Discourse on the environmental impact- Do mangroves/coral reefs matter? Why do mangroves Matter to the coastal Community in India

National convention on Who Owns India's Coastline?
Building Science Movements for Coastal Areas

Organised by
All India Peoples Science Network Partnership

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MSSRF
Science for Sustainable Development

Coastal Area

- Coastal areas are diverse and highly productive
- Comprises 20% of the earth's surface; nearly 40 % of the human population living within 60 km of the sea
- Geomorphology includes coastal plains, wetlands, sea cliffs, rocky shorelines and reefs.
- The coastal area is comprised of forests, **mangroves**, salt marshes, Tropical Dry Evergreen forests, coral reefs, lakes, rivers, estuaries, sand dunes and beaches
- Exposed to hazards such cyclones, associated waves and storm surges, tsunamis, river flooding, shoreline erosion, and the influx of biohazards such as algal blooms and pollutants

What are mangroves?

"Mangroves are a group of plants that grow in the intertidal area along the coast in most tropical and sub-tropical countries predominantly where river water mixes with seawater.

Where mangrove grows?

- Intertidal areas with less wave energy
- Substratum is composed of muddy or accumulated deposits of sediments
- Salinity of the water undergo constant variations due to freshwater flow

Mangroves wetland

Freshwater

- Mangrove plants are halophytes – saline tolerant
- Few species can grow in very high saline conditions

  Avicennia marina 90 grams per litre – seawater salinity 35g/l
- Rich diversity in low saline areas
- Luxuriant mangroves can be seen only in areas where the salinity is moderate 10 to 20g/l. – High Rain Fall areas
- Brackish water environment – such environment can be created only by mixing of seawater with freshwater flow

Tidal amplitude

- Tides are nothing but temporary rise and fall of seawater
- Happens due to gravitational pull of moon and sun
- Due to local condition and other factors in some are tidal amplitude – difference between high and low tide – is high

  Example: Sunderbans and Gujarat - 6m

  In some areas low

  Example: Tamil Nadu and Andhra Pradesh

Soil

- Mangrove plant survive in all kinds of soil – sandy, clayey
- Thrive both in deep and shallow sediments
- Luxuriant mangroves only clayey soil
- Sand mixed with clay is also a good soil

Adaptations

- Stilt Roots
- Pneumatophores
- Salt Excretory Glands
- Salt Excluding Roots
- Vivipary - seeds

Adaptation in leaves

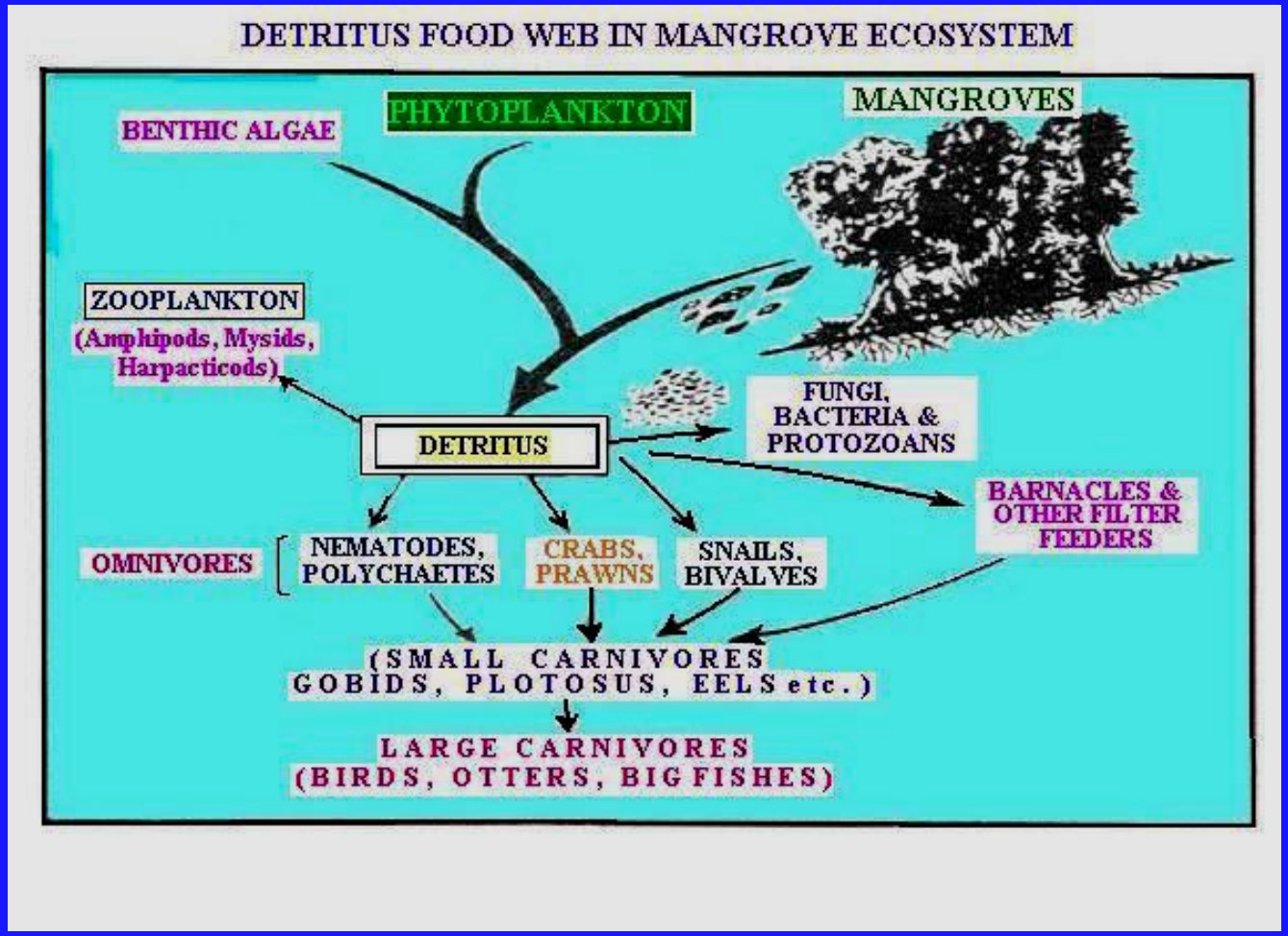
- Salt glands
- Leathery leaves
- Hairy surfaces
- Wax coating
- Thick leaves

Root/shoot Modifications

- Firm support to mangroves
- Facilitate O2 transport to below ground roots
- Intangible – Shelter for juveniles from predation
- Withstands wind and water velocity

Ecosystem services - Mangroves

REGULATING	PROVISIONING
▪ Protection of beaches and coastlines from storm surges and waves ▪ Reduction of beach and soil erosion ▪ Stabilization of land by trapping sediments ▪ Water quality maintenance ▪ Climate regulation	▪ Subsistence and commercial fisheries ▪ Aquaculture ▪ Honey ▪ Fuel wood ▪ Building materials ▪ Traditional medicines
CULTURAL	**SUPPORTING**
▪ Tourism and recreation ▪ Spiritual – sacred sites	▪ Cycling of nutrients ▪ Nursery habitats


DETRITUS FOOD WEB IN MANGROVE ECOSYSTEM
BENTHIC ALGAE
PHYTOPLANKTON
MANGROVES
ZOOPLANKTON
(Amphipods, Mysids, Harpacticods)
DETRITUS
FUNGI, BACTERIA & PROTOZOANS
BARNACLES & OTHER FILTER FEEDERS
OMNIVORES
NEMATODES, POLYCHAETES
CRABS, PRAWNS
SNAILS, BIVALVES
(SMALL CARNIVORES GOBIDS, PLOTOSUS, EELS etc.)
LARGE CARNIVORES (BIRDS, OTTERS, BIG FISHES)

USES OF MANGROVES

Thaching and Basket weaving*: Myriostachya*
Floats: Pneumatophores and Roots
Paper Industry: *Excoecaria agallocha, Avicennia marina*
Tannins: *Ceriops decandra*
Food: *Suaeda and B. gymnorrhiza*
Fibres: *Hibiscus tiliaceus, Thespesia populnea* and *Pandanus* spp.
Honey : *Aegiceras corniculatum*
Fodder: *Porteresia, Avicennia*
Charcoal: *Rhizophora*
Firewood:
Eco Tourism: National and International

No	Name of the species	Medicinal uses
1	*Acanthus illicifolius*	diabetes, diuretic, dyspepsia, hepatitis, leprosy, paralysis, ringworms
2	*Aegiceras corniculatum*	asthma, diabetes, rheumatism
3	*Avicennia alba*	antifertililty, skin diseases, tumors, ulcers
4	*Avicennia marina*	rheumatism, small pox, ulcers
5	*Avicennia officinalis*	aphrodisiac, diuretic, hepatitis
6	*Bruguiera cylindrica*	hepatitis,
7	*Bruguiera gymnorhiza*	eye diseases,
8	*Ceriops decandra*	hepatitis, ulcers,
9	*Derris trifoliata*	laxative
10	*Excoecaria agallocha*	epilepsy, conjunctivitis, dermatitis, leprosy, purgative, toothache
11	*Lumnitzera racemosa*	antifertility, asthma, diabetes, snake bite
12	*Rhizophora apiculata*	antiemetic, antiseptic, diarrhoea, haemostatic, (B), hepatitis, stops bleeding, typhoid
13	*Rhizophora mucronata*	elephantiasis, febrifuge, hepatitis, ulcers
14	*Sonneratia apetella*	hepatitis

Indirect Benefits

- Natural spawning ground for fish and crustaceans, especially for shrimps and prawns.
- Protection and conservation of wildlife habitats of a rare nature, control and regulation of the food chains.
- Contribution to mud flat formation and control of erosion .
- Capability to check inland salinity intrusion.
- Enhanced capability to combat the impact of cyclone and tidal surge.

Indian Mangroves – Economic evaluation

Mangrove Ecosystem contributes to 1.86 tonnes of annual marine fish catch in India which is 23% of India's total catch, roughly translating to Rs 68 billion.

Coastal protection and carbon sequestration are Rs 754 billion and Rs 1.65 billion respectively.

Distribution and area of mangroves

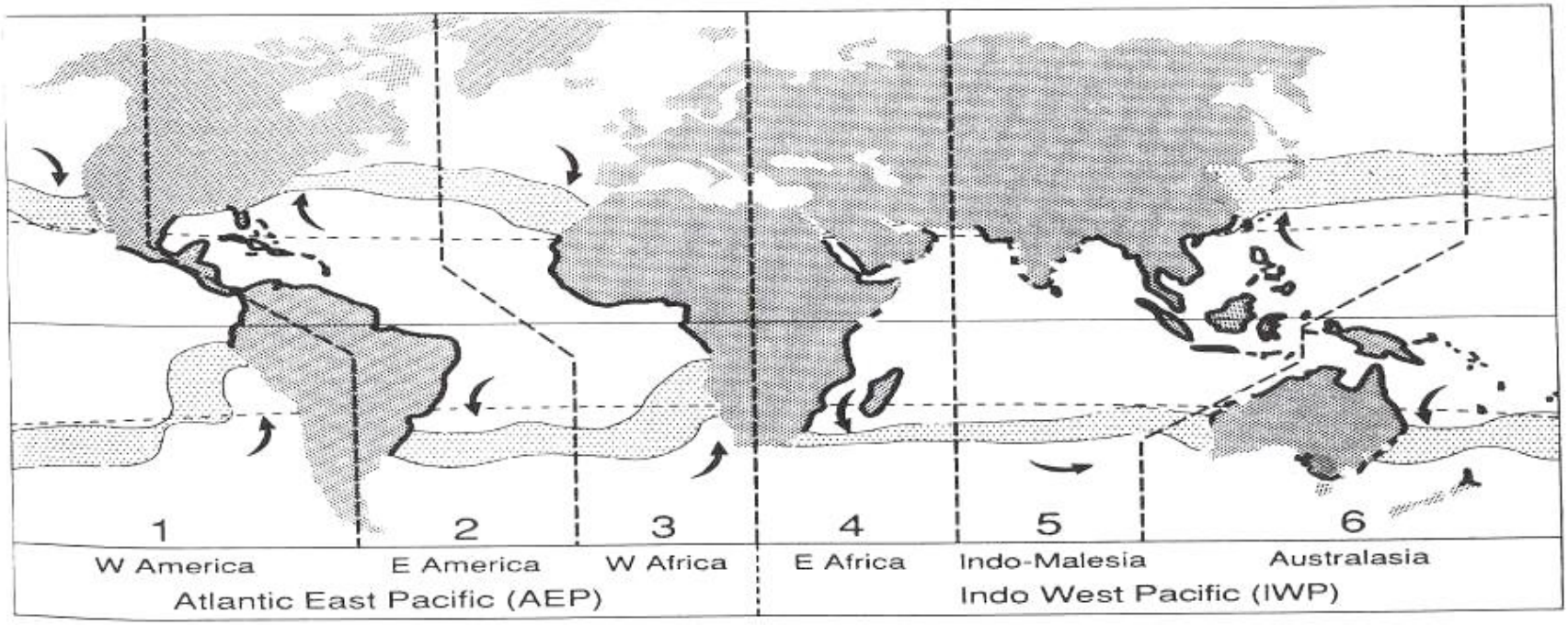
Mangrove ecosystems are estimated to cover 181,000 km^2 worldwide.

Indonesia, Brazil, Australia and Nigeria have 43% of the world's mangroves and each has between 25% and 60% of the mangroves in their respective regions.

Indian Mangroves – 3%

Global Distribution of Mangroves (FAO, 2007)

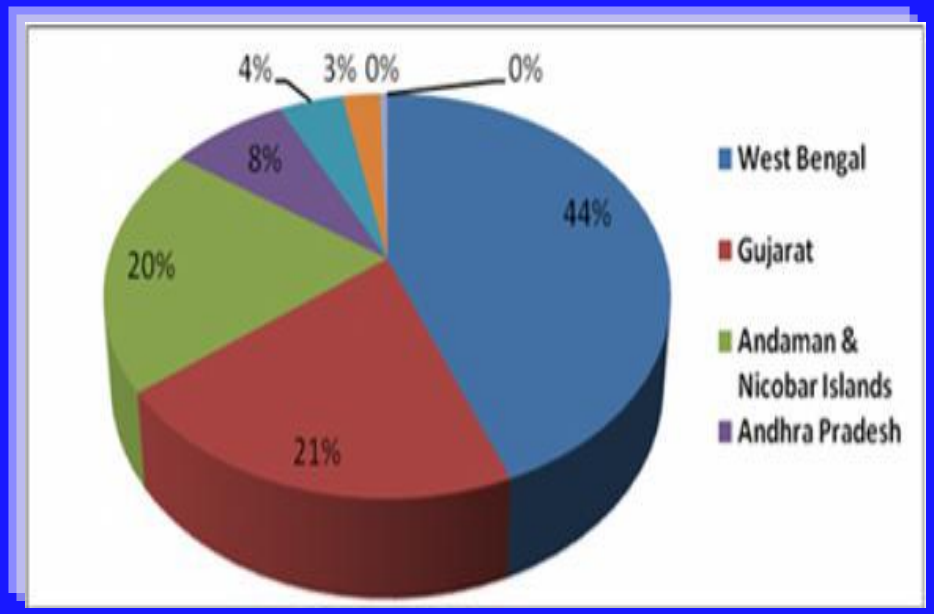
- Total area 18 million hectares
- 124 countries
- Between 30° South & 30° North (high around equator)
- Most extensive in Asia
- Indonesia, Australia, Brazil, Nigeria and Mexico (48% of total area)
- India is the 9th 1argest country



Classification of Mangrove

- Mangroves to be broadly divided into two main areas, (1) the Indo-Pacific region and (2) western Africa and American regions.
- Indo Pacific region is about five times more diverse with 58 species compared to 12.
- The five basic requirements for extensive mangrove development are: (1) tropical temperature, (2) fine grained alluvium, (3) low wave and tidal action, (4) salt water and (5) large tidal range.

Distribution of Mangroves in India



Mangrove cover assessment in 2017 (sq km)

Sl.No.	States/UTs	Very Dense Mangrove	Moderately Dense Mangrove	Open Mangrove	Total Mangrove	Change with respect to ISFR 2013
1.	Andhra Pradesh	0	129	238	367	15
2.	Goa	0	20	6	26	4
3.	Gujarat	0	174	933	1,107	4
4.	Karnataka	0	3	0	3	0
5.	Kerala	0	5	4	9	3
6.	Maharashtra	0	79	143	222	36
7.	Odisha	82	95	54	231	18
8.	Tamil Nadu	1	18	28	47	8
9.	West Bengal	990	700	416	2,106	9
10.	A&N Islands	399	168	50	617	13
11.	Daman & Diu	0	0	3	3	1
12.	Puducherry	0	0	2	2	1
	Total	1,472	1,391	1,877	4,740	112

Mangrove cover increased by 112 sq km between 2013-2015

Indian mangroves: significant habitat for wild life

Globally threatened

- Royal bengal tiger
- Sea turtles
- Fishing cat
- Estuarine crocodile
- Gangetic dolphin
- River terrapin
- Whale shark

- Sea otters
- Water monitor lizard
- Wild boar
- Horse shoe crabs
- Snakes
- Spotted deer
- Mangrove monkey
- Birds (Brown winged, Collard)

DESTRUCTION OF MANGROVE ECOSYSTEM

- Anthropological activities like

  a) House construction

  b) Salt pan construction

  c) Coastal aquaculture/ agriculture

  d) Port construction

  e) Power plants construction

  f) Other Industries

  g) Uncontrolled discharge of industrial, agricultural, domestic and aquaculture farm effluents into the mangrove ecosystem

  h) Surrounding villagers depend to a greater extent on mangroves for

  1. Timber for house construction 2. Wood for fuel

  3. Barks for tannin extraction 4. Foliage for cattle

- Natural calamities like cyclones, climate change and erosion


Fire wood collection
15/09/2005


Fencing with mangroves

Grazing/Fodder

Major Players

•Community – Aquaculture; Agriculture; Salt Pans;

•Government – SEZs; Green Air port; Ports;
•Land Ownership – Private; Forest; Revenue

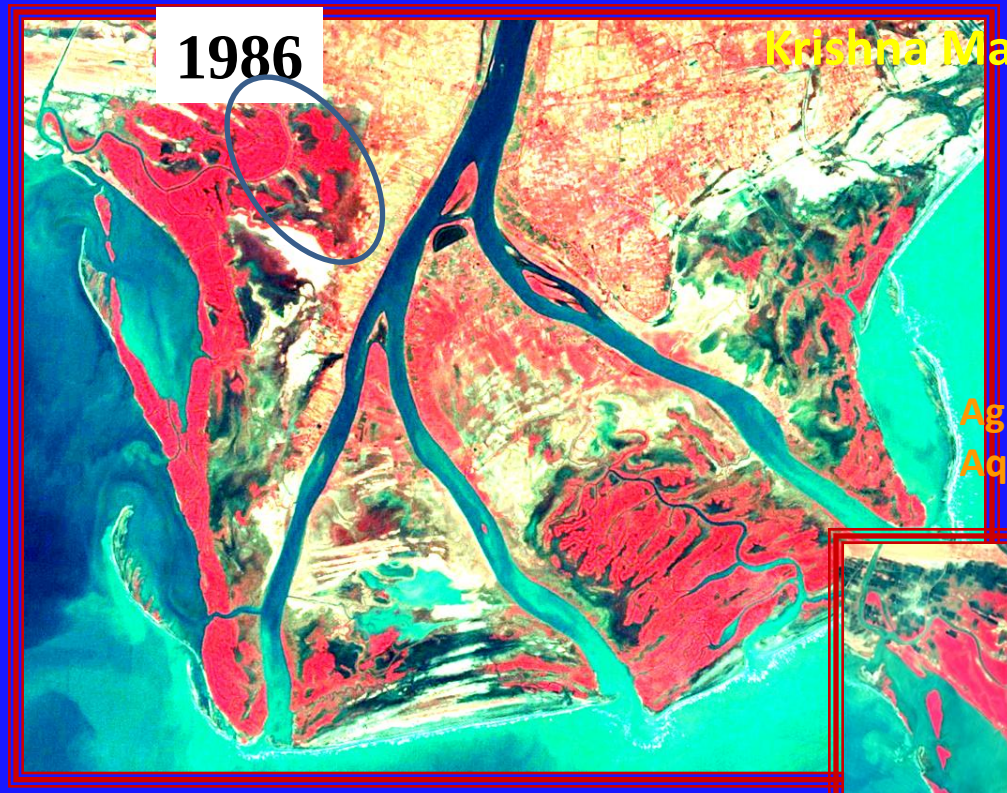
•Industries – Oil refineries; Fertilizer; Power Plants

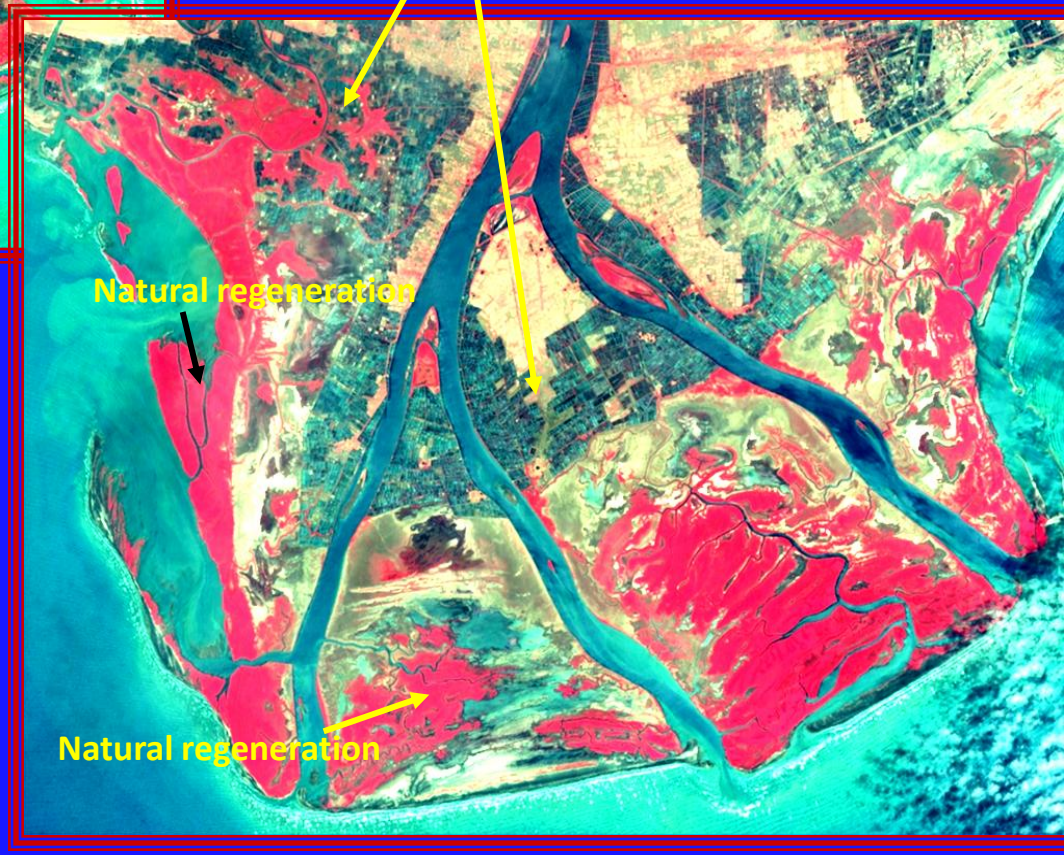
Change in Landuse – Who does?

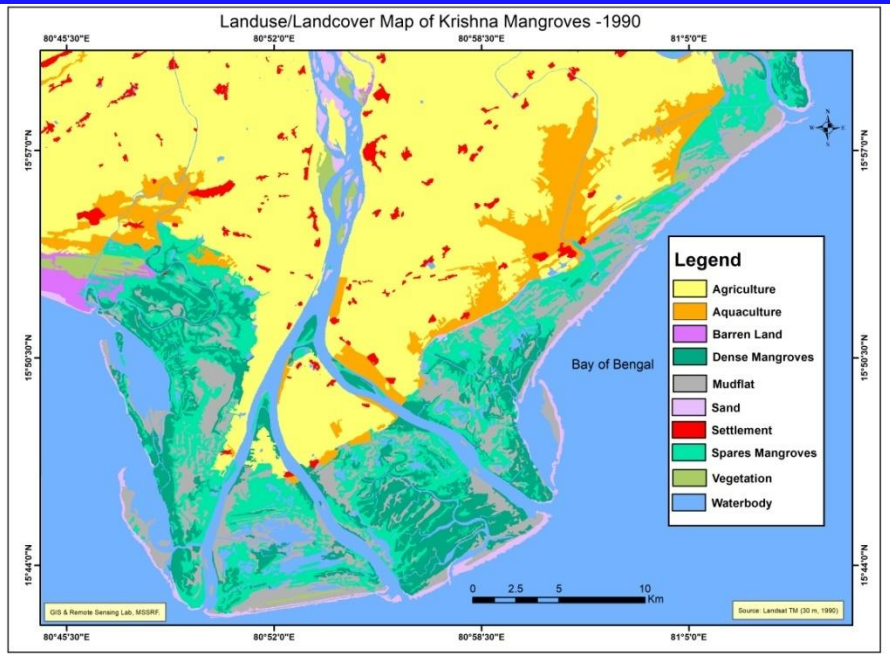
Godavari Mangroves – Aquaculture

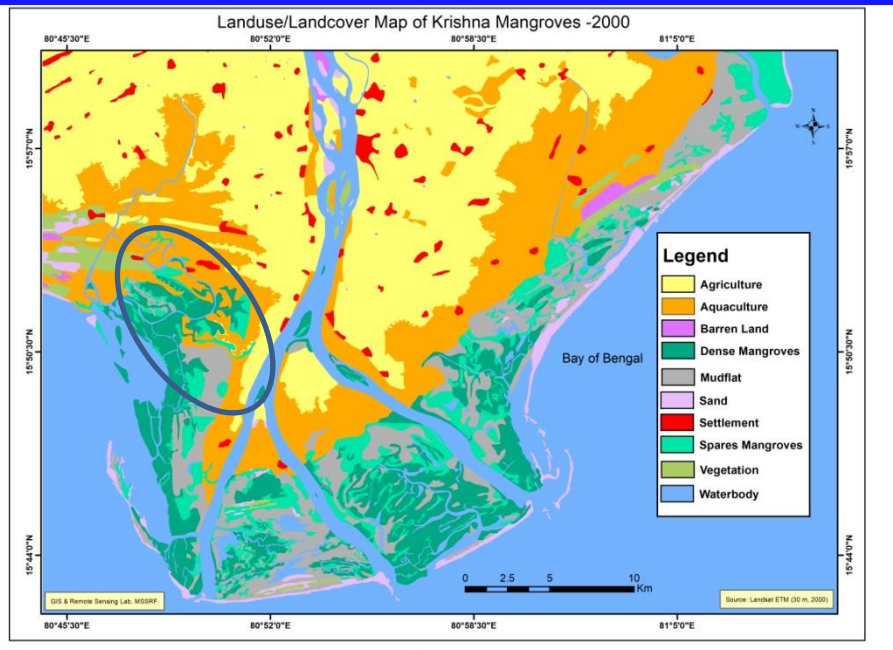
Extent : 33,263. 32 ha.

Krishna Mangroves Aquaculture






Landuse/Landcover Map of Krishna Mangroves -1990
80°45'30"E
80°52'0"E
80°58'30"E
81°5'0"E
15°57'0"N
15°50'30"N
15°44'0"N
Bay of Bengal
Legend
Agriculture
Aquaculture
Barren Land
Dense Mangroves
Mudflat
Sand
Settlement
Spares Mangroves
Vegetation
Waterbody
0 2.5 5 10
Km
GIS & Remote Sensing Lab, MSSRF
Source: Landsat TM (30 m, 1990)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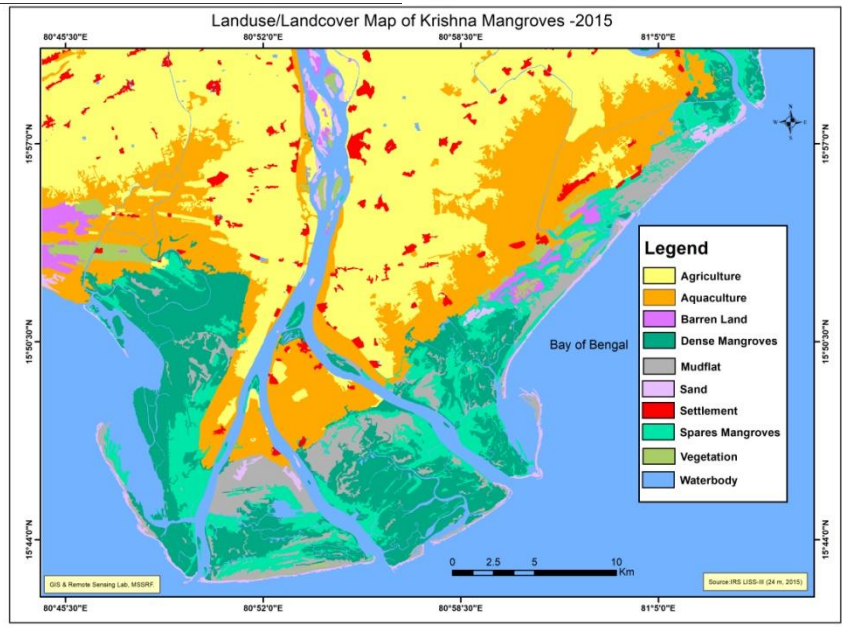
0 2.5 5 10
Km
GIS & Remote Sensing Lab, MSSRF
Source: Landsat ETM (30 m, 2000)


Landuse/Landcover Map of Krishna Mangroves -2015
80°45'30"E
80°52'0"E
80°58'30"E
81°5'0"E
15°57'0"N
15°50'30"N
15°44'0"N
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Waterbody
0 2.5 5 10
Km
GIS & Remote Sensing Lab, MSSRF
Source:IRS LISS-III (24 m, 2015)

Changes in wetland Between 1986 and 2008

Restoration of degraded mangroves

Developed a science based, community centred and process oriented Joint Mangrove Management Model through which 3,000 ha of degraded mangroves were restored along the East coast.

The MoEF&CC accepted this model and included in the National Mangrove Action plan. This resulted in large scale replication of JMM in all the coastal states. The extent of mangrove forest cover has increased by about 87,500 ha between 1987 and 2017 (FSI, 2017).

Degraded area for Mangrove Plantation

Planting of saplings

Godavari Mangroves

Krishna Mangroves

1990

2018

Impacts of Climate Change on mangrove ecosystem

Temperature

Reduction in Photosynthesis in elevated temperature (no photosynthesis above 40^0 C (McLeod, 2006)

Enhanced evapo-transpiration

Increase in salinity levels; Loss of fresh water species leading to loss of diversity)

Increase in the intensity of cyclones

Shoot Dieback disease: Pichavaram and Muthupet mangroves lost large areas recently

Erosion of mangrove areas

Rhizophora apiculata dieback at Pichavaram mangroves Tamil Nadu Jan-2017

Dieback of mangrove forests in the Gulf of Carpentaria northern Australia

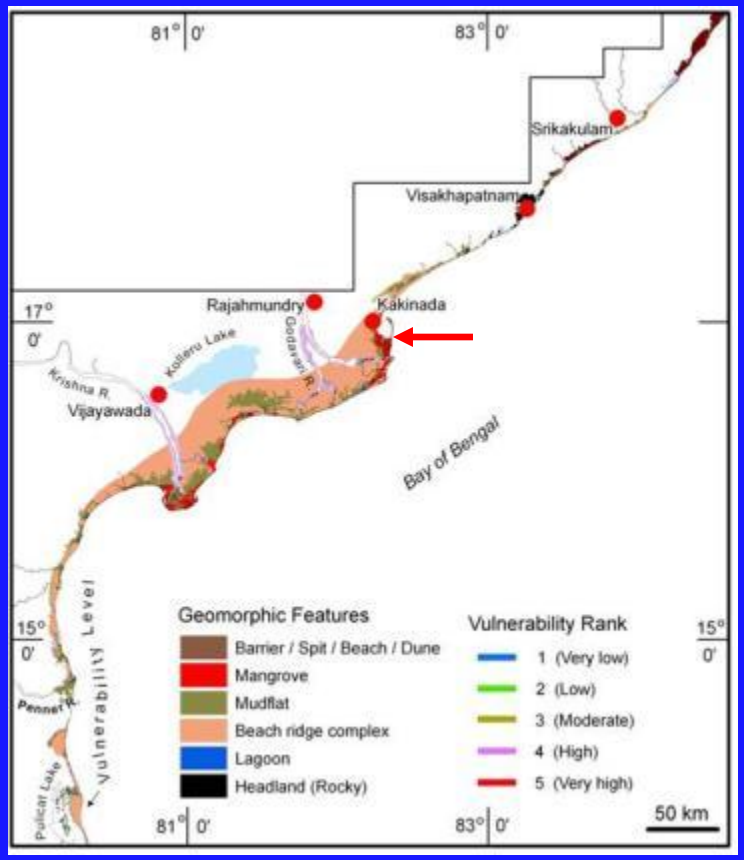
Between late 2015 and early 2016, extensive areas of mangrove were lost (7400 ha); A combination of extreme temperatures, drought and lowered sea levels likely caused this dieback

Impacts of Climate Change on mangrove ecosystem

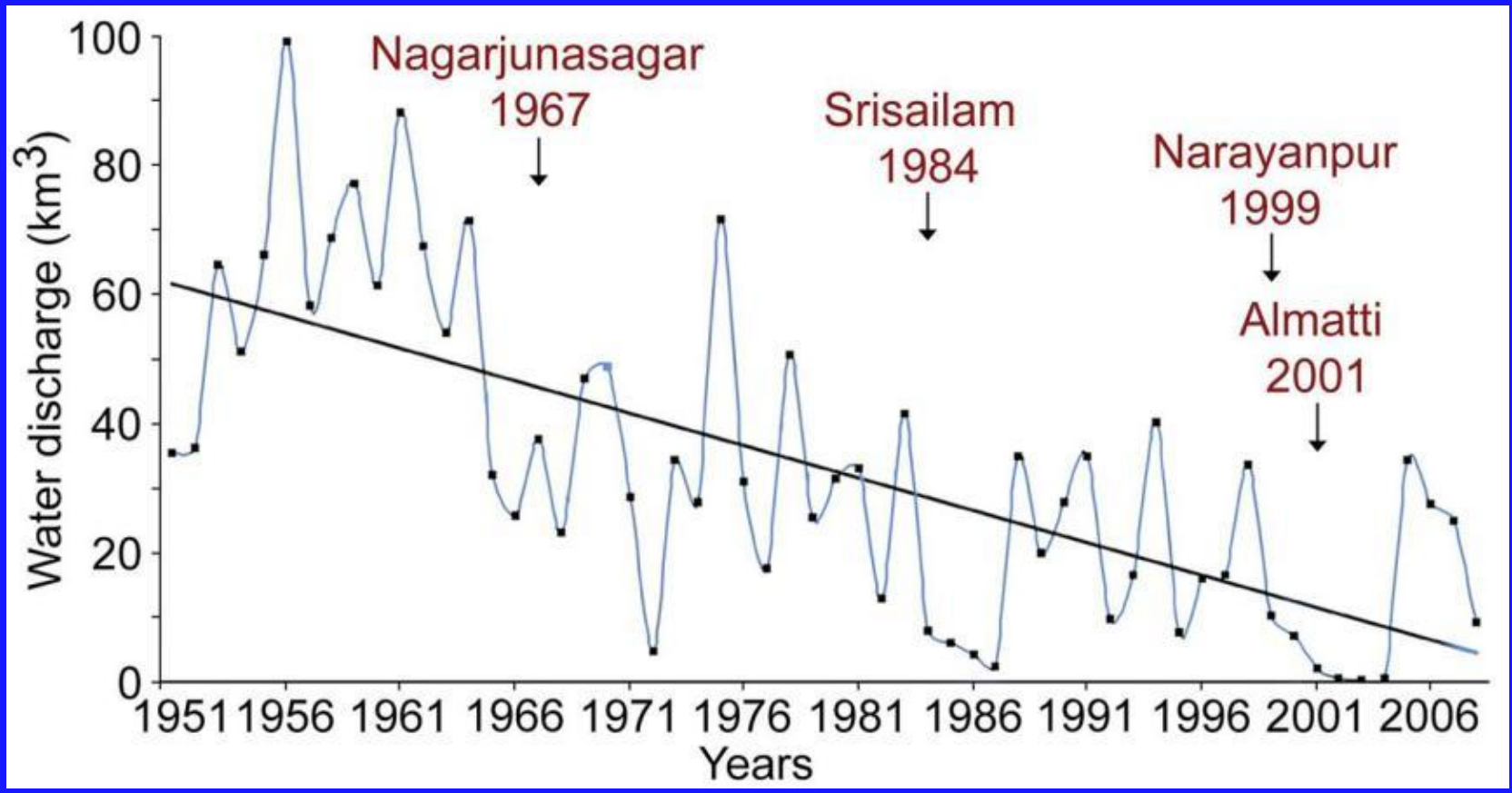
Sea level rise

- Permanent Inundation (change in the amplitude and flooding), lead to loss of mangroves and shift in species composition
- Acceleration in coastal erosion and mangroves (Suparibhanga and Lohachara Island in Sunderbans)
- Mangroves have the ability to trap and retain inorganic sediments (Root structure) that lead to increase in surface elevation provided sediment supply (vertical accretion rate may be between 0.7 and 20.8 mm/yr -site-specific)
- Tend to migrate to other ecosystems like salt marshes (Possibility of expanding towards landward side and some elevated areas)

Erosion - Mangroves

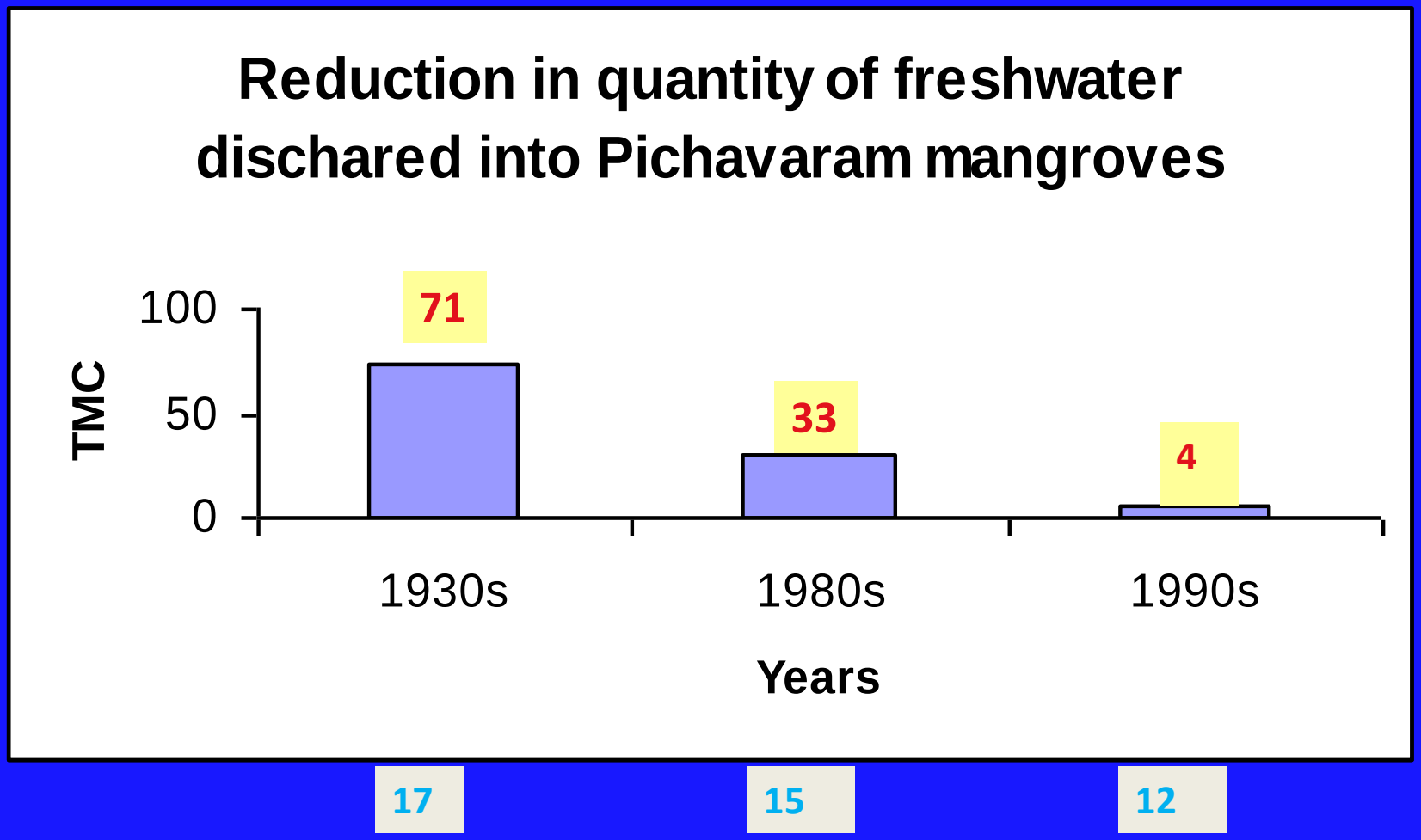


Annual Water discharges recorded at Vijayawada barrage (at the apex of the Krishna Delta)



Data source: CWC

Reduction in freshwater flow causes reduction species diversity and freshwater flow – Pichavaram mangroves



Impacts of Climate Change on mangrove ecosystem

Cyclones

Cyclones have impacts on mangroves particularly in the East coast

Super cyclone in Odisha -

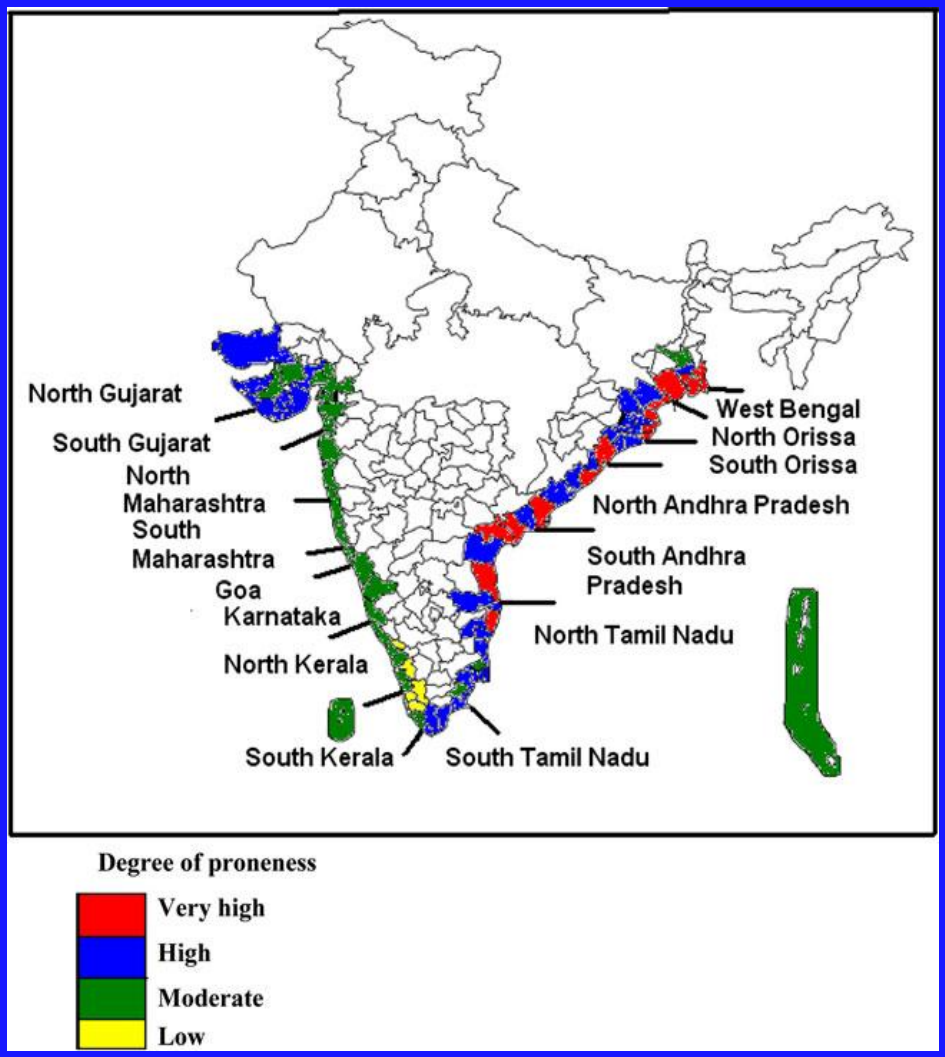
1977 cyclone in Krishna mangroves – changes in the topography

Cyclone Nargis destroyed 38,000 hectares (ha) of natural and replanted mangroves

Recent Gaza in Muthupet (more than 70% mangroves were lost

The 13 Deadliest Tropical Cyclones for the World

Rank	Name / Areas of Largest Loss	Year	Ocean	Deaths
1.	Great Bhola Cyclone, Bangladesh	1970	Bay of Bengal	550,000
2.	Hooghly River Cyclone, India	1737	Bay of Bengal	350,000
3.	Haiphong Typhoon, Vietnam	1881	West Pacific	300,000
4.	Backerganj Cyclone, Bangladesh	1584	Bay of Bengal	200,000
5.	Great Backerganj Cyclone, Bangladesh	1876	Bay of Bengal	200,000
6.	Bangladesh	1897	Bay of Bengal	175,000
7.	Super Typhoon Nina, China	1975	West Pacific	171,000
8.	Cyclone 02B, Bangladesh	1991	Bay of Bengal	140,000
9.	Great Bombay Cyclone, India	1882	Arabian Sea	100,000
10.	Hakata Bay Typhoon, Japan	1281	West Pacific	65,000
11.	Calcutta, India	1864	Bay of Bengal	60,000
12.	Bangladesh	1822	Bay of Bengal	50,000
13.	Bengal Cyclone, Calcutta, India	1942	Bay of Bengal	40,000

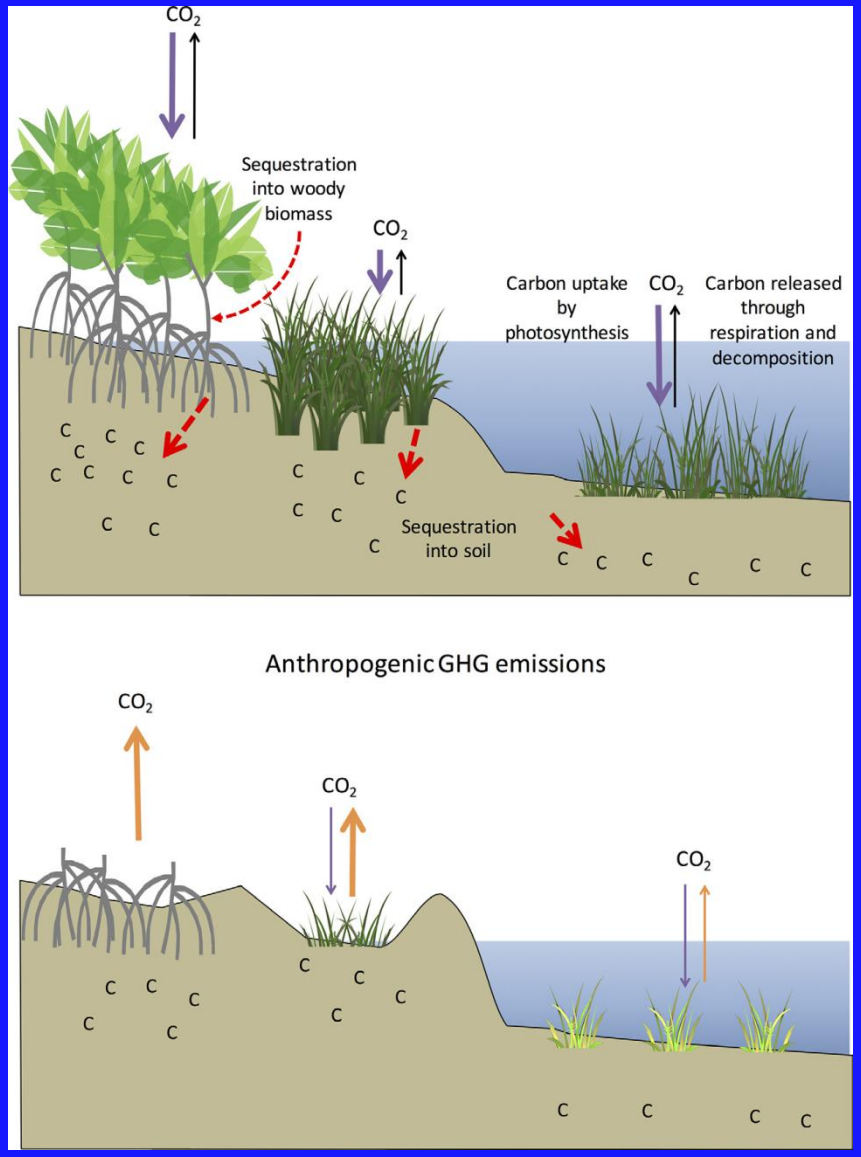


Cyclone hazard prone districts (based on past cyclones) Source: Article *in Natural Hazards · September 2012* DOI: 10.1007/s11069-011-9891-8

Before Gaja Cyclone Sep 2018 - Muthupet

After Gaja Cyclone Dec 2018

Coastal Ecosystems as Potential Carbon Sequesters)

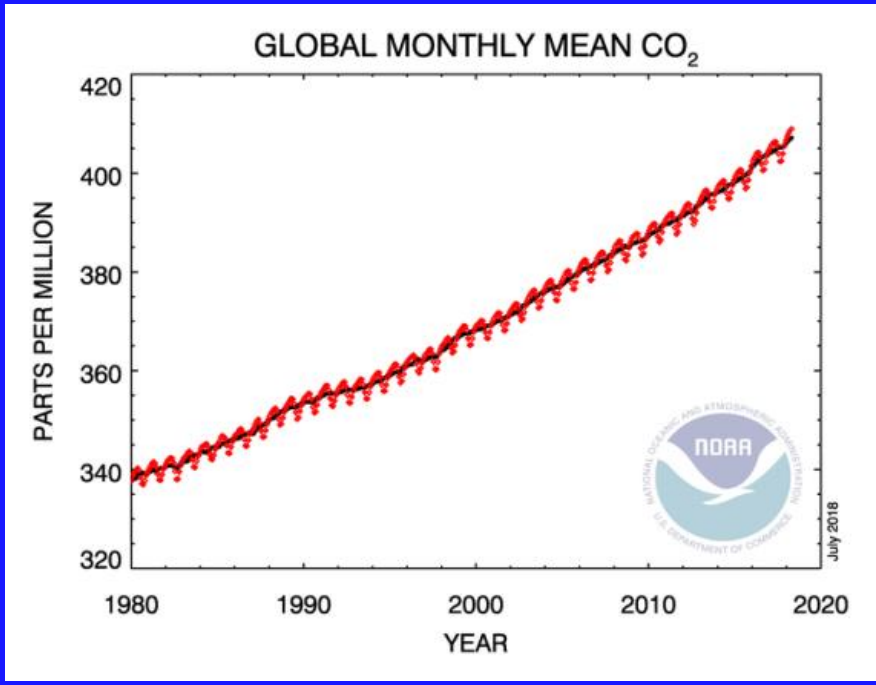


Coastal blue carbon ecosystems (mangroves, tidal marshes, and sea grasses)

Mangrove Blue Carbon Sequestration

The rate of CO_2 increase is ~ 2 ppm/ year

Current understanding of the global carbon cycle suggests that increase in green cover will substantially decrease the amount of CO_2



The high rate of primary production, high underground biomass and permanent storage of organic carbon in the sediments Indicates mangroves are sink of atmospheric CO_2

Mangroves sinks about carbon =218 ± 72 Tg C yr-1 globally.

Researchers estimated that mangrove forests alone capture and store as much as 34 million metric tons of carbon annually, which is roughly equivalent to the carbon emitted by 26 million passenger cars in a year.

Credit: Howard et al., 2017, Frontiers in Ecology and the Environment

MANAGEMENT OPTIONS

- Regulation of all activities detrimental to the mangrove ecosystem

1. urgent need to assess the present status of mangroves – FD, RD, Private

   Resources – the socio economic conditions
   Pollutants - impact on of mangroves; Polluter pays; Compensation

2. Enforcing Acts; regulations to protect mangroves and other coastal wetlands

3. Co-ordination among the various departments – So many actors

4. Improving / restoring the habitat