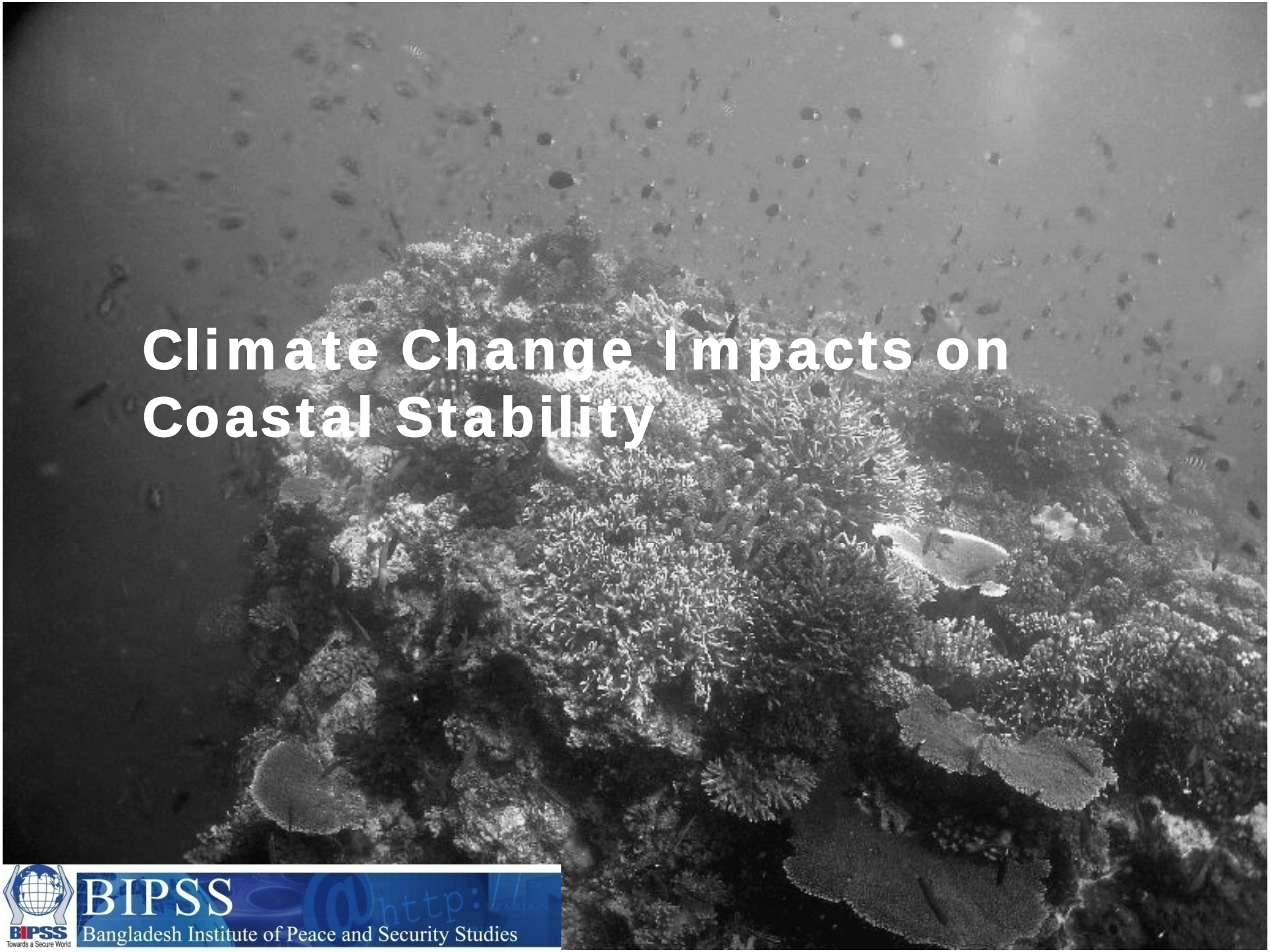
IMPACTS OF CLIMATE CHANGE

Conflict Drivers and Coastal Stability

Major General Muniruzzaman (Retd)
President
Bangladesh Institute of Peace and Security Studies (BIPSS)

Introduction

- The effects of increased climate change most particularly changes in ocean chemistry will adversely affect the physical and biological characteristics of coastal systems, modifying their ecosystem structure and functioning.
- As a result, coastal nations of South and South East Asia, Caribbean, North and Latin America, and Pacific region will face losses of land and shorelines, increased natural disasters, food insecurity, loss of livelihood, displacement and migration, loss of marine biodiversity and fisheries that will intensify exiting conflicts and at the same time will draw new lines of conflicts in the coastal belt regions.
- Efficient climate diplomacy through wide scale negotiation, dialogue and sharing of knowledge and technology can mitigate climate induced conflicts by increasing cooperation and collective measures.



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Climate Change Impacts on Coastal Belt Regions

- Coastal and marine ecosystems support diverse and important resources and fisheries throughout the nation's waters, hold vast storehouses of biological diversity, and provide unparalleled recreational opportunities.
- Demands on coastal and marine resources are rapidly increasing, and as coastal areas become more developed, the vulnerability of human settlements to hurricanes, storm surges, and flooding events also increases.
- Coastal and marine environments are intrinsically linked to climate in many ways. The ocean is an important distributor of the planet's heat, and this distribution could be strongly influenced by changes in global climate over the 21st century.

Impacts on Coastal Belt Regions (contd.)

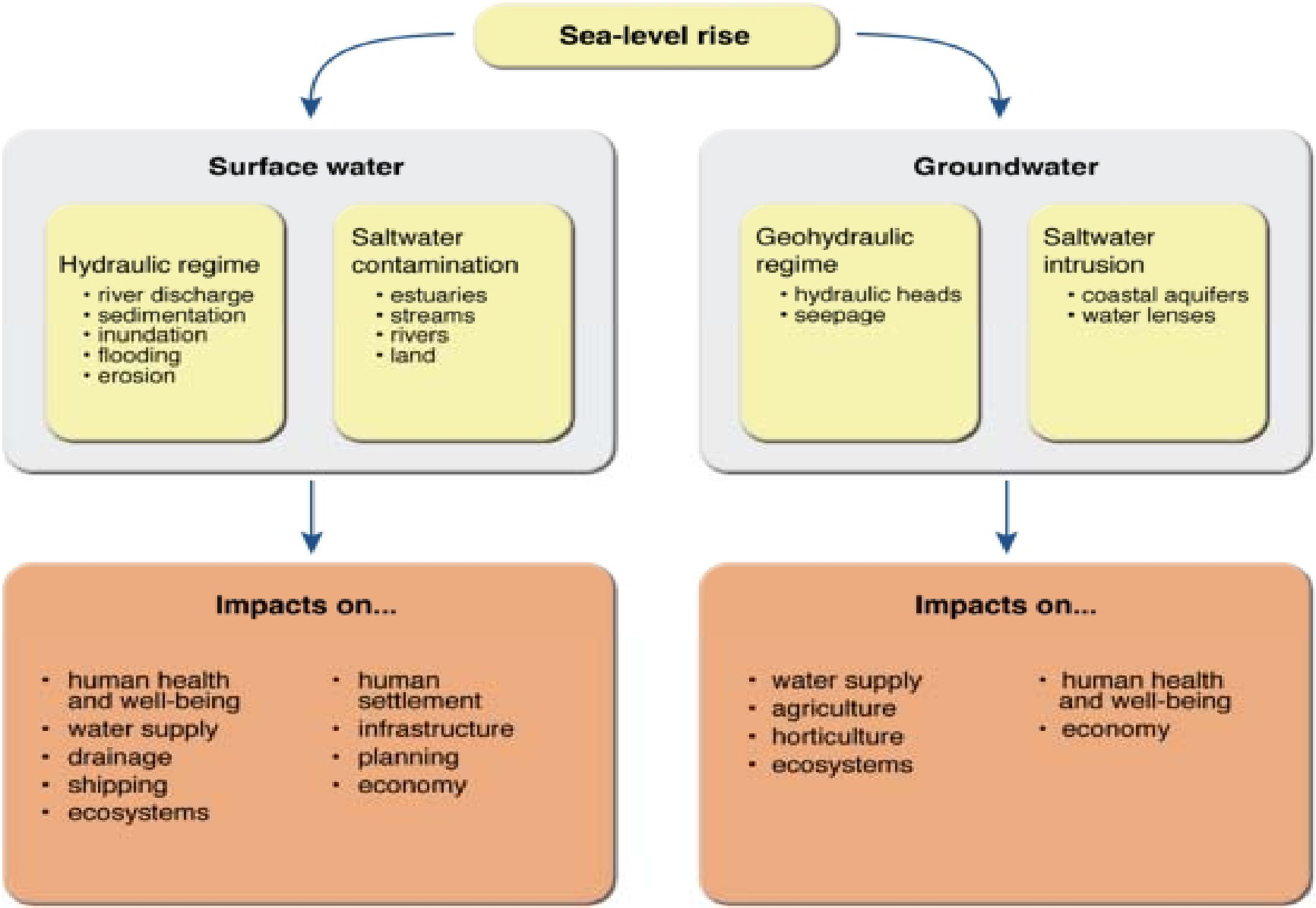
- Shoreline erosion and land inundation
- Coastal flooding and natural calamities such as increased cyclone and storm
- Loss in coral reefs and marine fisheries
- Loss in marine biodiversity
- Salinity intrusion
- Crop failure and food insecurity
- River bank erosion
- Displacement and migration
- Health hazards
- Breakdown of coastal ecosystem

Sea Level rise and Coastal Vulnerabilities

Significant Sea level rise by 2100 is predicted by IPCC.

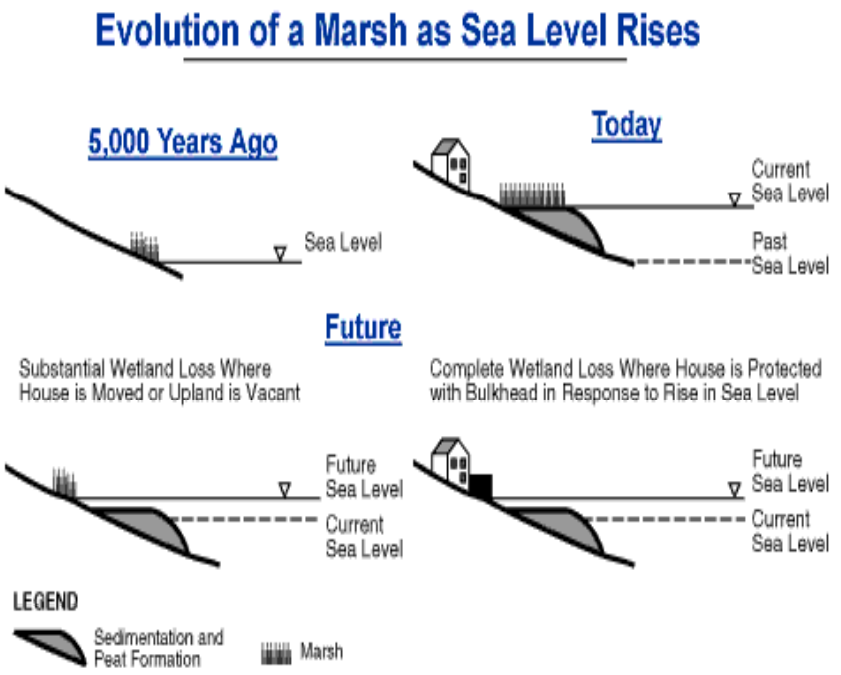
- According to Nicholls and Leatherman (1995), a 1m sea-level rise would affect 6 million people in Egypt, with 12% to 15% of agricultural land lost, 13 million in Bangladesh, with 16% of national rice production lost, and 72 million in China and "tens of thousands" of hectares of agricultural land.
- More than direct land loss due to seas rising, indirect factors are generally listed as the main difficulties associated with sea-level rise. These include erosion patterns and damage to coastal infrastructure, salinization of wells, sub-optimal functioning of the sewerage systems of coastal cities with resulting health impacts (WHO 1996, chapter 7), loss of littoral ecosystems and loss of biotic resources.

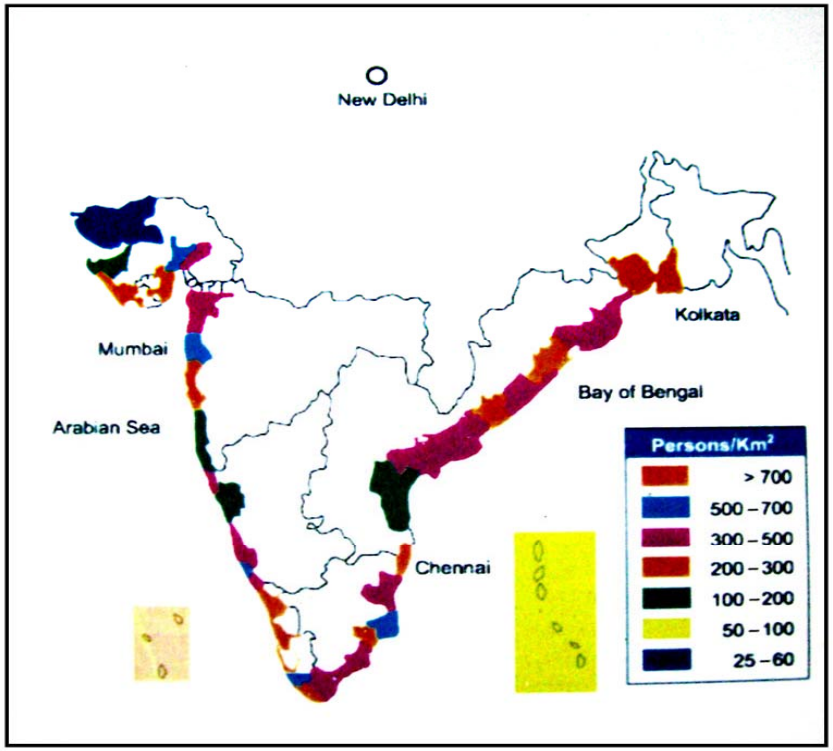
Coastal Vulnerabilities (contd.)



Sea Level Rise and Land Inundation

- Coastal wetland ecosystems, such as salt marshes and mangroves are particularly vulnerable to rising sea level because they are generally within a few feet of sea level (IPCC, 2007).
- A two foot rise in sea level would eliminate approximately 10,000 square miles of land) including current wetlands and newly inundated dry land, an area equal to the combined size of Massachusetts and Delaware (EPA, 1989).

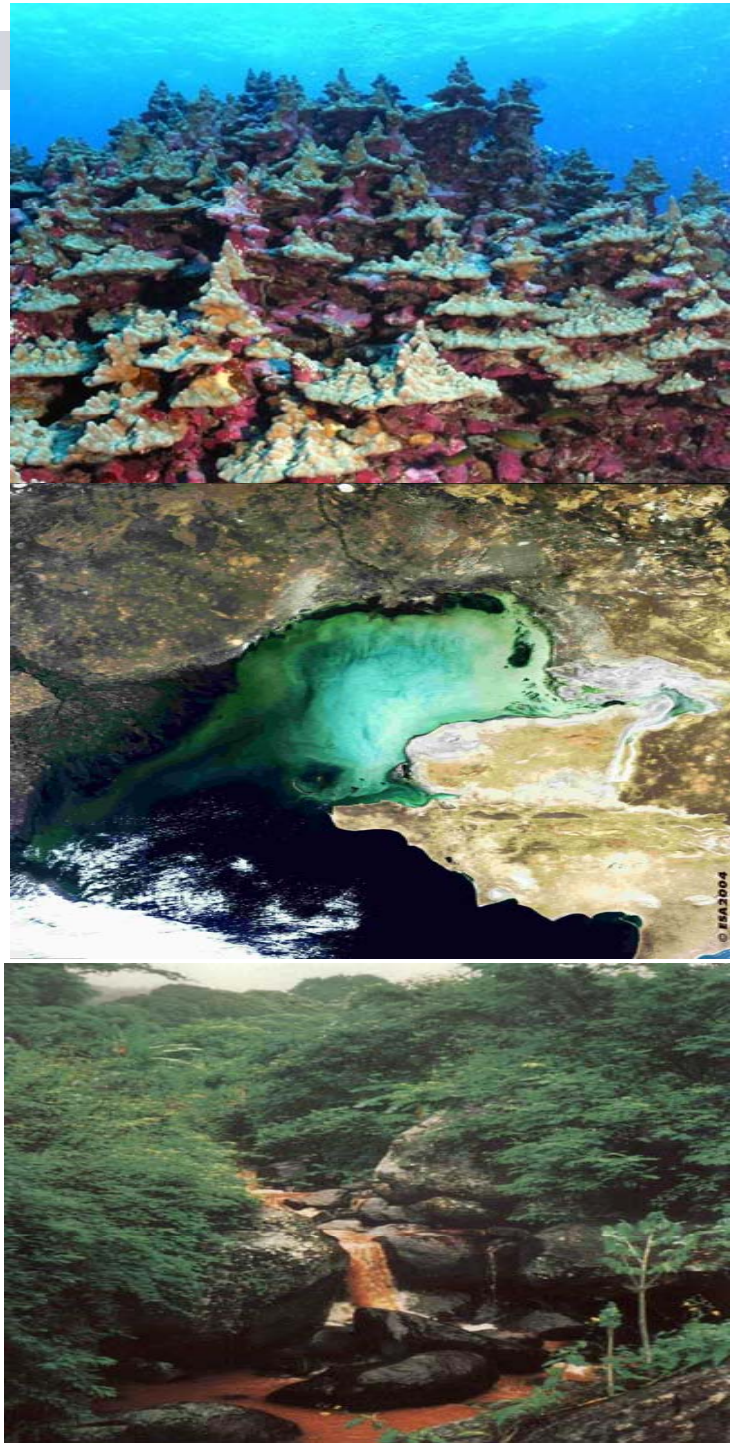




Impacts on Coral Reef

- Coral reefs, which are among the most biodiverse ecosystems on Earth, are highly sensitive to increases in sea surface temperature. A 2°C increase, associated with CO2 concentrations of 500 ppm, threatens to destroy most coral reefs.

- The last few years have seen unprecedented declines in the condition of coral reefs. The 1998 El Niño in particular was associated with record sea-surface temperatures and associated coral bleaching.



Impacts on Coastal Erosion

- Coastal erosion is already a widespread problem in much of the country and has significant impacts on undeveloped shorelines as well as on coastal development and infrastructure.
- Along the Pacific Coast, cycles of beach and cliff erosion have been linked to El Niño events that elevate average sea levels over the short term and alter storm tracks that affect erosion and wave damage along the coastline.
- Most erosion events in the Atlantic and Gulf coastlines are the result of storms and extreme events, and the slope of these areas is so gentle that a small rise in sea level produces a large inland shift of the shoreline.

Impacts on Wetlands

- Climate impacts will also affect wetlands that are already subject to land use changes, mangrove deforestation, pollution, and water diversion, which increase the ecosystem's vulnerability to expected climate change impacts and exacerbate the impacts.

- The IPCC suggests that by 2080, sea level rise could convert as much as 33 percent of the world's coastal wetlands to open water. (IPCC, 2007).

Impact on Coastal Ecosystem

- Climate models forecast significant increases or decreases in precipitation and river runoff in various parts of the country and such changes will affect salinity and water circulation.

- Climate change will have important implications for marine ecosystems that support ecologically and economically important fish populations.

- As a result of changes in ocean conditions, the distribution and abundance of major fish stocks will probably change substantially.

Coastal Instability and Drivers of Conflict

- Increased natural calamities such as coastal flooding, cyclone, and storm induced form Sea level rise
- Food insecurity from land inundation
- Reduced agricultural productivity caused by salinity intrusion
- Environmental resource scarcity
- Loss of usual pattern of livelihood
- Displacement, migration and IDPs
- Health hazards
- Social fragmentation

Challenges of Environmental Scarcity

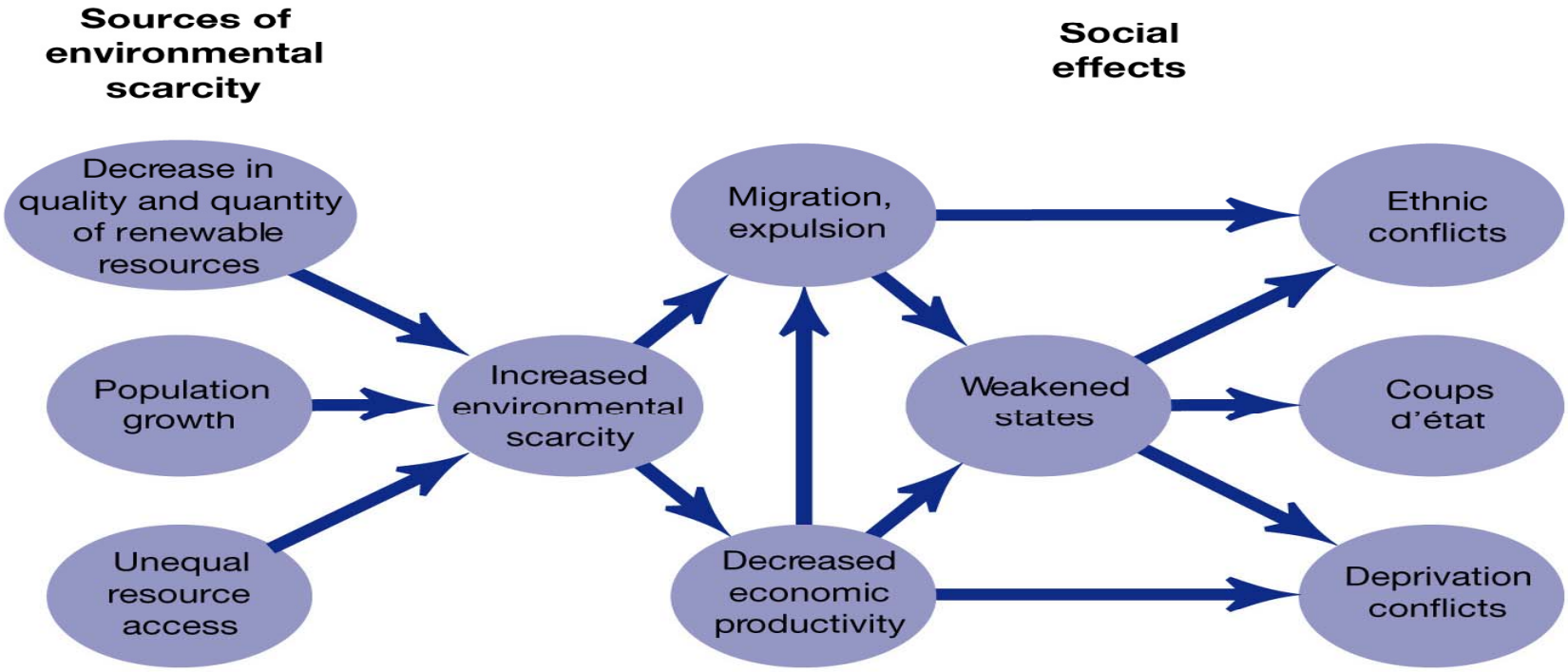
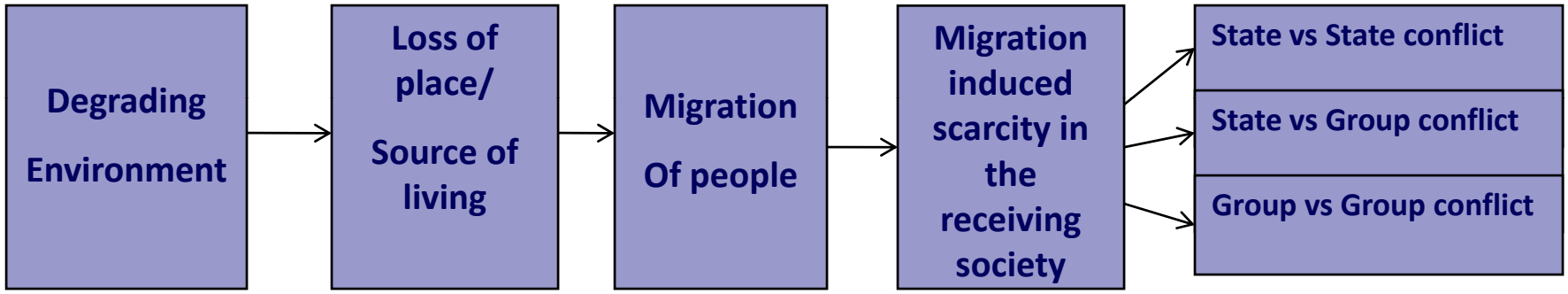
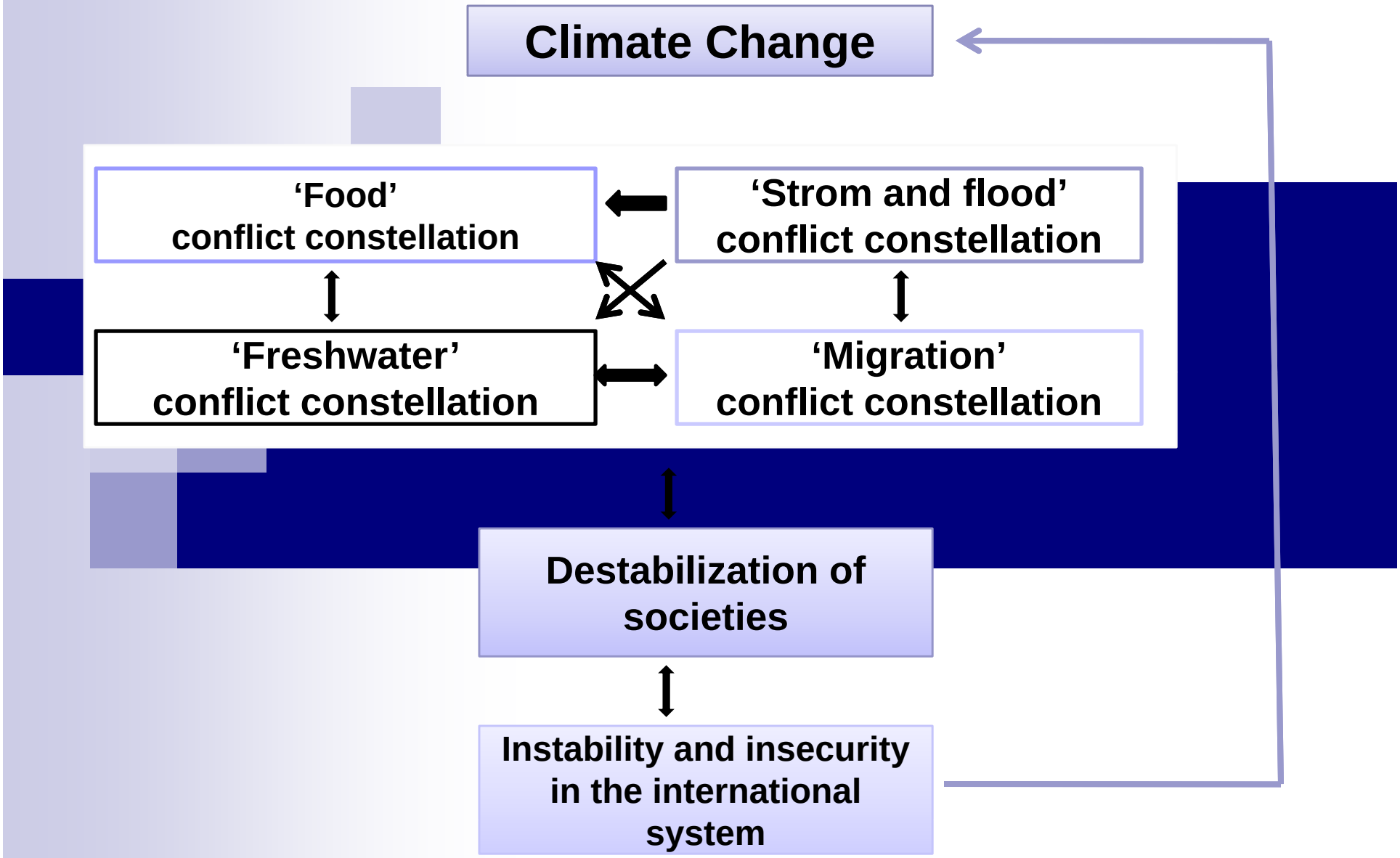


FIGURE 10.3 Some Sources and Consequences of Environmental Scarcity

The Environmental Trap: Environment and Conflict





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Climate Change as drivers of international destabilization

Coastal Instability and Drivers of Conflict
Bangladesh Case

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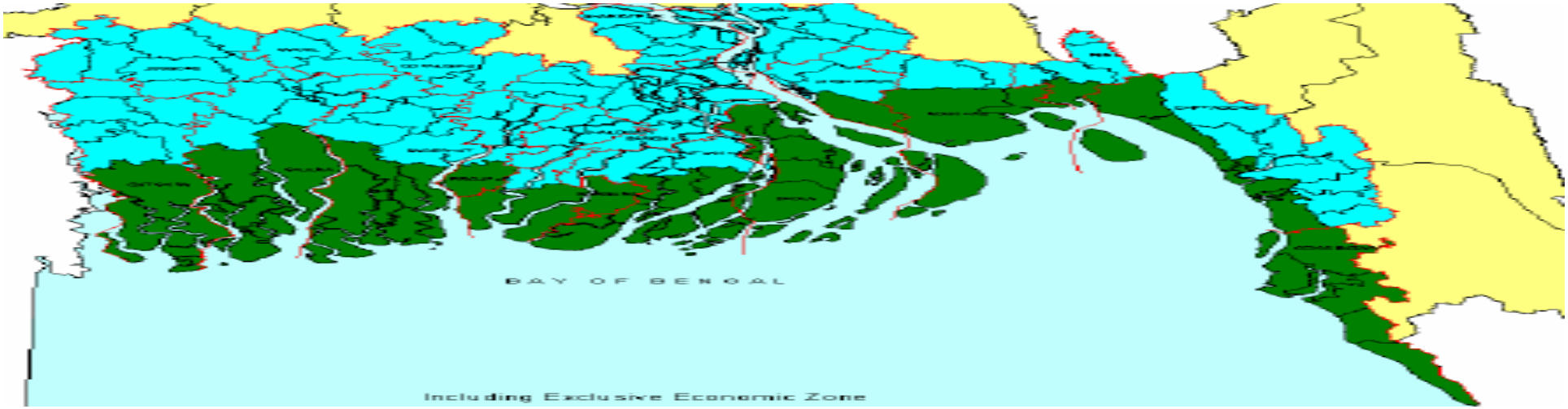
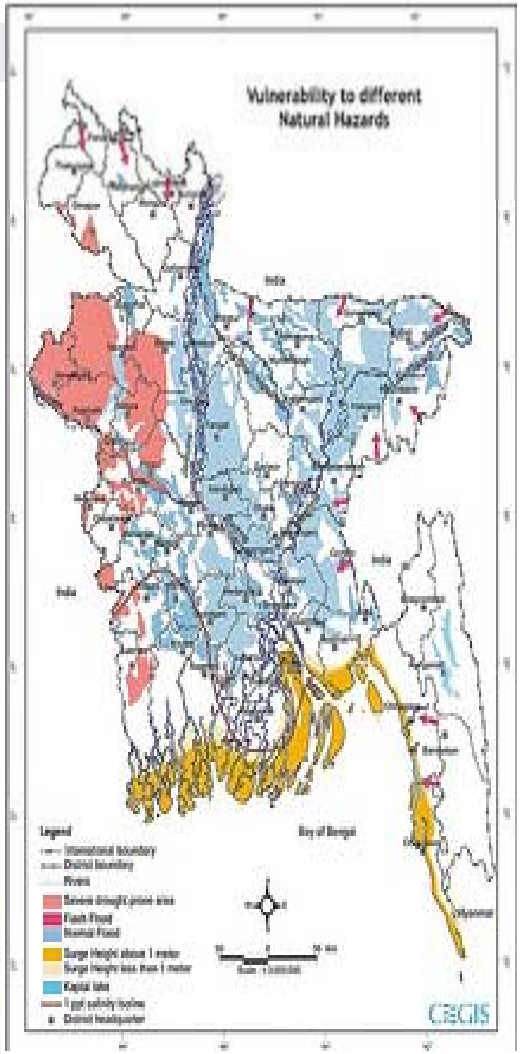
Bangladesh Coastal Boundary

- The whole coast runs parallel to the Bay of Bengal, forming 710 km long coastline comprising 19 districts out of 64 are in the coastal zone covering a total of 147 upazillas
- The coastal zone covers 47,201 square kilometer land area, which is 32 percent of total landmass of the country (Islam, 2004; p.xvii). Water area covers 370.4 km (200 nautical miles) from the coastline (UNCLOS, 1982; Article 57), estuaries and the internal river water.
- Total population living in the coastal zone is 35.1 million that represent 28 percent of total population of the country (BBS, 2003).



Bangladesh Case (Contd.)

- Major climate change impacts on Bangladesh include: sea level rise, land and shoreline erosion, natural disasters (flood, draught, cyclone, earthquake, tornado) and scarcity of food, salinity intrusion, river bank erosion so on.

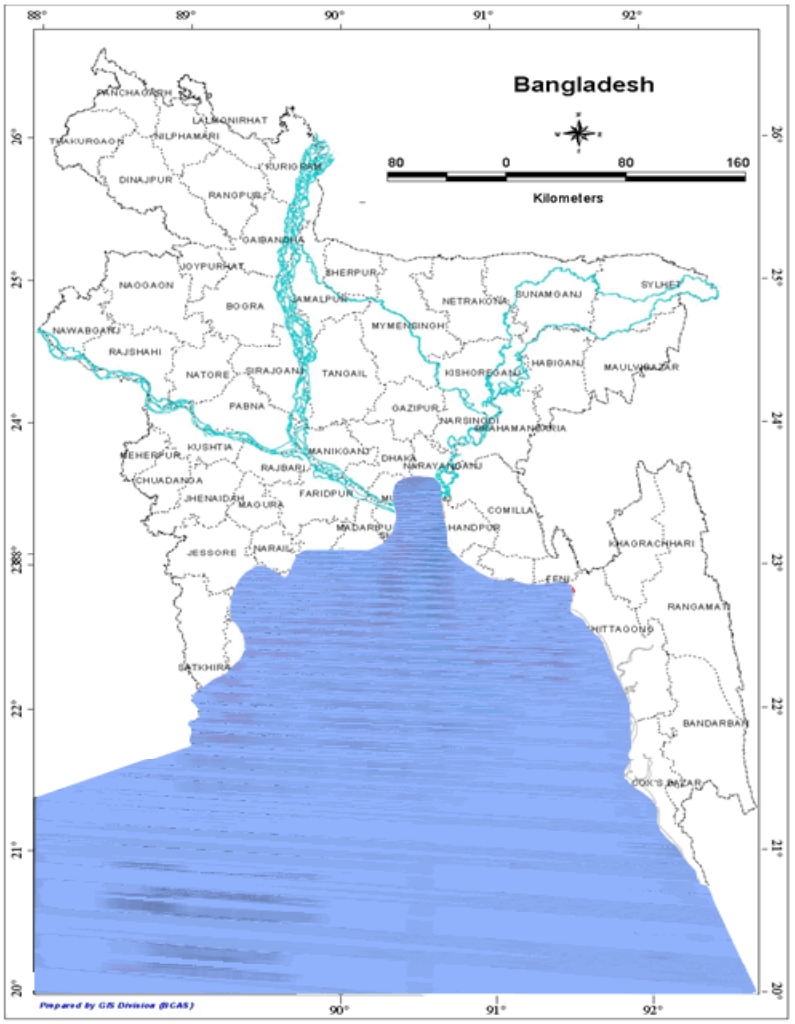


Impact of sea level rise on Bangladesh

- The coastal region covers almost 29,000 sq. km or about 20% of the country. Again, the coastal areas of Bangladesh cover more than 30% of the cultivable lands of the country. About 53% of the coastal areas are affected by salinity.
- The IPCC statistics shows that rising sea levels will wipe out more cultivable land in Bangladesh than anywhere in the world. By 2050, rice production is expected to drop 10 percent and wheat production by 30 percent.
- About 20 to 30 million people in Bangladesh alone could be on the move by 2050 because of climate change, causing the worst migration in human history.

Contd.


Potential impact of sea-level rise on Bangladesh
Today
Total population: 112 Million
Total land area: 134,000 km²
Dacca
1.5 m - Impact
Total population affected: 17 Million (15%)
Total land area affected: 22,000 km² (16%)
Dacca
GRID
Arendal
UNEP


Bangladesh
80 0 80 160
Kilometers
PANCHAGARH
LALMONIRHAT
NILPHAMARI
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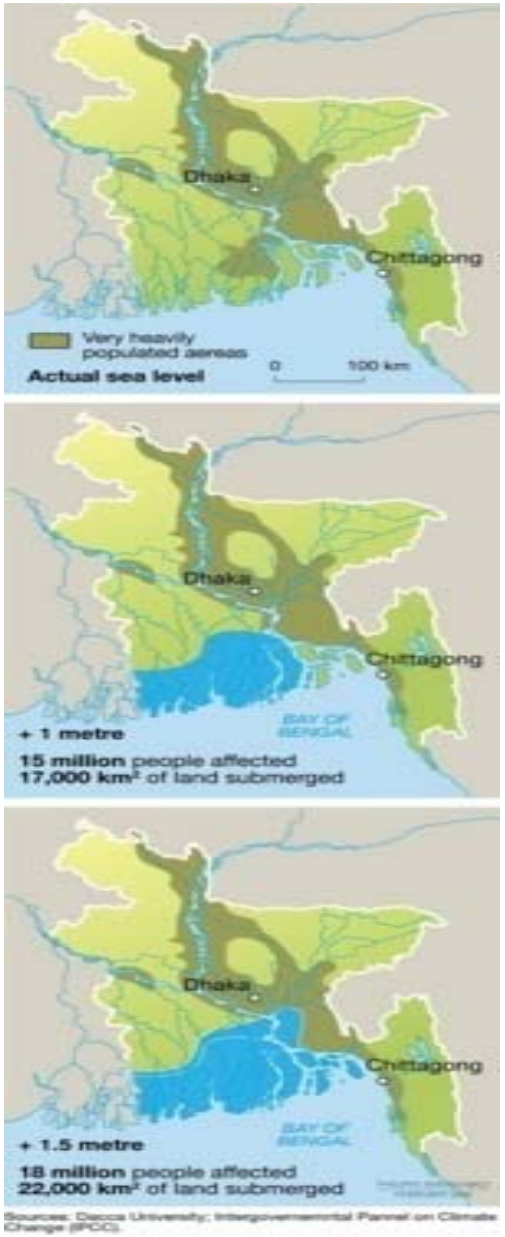
DINAJPUR
RANGPUR
GAIBANDHA
JOYPURHAT
BOGRA
NAOGAON
NAWABGANJ
RAJSHAHI
NATORE
SIRAJGANJ
PABNA
KUSHTIA
MEHERPUR
CHUADANGA
JHENAIDAH
MAGURA
JESSORE
NARAIL
SATKHIRA
BHERPUR
JAMALPUR
MYMENSINGH
TANGAIL
GAZIPUR
MANIKGANJ
DHAKA
RAJBARI
FARIDPUR
MADARIPUR
NETRAKONA
SUNAMGANJ
SYLHET
KISHOREGANJ
HABIGANJ
MAULVIBAZAR
NARSINGDI
COMILLA
CHANDPUR
KHAGRACHHARI
FENI
RANGAMATI
BANDARBAN
COX'S BAZAR
Prepared by GIS Division (BCAS)

- If sea levels were to rise by the predicted amount of 88 to 89 cm (2-3 ft) then the effect on Bangladesh would be disastrous. An 89cm increase in the sea level would eat up roughly one fifth (20%) of Bangladesh's landmass, displacing nearly 20 to 30 million people who will become environmental refugees (IPCC 2007)

(Source: UNEP, Vital Water Graphics, 2nd Edition, 2008)

- About 75% area of mangrove forest, Sundarban (60007 Sq. km) will submerse if the sea level will increase 45 cm.



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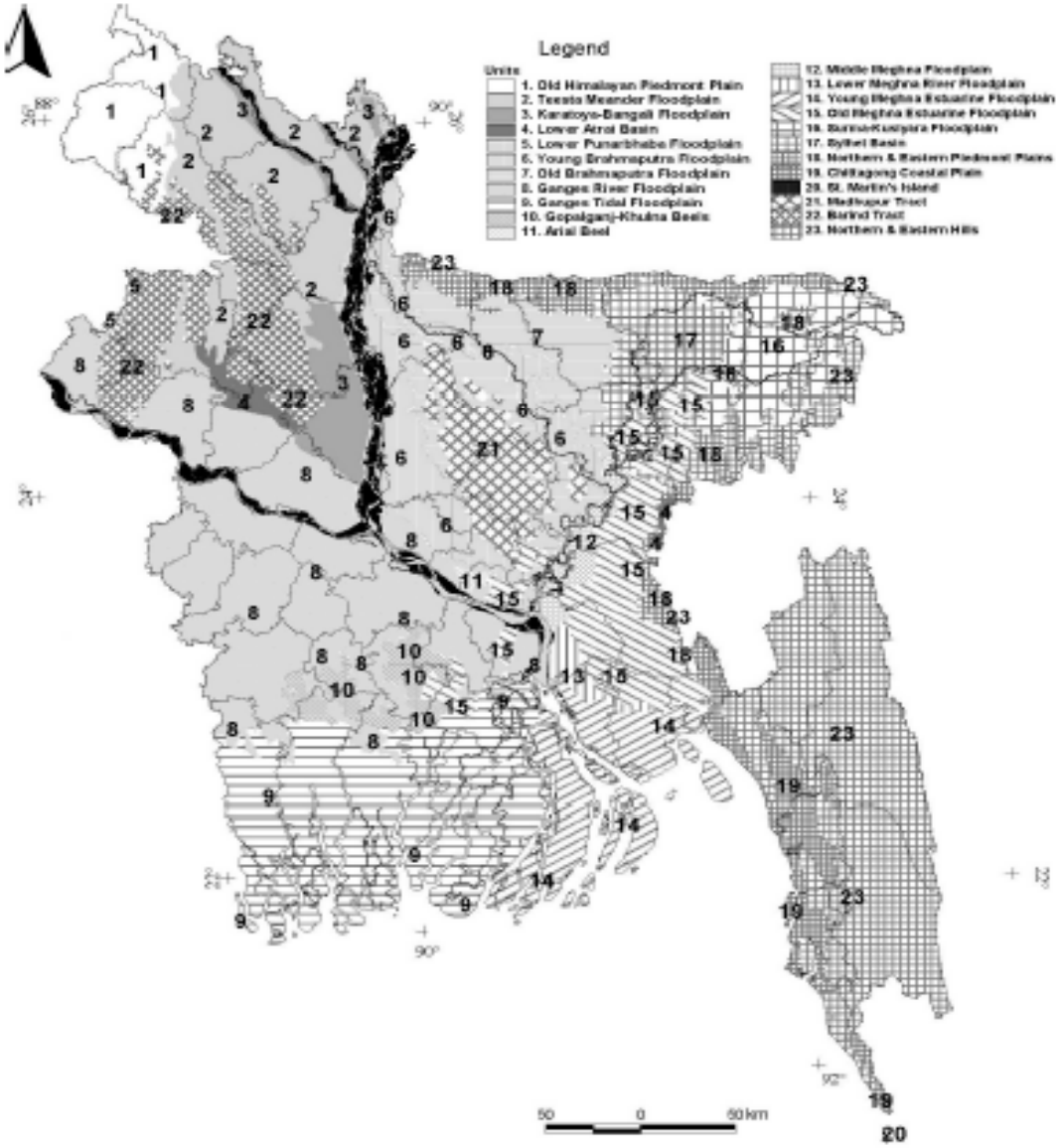
Year	2020	2050	2100
Sea level rise	10cm	25cm	1 m (high end estimate)
Land below SLR	2 % of land (2,500 km^2)	4 % of land (6,300 km^2)	17.5 % of land (25,000 km^2). Patuakhali, Khulna and Barisal regions will be most affected
Storm surge	-	1991 cyclone happens again with a 10 % increase in intensity, wind speed increases from 225 to 248 km/h; storm surge goes from 7.1 to 8.6 m with 0.3 m SLR.	Storm surge goes from 7.4 to 9.1 m with 1 m SLR.
Flooding	20% increase in inundation.	Increase flooding in Meghna and Ganges floodplain. Monsoonal floods increase yield loss.	Both inundation area and flood intensity will increase tremendously.
Agriculture	Inundate 0.2 Mmt. of production; < 1 % of current total.	0.3 m SLR inundate 0.5 Mmt. of production; 2% of current total.	Devastating flood may cause crop failure for any year.
Ecosystem	Inundates 15% of the Sundarbans	Inundates 40% of the Sundarbans.	The Sundarbans would be lost. Loss of the Sundarbans and other coastal wetlands would reduce breeding ground for many estuarine fish, which would reduce their population.
Salinity	Increase	Increase	Increase

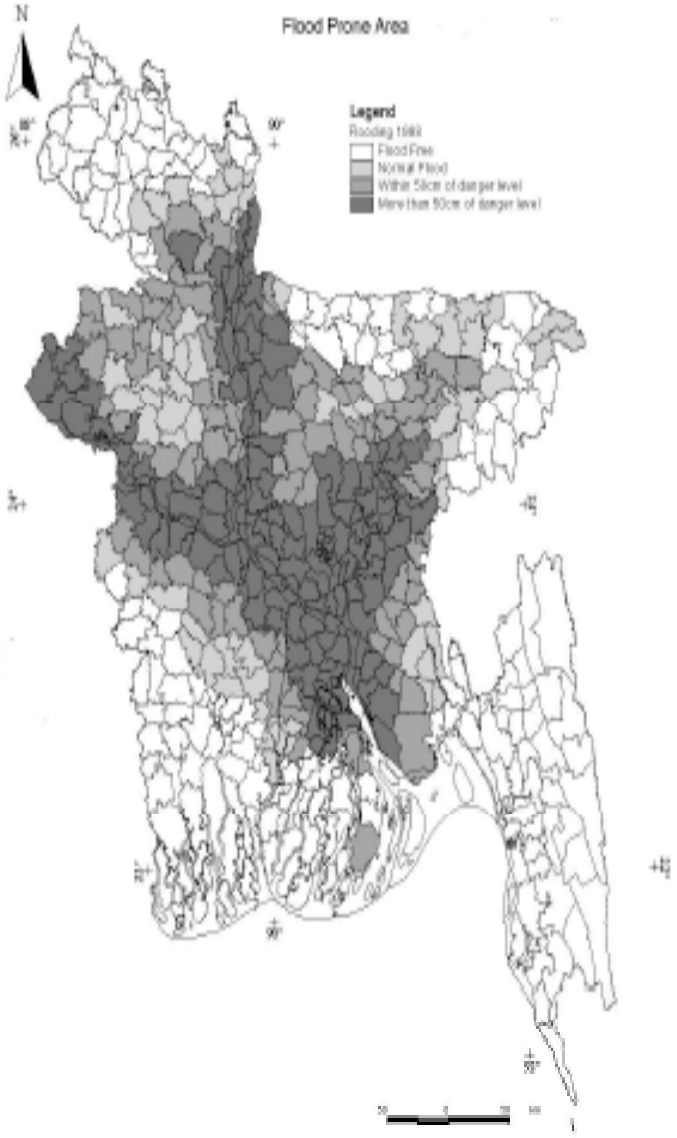
(Adapted from World Bank, 2000)

Coastal Erosion and Land Inundation

- Coastal areas of Bangladesh are formed of silty and sandy soils which make them vulnerable to sea level rise.
- Sandy and silty shores are easily eroded by sea level rise. It is supported by Vellinga (1988; cited in SDNP, 2004) stating that sea level rise of 1.0 metre will cause an erosion of a sandy shore in the order of 100-500 metre.
- Erosion rate due to sea level rise along the Bangladesh coast is even high.er

Coastal Flooding: Is Bangladesh Sinking?





Physiography of Bangladesh showing major floodplains

Areal coverage of the 1998 flood

Impacts of Major Floods in Bangladesh

Event	Impact
1954 floods	Affected 55% of country
1974 flood	Moderately severe, over 2,000 deaths, affected 58% of country, followed by famine with over 30,000 deaths
1984 flood	Inundated 52,520 sq-km, cost estimated at US$378 million
1987 floods	inundated over 50,000 sq-km, estimated damage US$ 1.0 billion, 2055 deaths
1988 floods	Inundated 61% of country, estimated damage US$ 1.2 billion, more than 45 million homeless, between 2,000-6,500 deaths
1998 floods	1,100 deaths, inundated nearly 100,000 sq-km, rendered 30 million people homeless, damaged 500,000 homes, heavy loss to infrastructure, estimated damage US$ 2.8 billion
2004 floods	Inundation 38%, damage US$ 6.6 billion, deaths 700, affected people nearly 3.8 million

Salinity Affected Areas in the Coastal and Offshore Regions of Bangladesh

- The main impacts of sea level rise on water resources are fresh water availability reduction by salinity intrusion. Both water and soil salinity along the coast will be increased with the rise in sea level, destroying normal characteristics of coastal soil and water.
- A water salinity map for the period of 1967 and 1997 produced by Soil Resources Development Institute (SRDI, 1998) shows that the problem is already on the way.

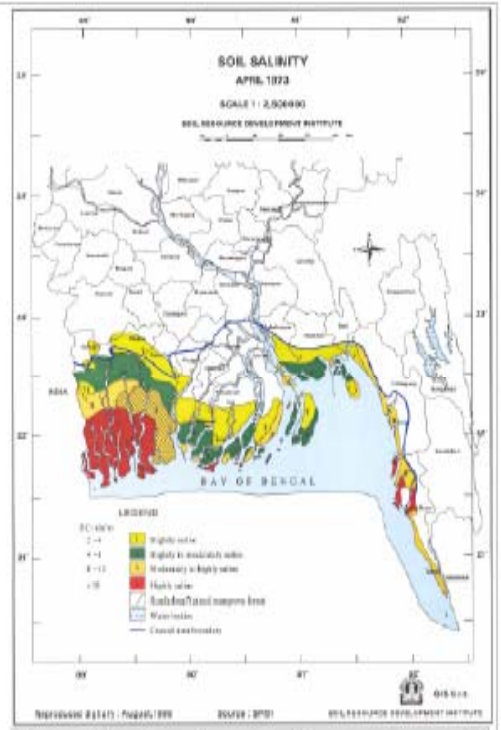


Figure-7:
Soil salinity map
of Bangladesh
of the year 1973
(Source: SRDI, 1998b)

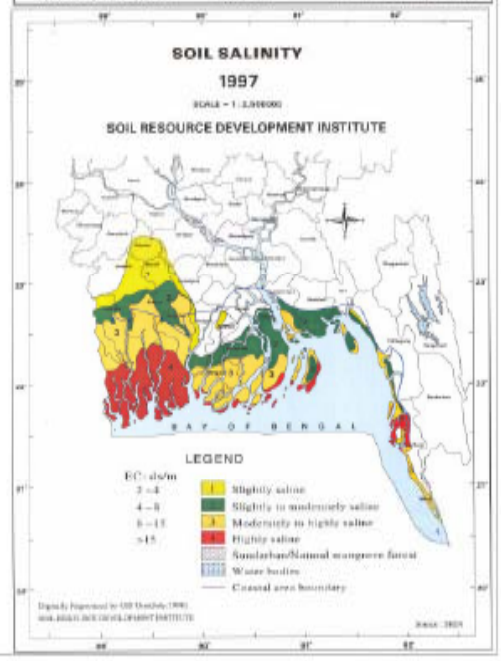


Figure-8:
Soil salinity map
of Bangladesh
of the year 1997
(Source: SRDI, 1998c)

Salinity (contd.)

Description	Total cultivated area(ha)	Saline Area(ha)
Non-saline with very slightly saline	4,25,490	1,15,370 (27%)
Very slightly saline with slightly saline	4,20,420	3,09,190 (73%)
Slightly saline with moderately saline	2,57,270	2,40,220 (93%)
Moderately saline with strongly saline	1,98,890	1,98,890 (100%)

Source:http://www.pakbs.org/pjbot/PDFs/38(5)/PJB38(5)1359.pdf

Human Exposure and Tracks of Cyclones in Bangladesh

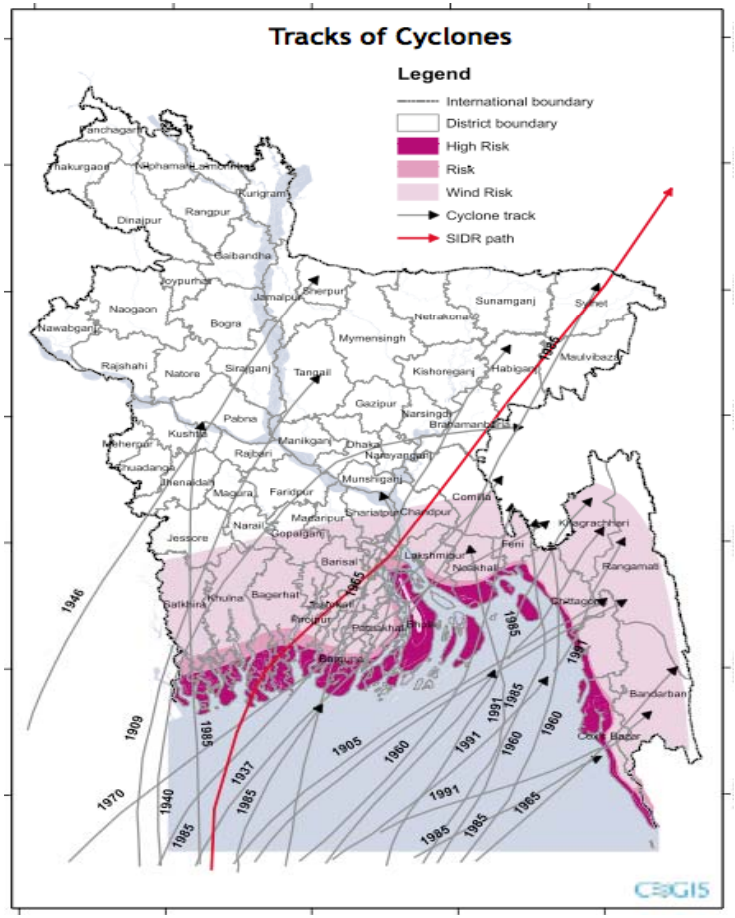
Human Exposure

Modelled number of people present in hazard zones that are thereby subject to potential losses.

Absolute human exposure

	Average people exposed per year	Country
1	22,548,120	Japan
2	16,267,090	Philippines
3	9,933,174	China
4	7,607,821	India
5	6,507,695	Taiwan, prov. of China
6	4,641,060	Bangladesh
7	3,573,351	United States of America
8	2,083,071	Korea (Rep. of)
9	1,885,541	Madagascar
10	872,234	Viet Nam
11	867,976	Myanmar
12	629,325	Mexico
13	602,264	Dominican Republic
14	488,556	Cuba
15	423,511	Hong Kong

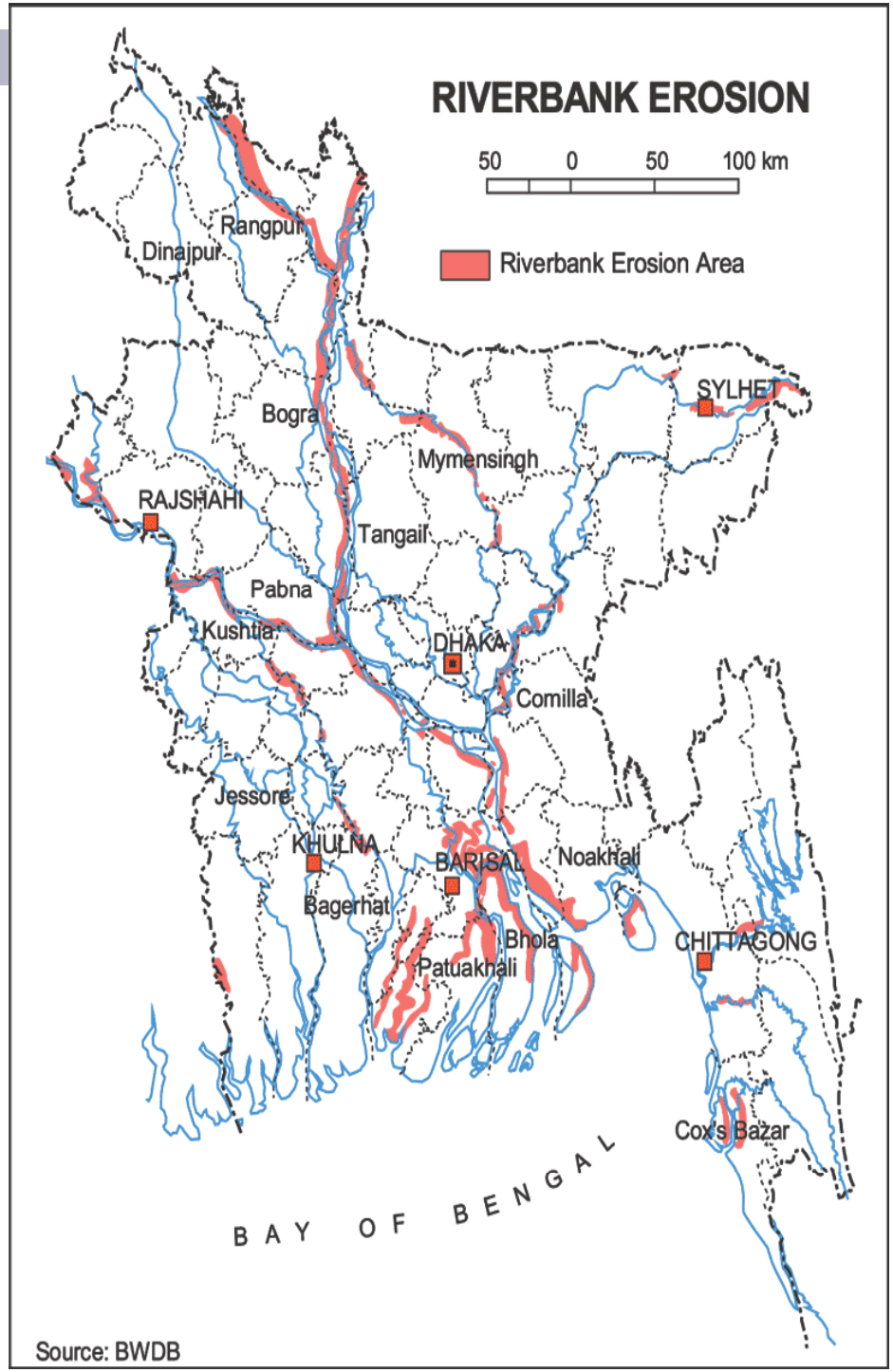
Legend:
Tropical Cyclones (Saffir-Simpson categories)
Cat1 Cat2 Cat3 Cat4 Cat5



Source:
http://www.preventionweb.net/english/hazards/statistics/risk.php?hid=58

River Bank Erosion

- Sea level rise will increase morphological activities in the river, inducing increased river flow. Accelerated river flow will increase river bank erosion too (Alam 2003, p.13).
- Bank erosion is severe in char areas and sometimes it may wipe out chars from the map of Bangladesh.
- About 196 square kilometers of char area was eroded and a total of 11 chars were disappeared from Meghna river estuary area during the period of 1972-1987 (Pramanik, 1988; Cited in SDNP, 2004).



Impact on Agriculture and Food Security

- Sea level rise, and salinity intrusion decrease agricultural production by unavailability of fresh water and soil degradation. (Rashid et al., 2004; Ashraf et al., 2002).
- For example Loss of rice production in a coastal village of Satkhira district rice production in 2003 was 1,151 metric tons less than the year 1985, corresponding to a loss of 69 per cent. Ali (2005)

	Year	**1985**	**1990**	**1995**	**2003**
Area & months under rice and shrimp farming in ha (% crop land)	HYV Aman July - Nov.	345.5 (100)	344.6 (100)	332.4 (97.0)	314 (91.9)
	HYV Boro Dec. - May	200.4 (58)	269.6 (78.2)	122.4 (32.8)	58.2 (17)
	One shrimp cycle Dec. – Jan.	36.5 (10.6)	75.0 (21.8)	210.0 (67.2)	255.8 (91.0)
	Two shrimp cycle Dec. – Nov.	0	0	20.6 (3.0)	55.0 (8.0)
Expected total rice production		1373	1689	1679	1673
Observed total rice production		1265	1260	745	522
Decline in rice production due to loss of	Area	108	221	670	890
	Yield	-	208	264	261
Total loss of rice production		**108**	**429**	**934**	**1151**

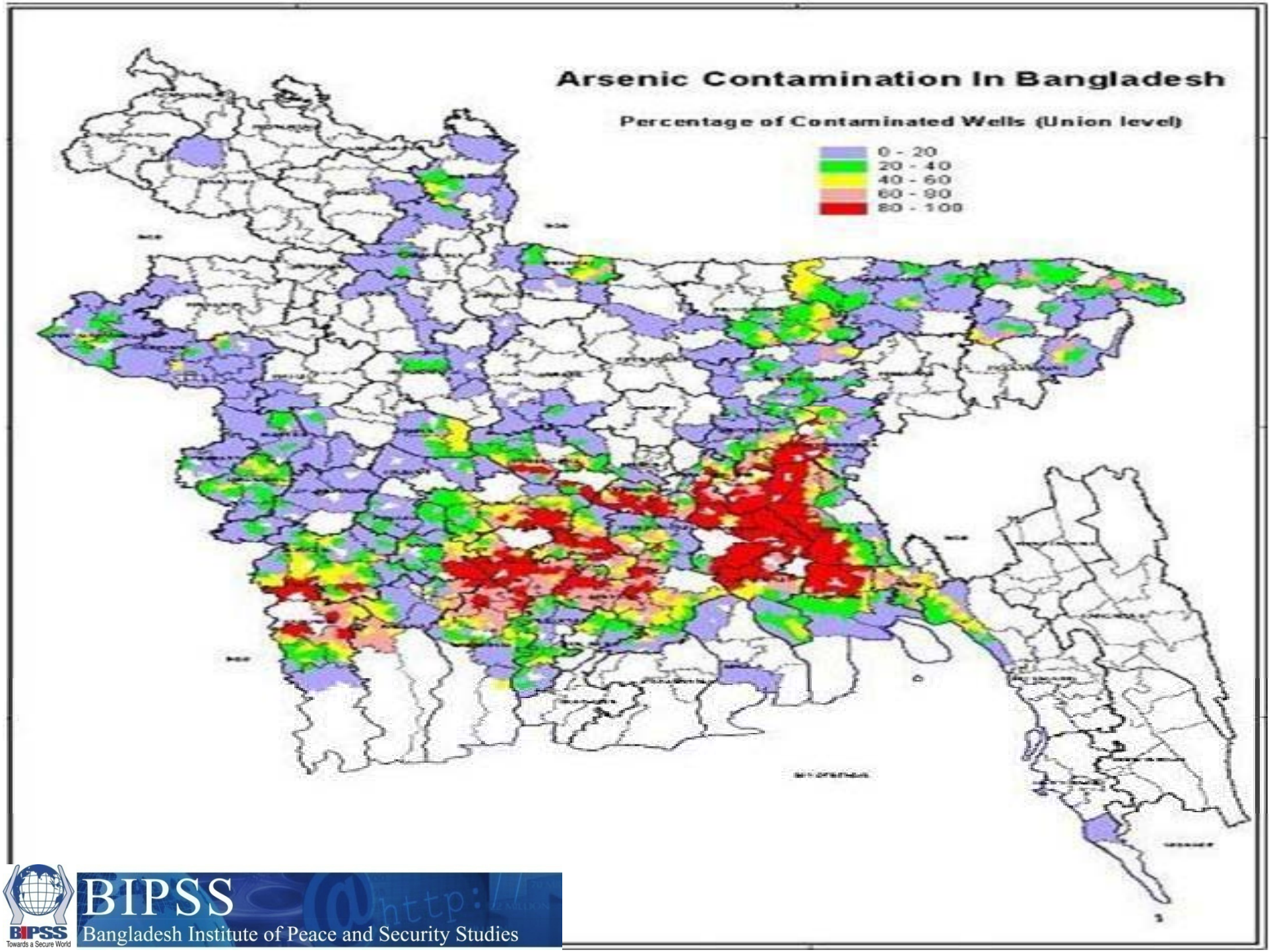
(Adapted from Ali, 2005)

Water Borne Diseases in Coastal Bangladesh

- Almost one in five people in Bangladesh still lack improved water resources making them susceptible to water borne diseases like Anaemia, Arsenicosis, Cholera, Diarrhoea, Hepatitis, Malaria, schistosomes, Typhoid and so on.
- With the increased density and distribution of salinity, cholera germs are getting favorable habitat and spreading in the coastal area.
- Most major epidemics that have occurred during the last 50 years originated in coastal region.

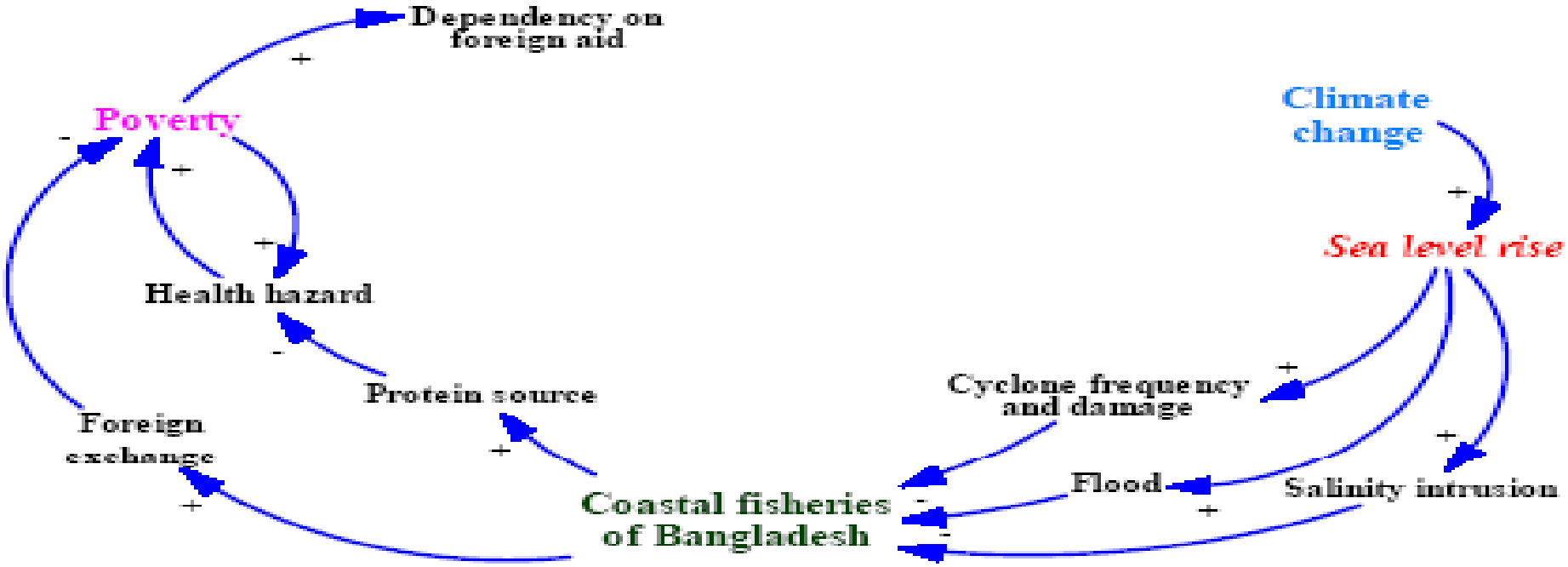
Arsenic Poisoning

- World Health Organization described the arsenic contamination in Bangladesh as “the largest mass poisoning of a population in history”.
- Half of Bangladeshis, up to 77 million people, have been exposed to the toxic arsenic (according to British Medical Journal “The Lancet”)



Impact on Marine Fisheries

- Sea level rise would change the location of the river estuary, causing a great change in fish habitat and breeding ground.
- Coastal fisheries are affected by sea level rise in three ways; by salinity, by flooding and by increasing cyclone frequency and damage.



Figure–9: Causal Loop Diagram of sea level rise impacts on coastal fisheries sector

Coastal Human Displacement and Migration

- The forecasted land erosion will cause displacement of coastal population. Most of the poor people do not own land.
- According to several authors, between 64, 000 and 1 million Bangladeshis are rendered homeless every year due to riverbank erosion alone (Haque and Zaman 1994; Lein 2000; Siddiqui 2005).
- Myers (2002) argues that climate refugees from Bangladesh alone might outnumber all current refugees worldwide. He projected that 26 million refugees will come from Bangladesh.

Impact on Tourism

- Out of 18 tourist areas identified by Bangladesh Parjatan Corporation (BPC), five spots namely Chittagong, Cox's Bazar, Kuakata, Khulna and the Sundarbans are located in the coastal zone (Bangladeshonline, 2005).
- A study of Bangladesh Parjatan Corporation suggests that 19 per cent of foreigners visiting Bangladesh are tourists
- Sea level rise, by affecting this promising sector will affect the national economy and heritage of Bangladesh.

Conflict Consequences of Climate Change

- Conflict over scarce resources
- Radicalization and terrorism
- Intra and inter state conflict
- State collapse
- Regional destabilization

Conflict over Resources

- Climate change will affect already scarce resource that has the potential to be a contributing factor to conflict and instability.
- The 1994 genocide in Rwanda was furthered by violence over agricultural resources.
- The 1974 Nigerian coup that resulted largely from an insufficient response to famine.
- Situation in Darfur, Sudan, which had land resources at its root and which is increasingly spilling over into neighboring Chad.
- In the late 1990s conflict took place over timber resources in Liberia.

(Source: CNA Report, 2009)

Radicalisation and Terrorism

- Radicalisation and terrorism may increase in many developing societies particularly in South Asia due to the climate induced social and economic deprivation.
- When a government can no longer deliver services to its people, conditions are ripe for the extremists and terrorists to fill the vacuum.
- The Rohingyas of Myanmar is a very relevant example of how marginalized people get involved in radicalisation and subsequently to terrorism.

Inter-state Conflict

- Rising tension
- Localised war
- Inter-state conflict/war

"For centuries, wars have been fought for territorial expansion, ideological or religious dominance, and national pride. In the future, as climate change progresses and its effects become more pronounced, conflicts between states over natural resources could increasingly take centre-stage."

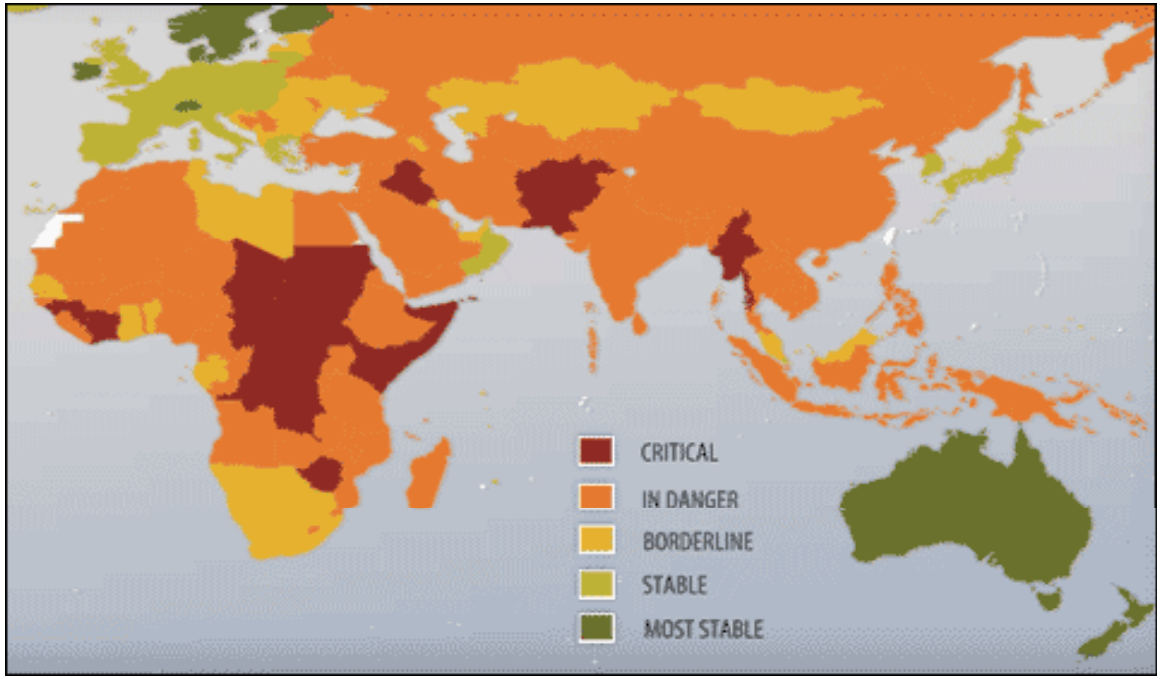
Byers & Dragojlovic, Human Security Bulletin, October 2004

Intra-state Conflict

- Ethnic conflict
- Civil strife
- Terrorism
- Social Fragmentation

State Collapse

- Vulnerable state
- Weak state
- Fragile state
- Failed state
- Non-state

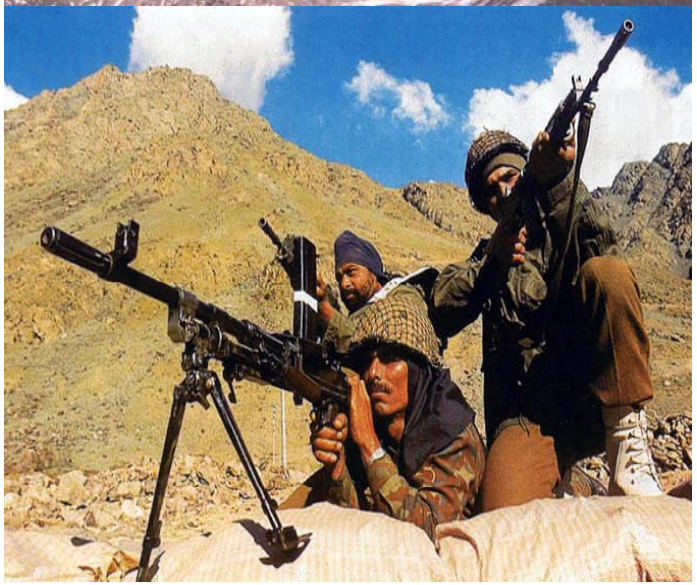


"*When climate change significantly or environmental conditions deteriorate to the point that necessary resources are not available, societies can become stressed sometimes to the point of collapse*"

CNA Report on the National Security and the Threat of Climate Change

Regional Destabilisation

- Climate change acts as a threat multiplier for instability in some of the most volatile regions including South Asia.
- Projected climate change will seriously exacerbate already marginal living standards in many Asian, African, and Middle Eastern nations, causing widespread political instability and the likelihood of failed state.



Role of Climate Diplomacy

- Interlocked by common geography and geology
- Common vulnerabilities.
- Natural disasters do not respect national boundaries.
- All major flood have their origin and consequence beyond one single country.
- Earthquake in the Himalayas are likely to affect more than one country.
- Countries have interest in collective pollution control, disaster management and cooperation.
- Forecasting and identifying major future risks and insecurities through wide scale negotiation and exchanges
- Wider dialogue among all the stakeholders in the region and beyond the region

Measures to take

- Capacity building of the states, military and the coastal community.
- Knowledge, information, technology and expertise sharing and exchange.
- National/ Regional policy framework.
- Public Awareness.
- Political will and co-operation.
- Strengthening the Role of international organization.
- Legal regimes.

Questions and Comments

Thank You

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