Intervention	Department of Fisheries (DoF)	Full project: USD4 million Project design: USD 50,000
15	Exploring options for insurance to cope with enhanced climatic disasters.	Research	Department of Environment (DOE)	Full Project: USD0.2 million Project design: USD 25,000

Concluding Remark

- Climate change will exacerbate many of the existing problems and natural hazards that the country faces
- There are various coping mechanisms, formal and informal, in place
- Urgency of the matter to be integrated within the development process so that when the Climate Change impacts become more clearly discernible, the nation shall be ready to handle it
- The strategic goals and objectives of future coping mechanisms are to reduce adverse effects of climate change including variability and extreme events and promote sustainable development

EXPECTATIONS FROM GEOSS

- High resolution DEM
- Climatological data with higher time frequency and spatial resolution
- More parameters of Agro meteorological data
- Data for Crop water prediction (crop coefficient etc.)
- Capacity Building -Technology sharing among Trainers (Academics of different Nations)
- Technical sharing regarding the use of modern technologies/equipments for model handling/field level measurement/RS data interpretation etc (Academics and the Government agencies of different nations)