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RESILIENT STRATEGIES FOR AQUACULTURE AND FISHEREIS TO FACETHE EXTREME WEATHER SHOCKS




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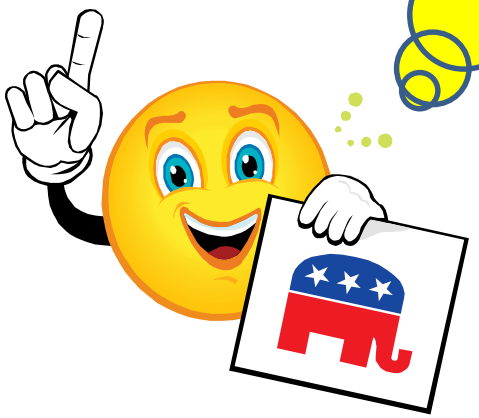
Outline of presentation

- ❖Climate shifts leading to weather shocks
- ❖Impacts on fisheries and aquaculture
- ❖Some adaptation and resilient strategies
- ❖Future that beckons on us

Do we have a weather shocks?



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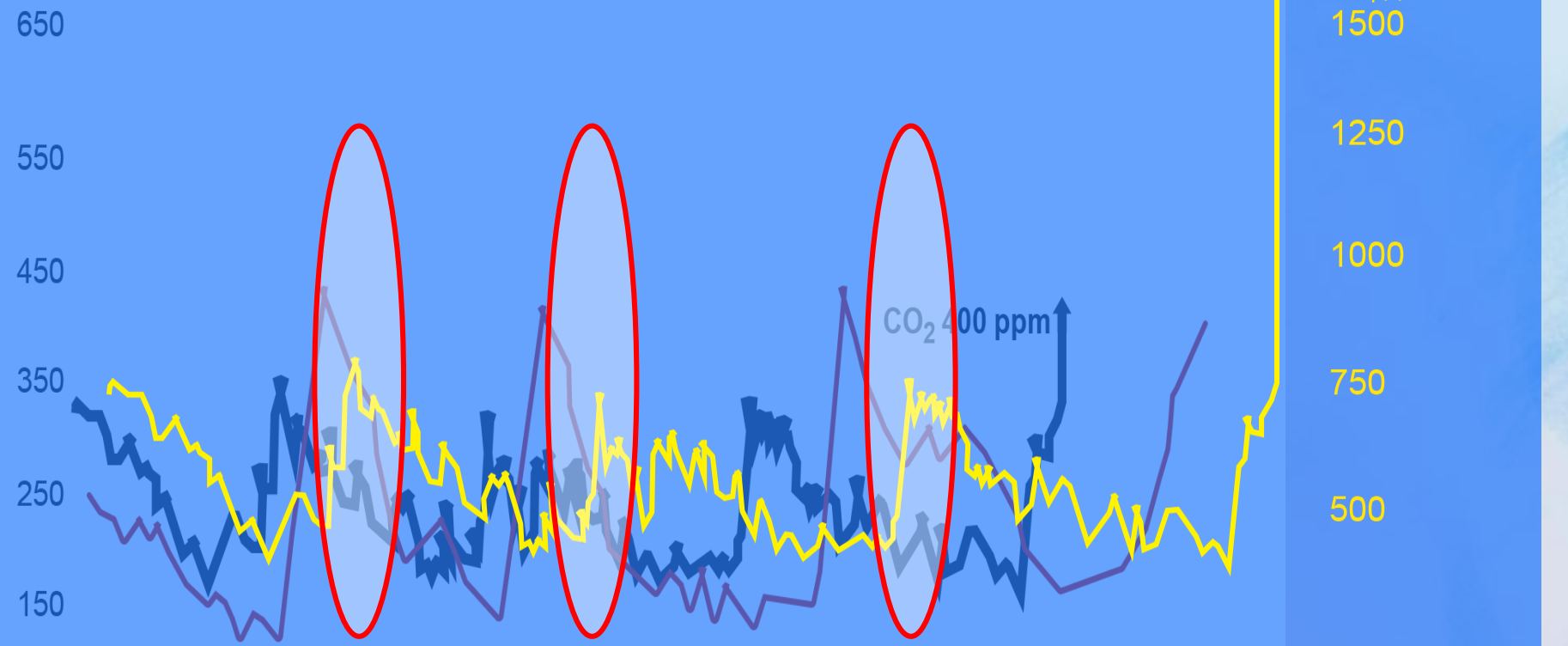
Great Climate Shift



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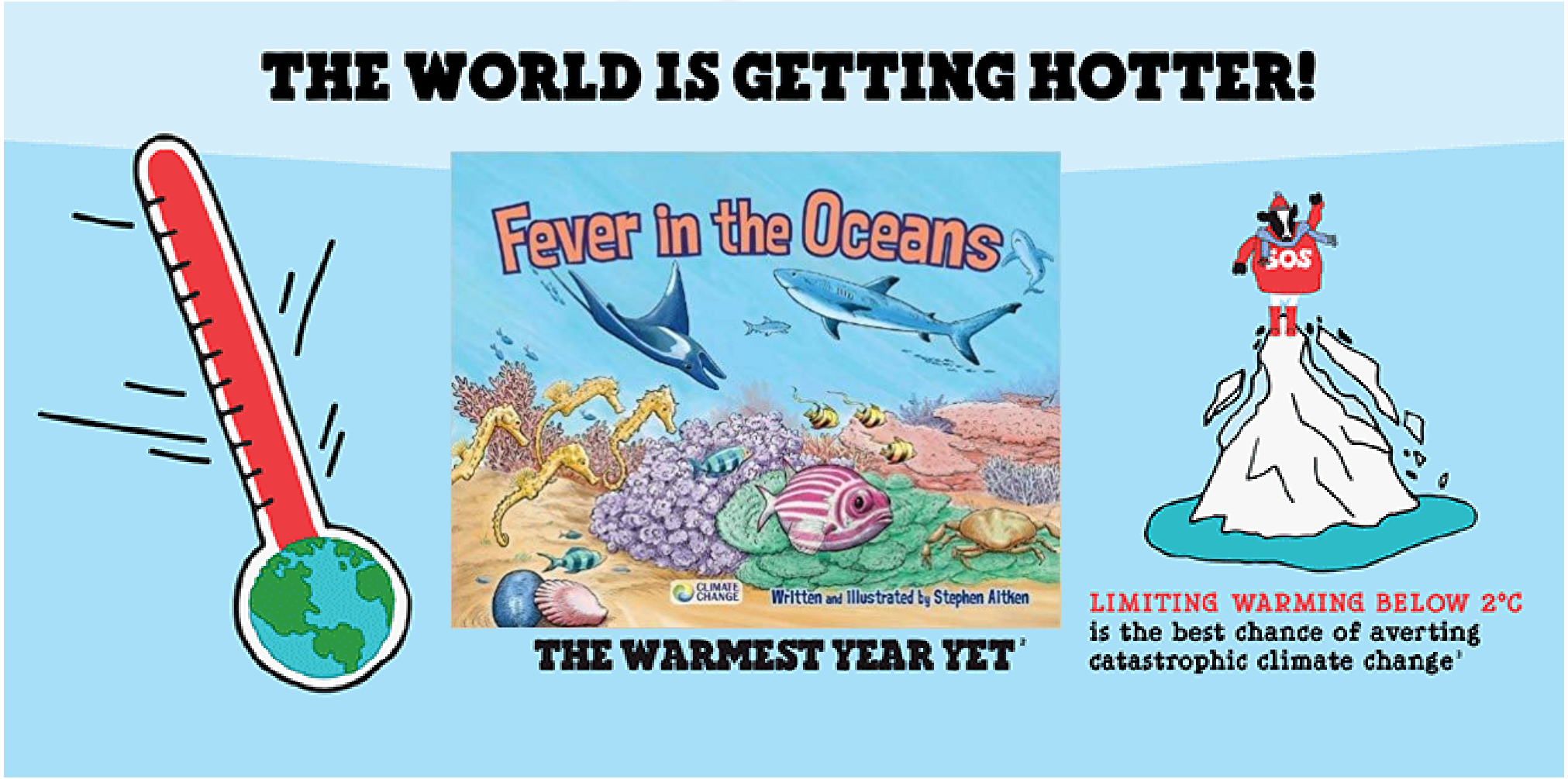
Oceans plagued with fever



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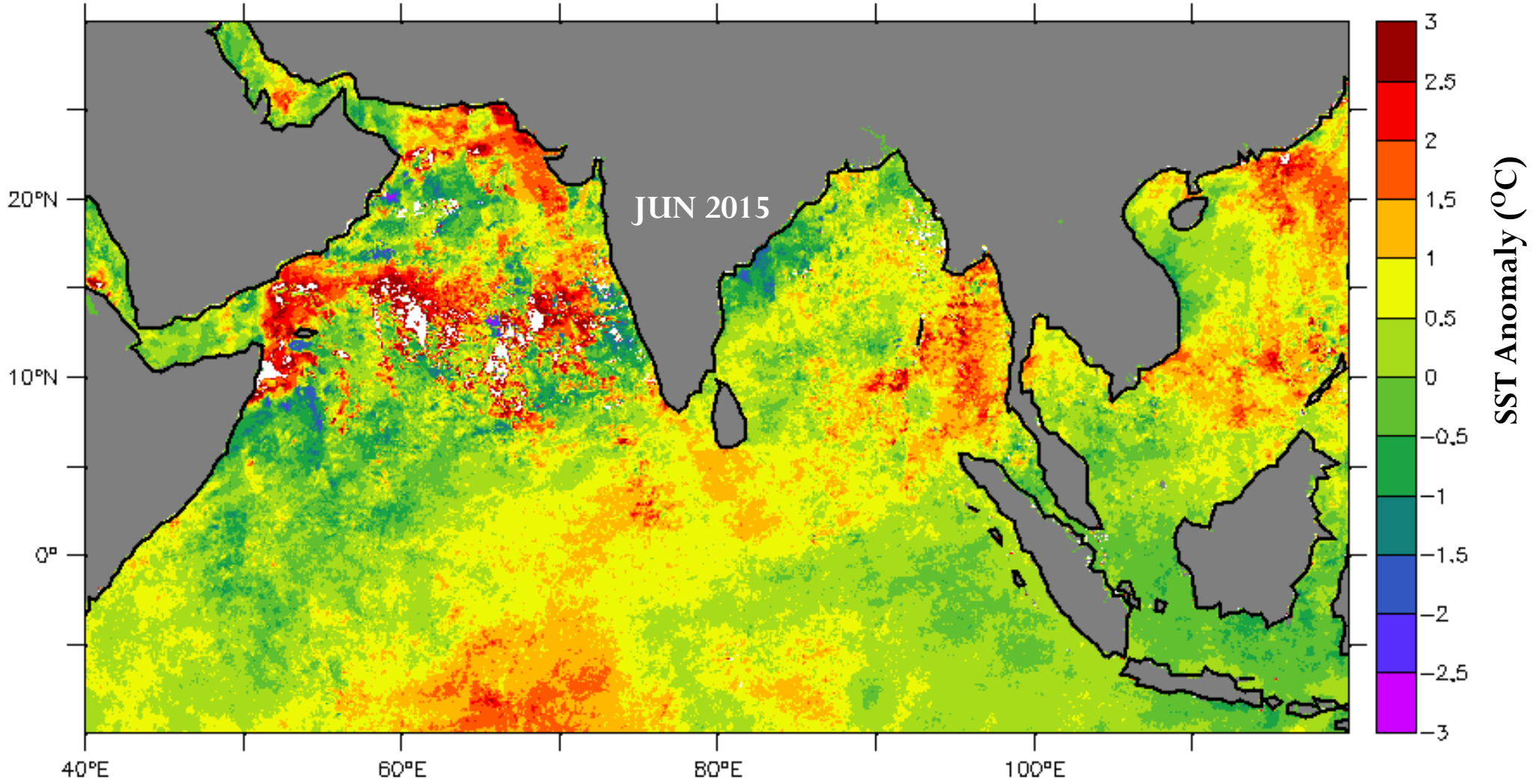
Monthly SST Anomaly (MODISA) for June 2015



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We have a climate shift…What are weather shocks?

"Its not the melting ice alone, but we have a shrinking ecosystem - with all its biotic and abiotic components loosing to sudden changes in weather and the ecological succession is worrying us .
– the top predators."

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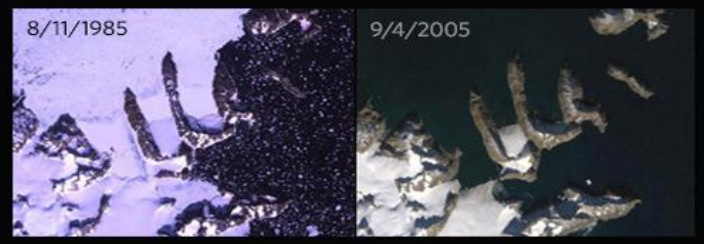
OUR OCEAN ABSORBS MORE THAN 90% OF THE HEAT TRAPPED BY HUMAN-PRODUCED GREENHOUSE GASES

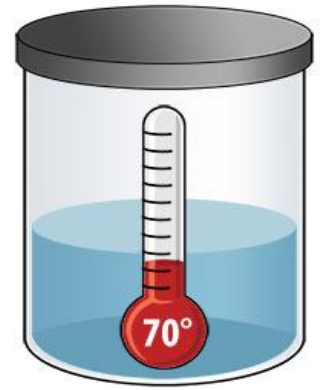
This extra heat causes the sea level to rise. But why?

As water warms, its molecules move and interact more, causing the water to take up more space. If you've used a mercury thermometer, you've seen the same effect, **thermal expansion**, in action.



The extra heat causes the **melting of ice sheets and glaciers** on land. Greenland, in the Arctic, is warming about two times faster than the rest of the planet.

Source: NASA



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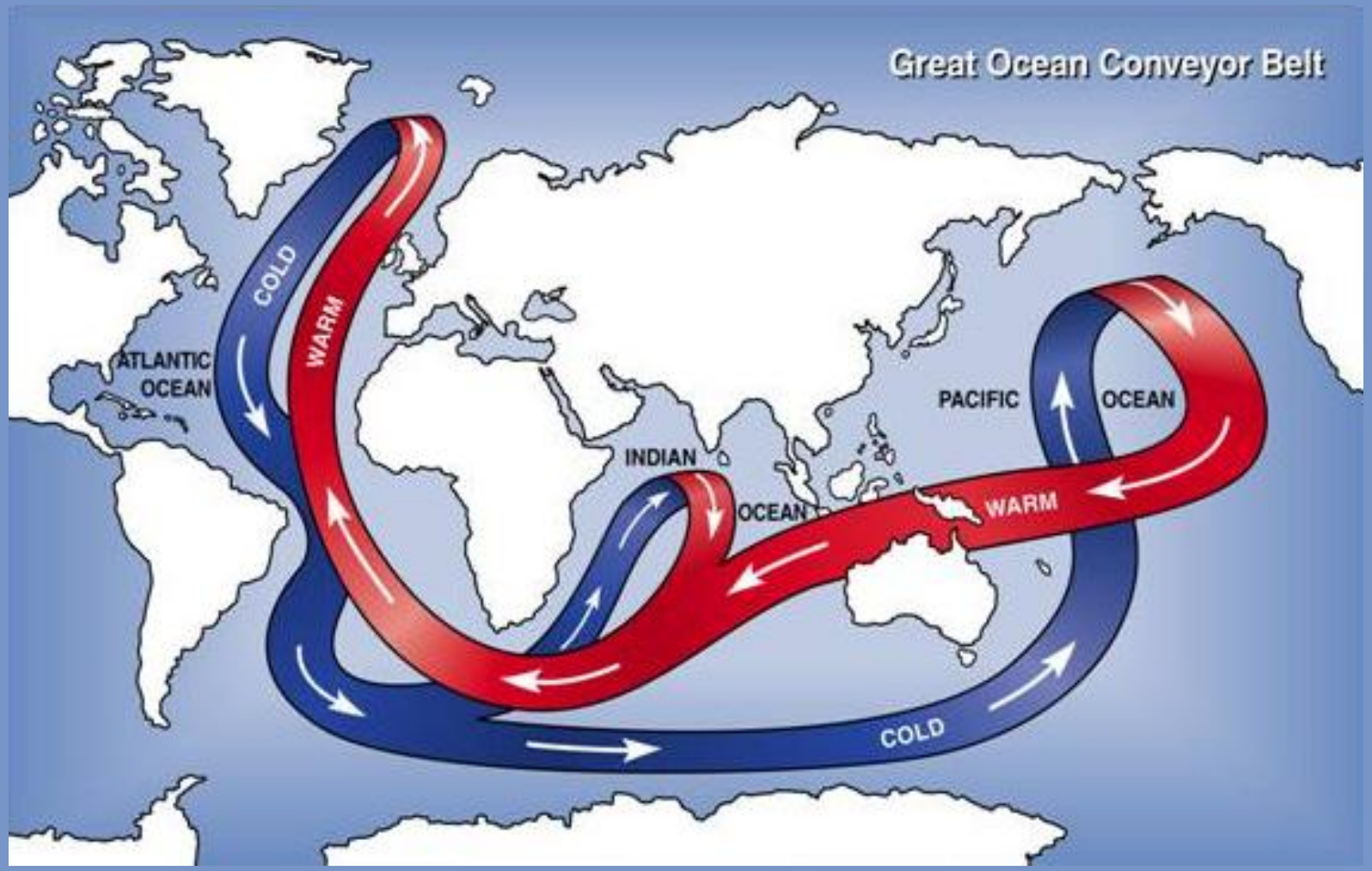
Ocean Currents Dysfunction



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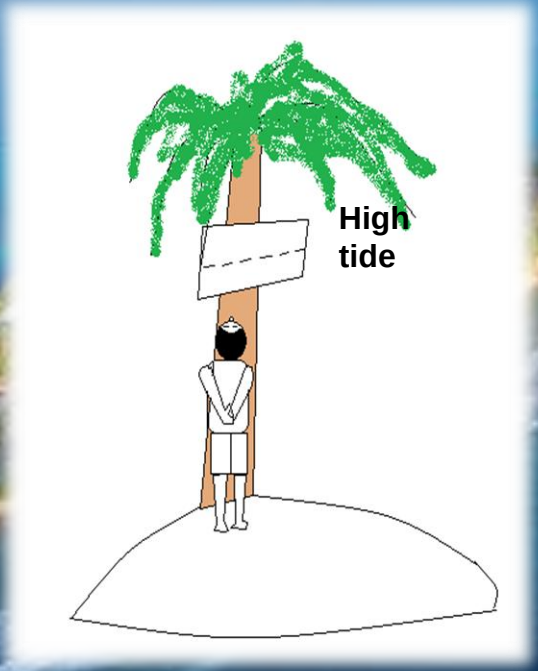
Shrinking small Island nations and low lying areas are vulnerable and facing the threats of sea level rise during extreme rains.

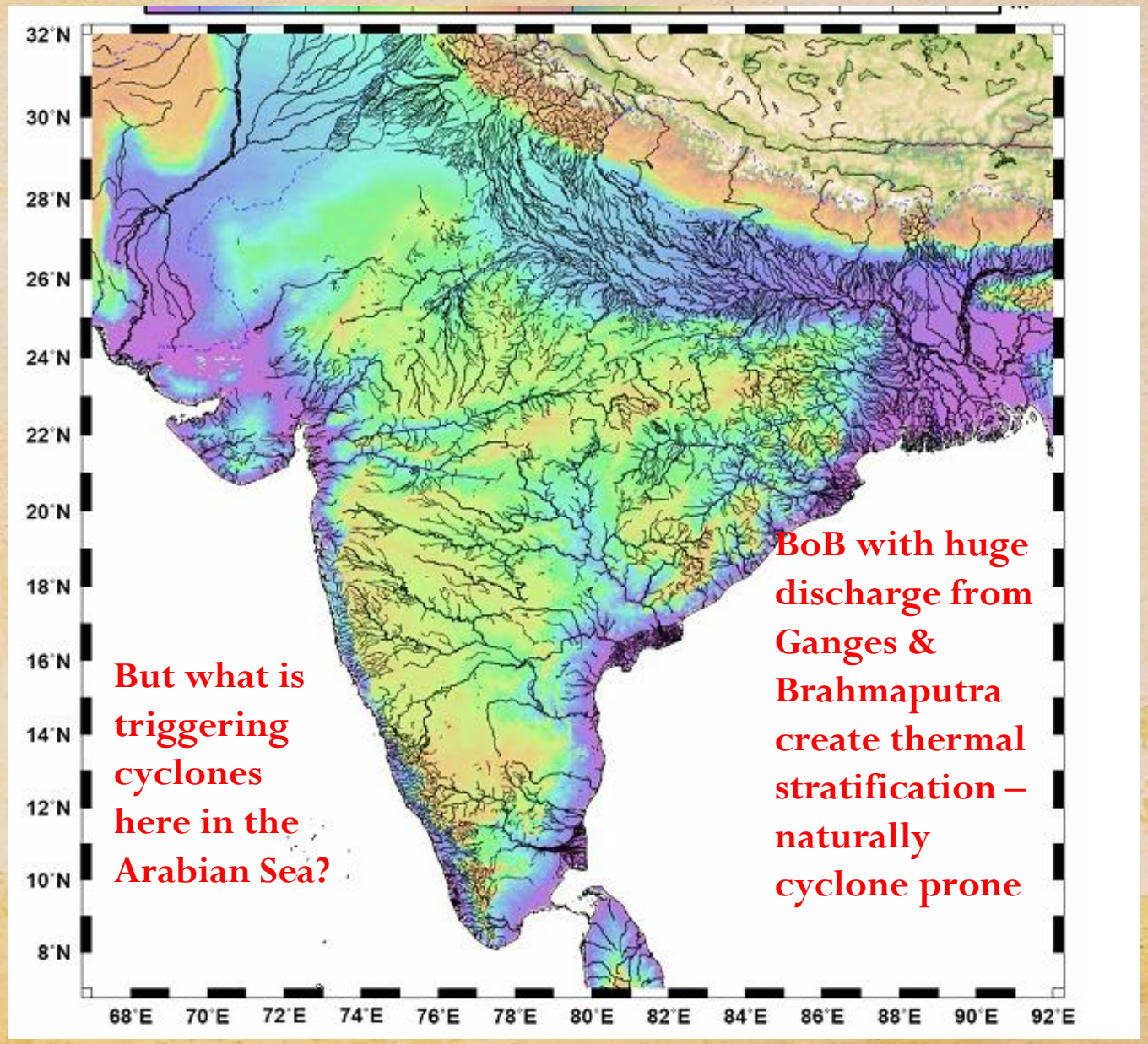
From our own houses to hill, hill tops to rivers. river to oceans and back to us.



Do we have frequent weather crises..!

?

River systems



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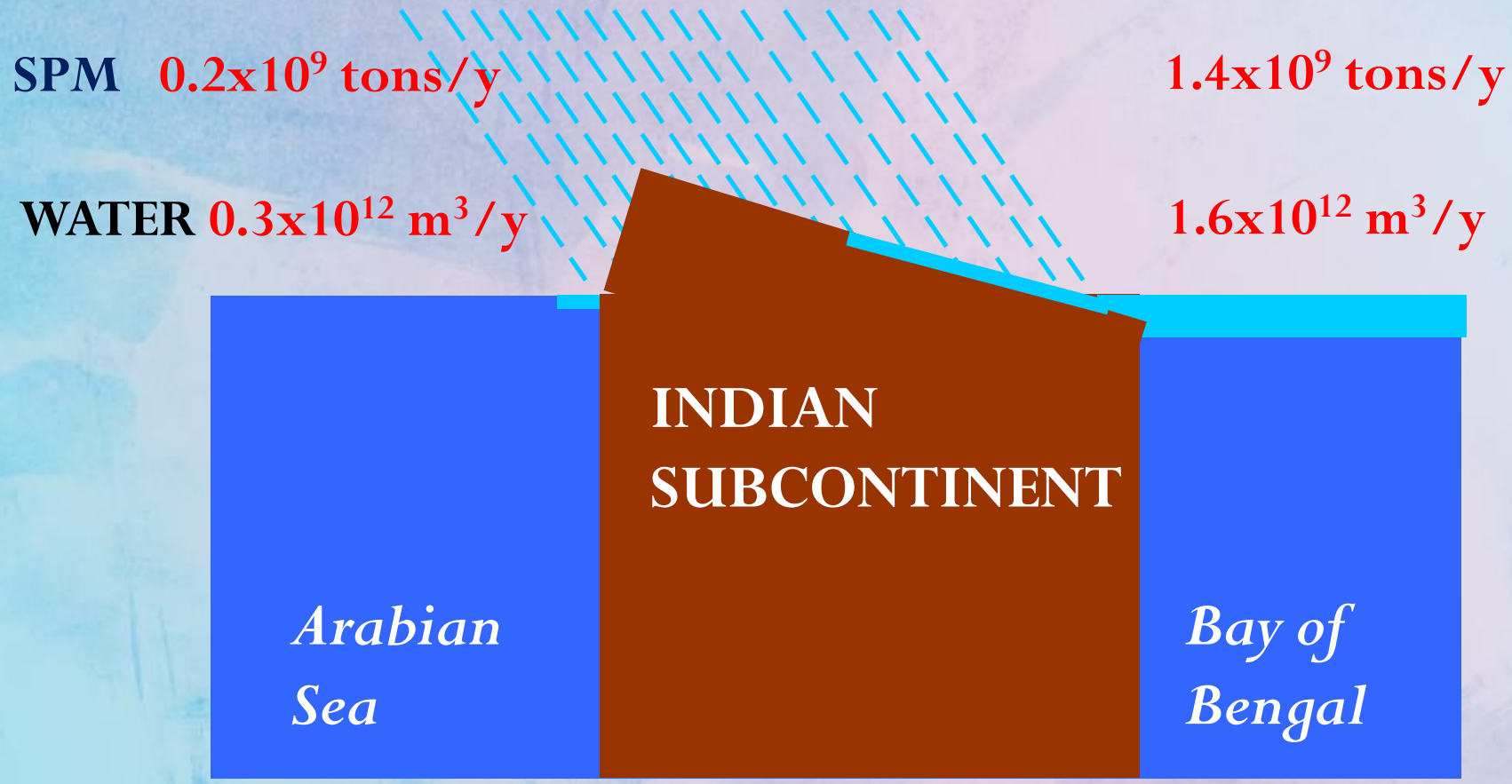
Influence of different river discharges on oceans in our neighborhood



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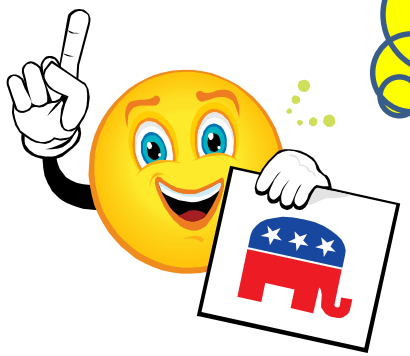
Agni, Akash, Bijili, Jal, Leher, Megh, Sagar, Vayu

Nilofar, Titli, Bulbul

Gaja, Amphan, Ockhi, Tauktae, Yaas?

Floods in Kerala

Impacts of Weather shocks

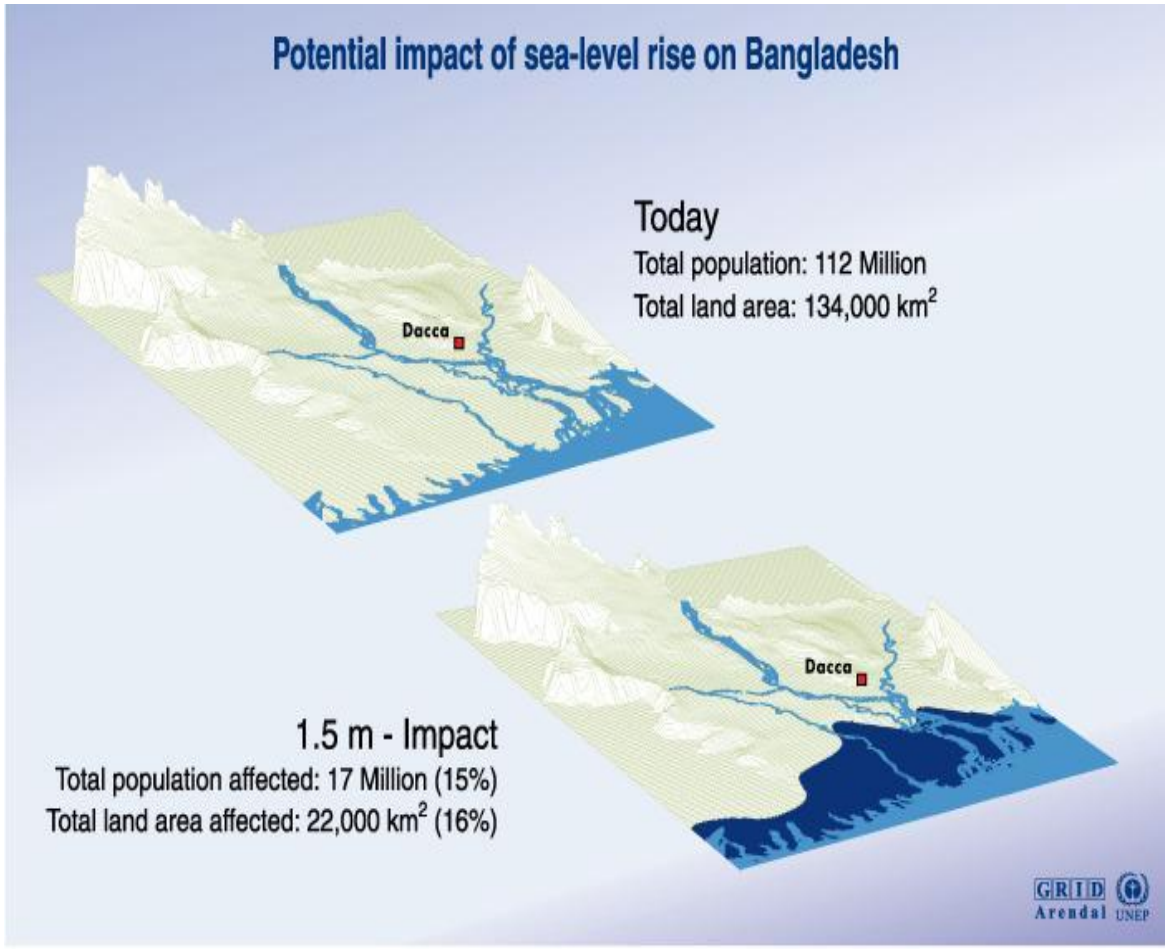


EFFECT OF CLIMATE CHANGE IMPACTS ON OUR NEIGHBOURS

- Displaced people may move to so called ideal places – migration (legally and illegally
- As the population is ethnically similar or different to the countries migrated – unrests happen
- Loss of livelihood of this huge population may lead to poaching in the seas.

BANGLADESH

- 1% of the world's tropical storms hit Bangladesh.
- About 10% hardly 1 m above MSL; 80% Low level disaster prone lands.
- High population density (>1209 persons per km^2; limits migration within the country.



Source : UNEP/GRID Geneva; University of Dacca; JRO Munich; The World Bank; World Resources Institute, Washington D.C.

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Direct Impact of Ockhi cyclone on the fishery- as reflected in the seasonal marine fish landings of Kerala.

- Loss of effort in units -56,610 in 2017, which is 46% less compared to 2016
- Loss of effort in AFH - 5,70,495 which is 57% less than 2016.
- Due to the loss of fishing days during Ockhi cyclone, the landings share during the above period reduced to 13.5% in 2017 from 22% in 2016.
- The estimated loss during the above period was 35,465 t valued at Rs.58.5 million at landing centre level and Rs.82.1 million at retail level.

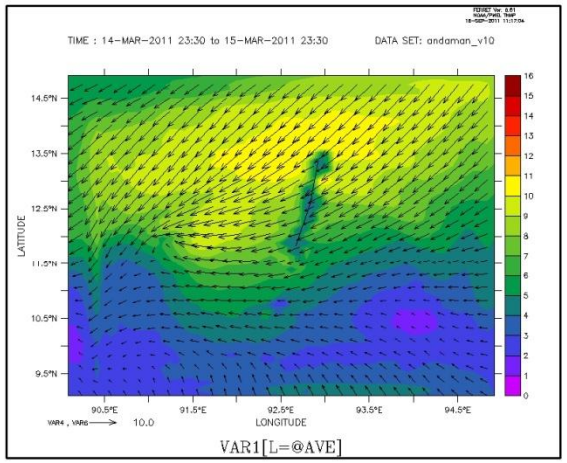
Study on Storm surge dynamics

May 2010
Bleaching

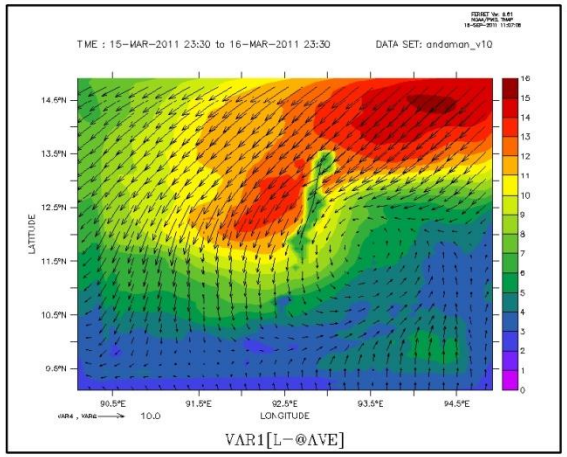
Mar 2011 Surge

NWF modelled winds around A&N Islands for the period 14 -17 March 2011

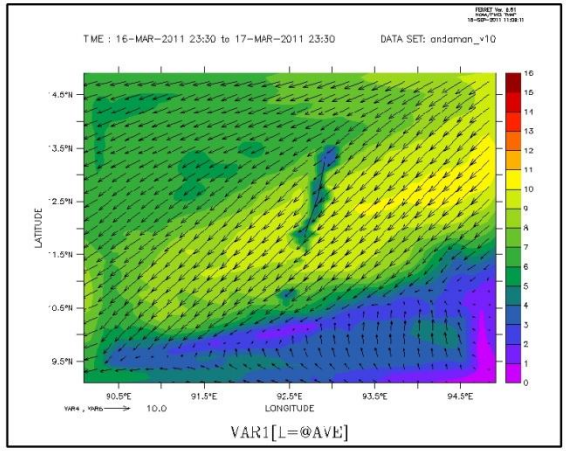
A. 14-15 March



B. 15-16 March

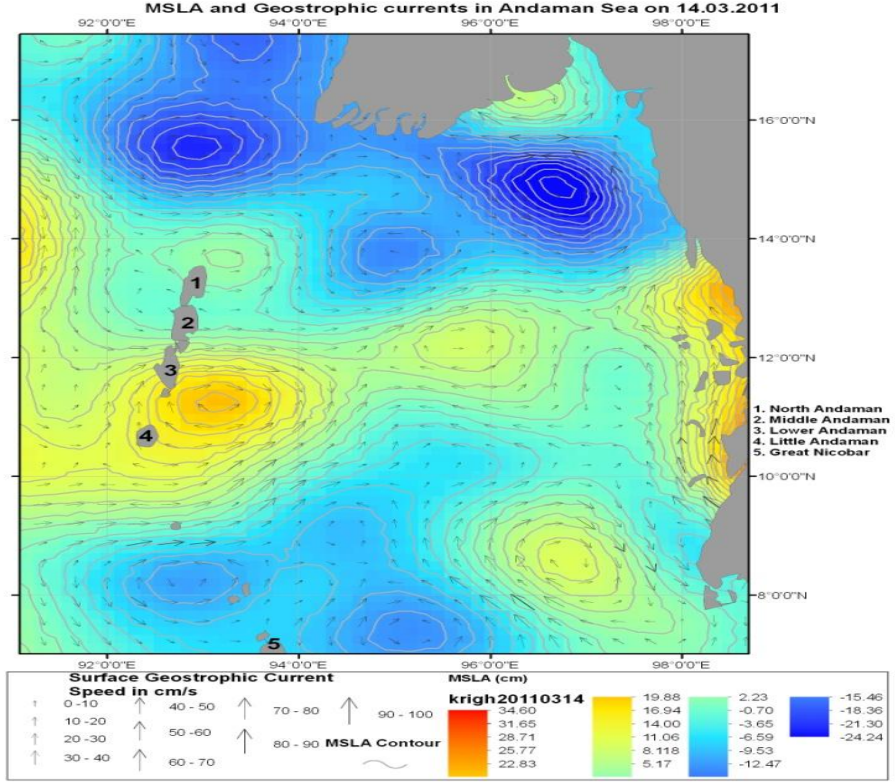


C. 16-17 March

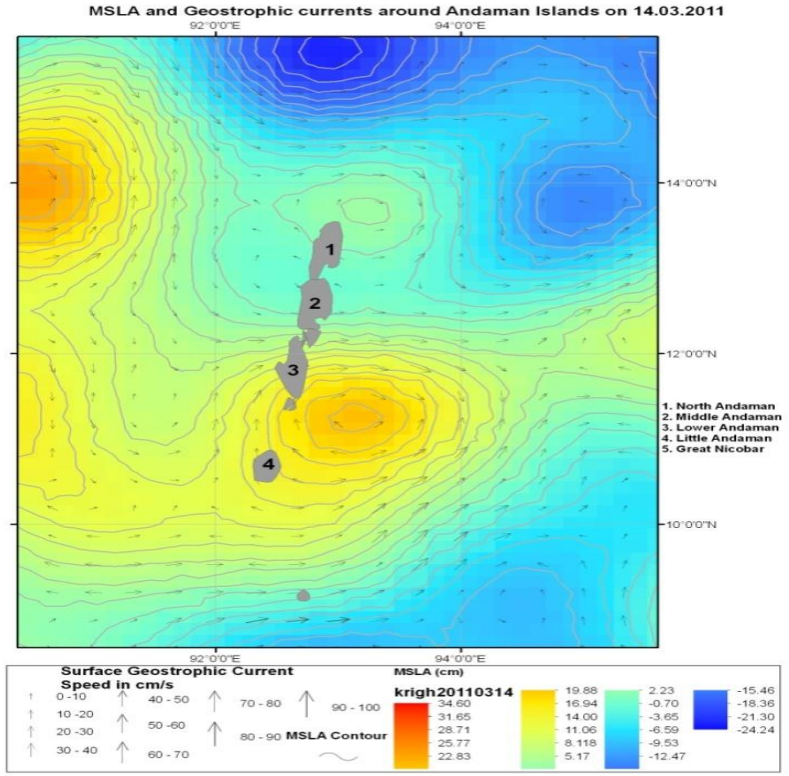


(Courtesy: NIO, Goa)

MSLA and Geostrophic currents in Andaman Sea on 14.03.2011



MSLA and Geostrophic currents around Andaman Islands on 14.03.2011



(Courtesy: RRSC)

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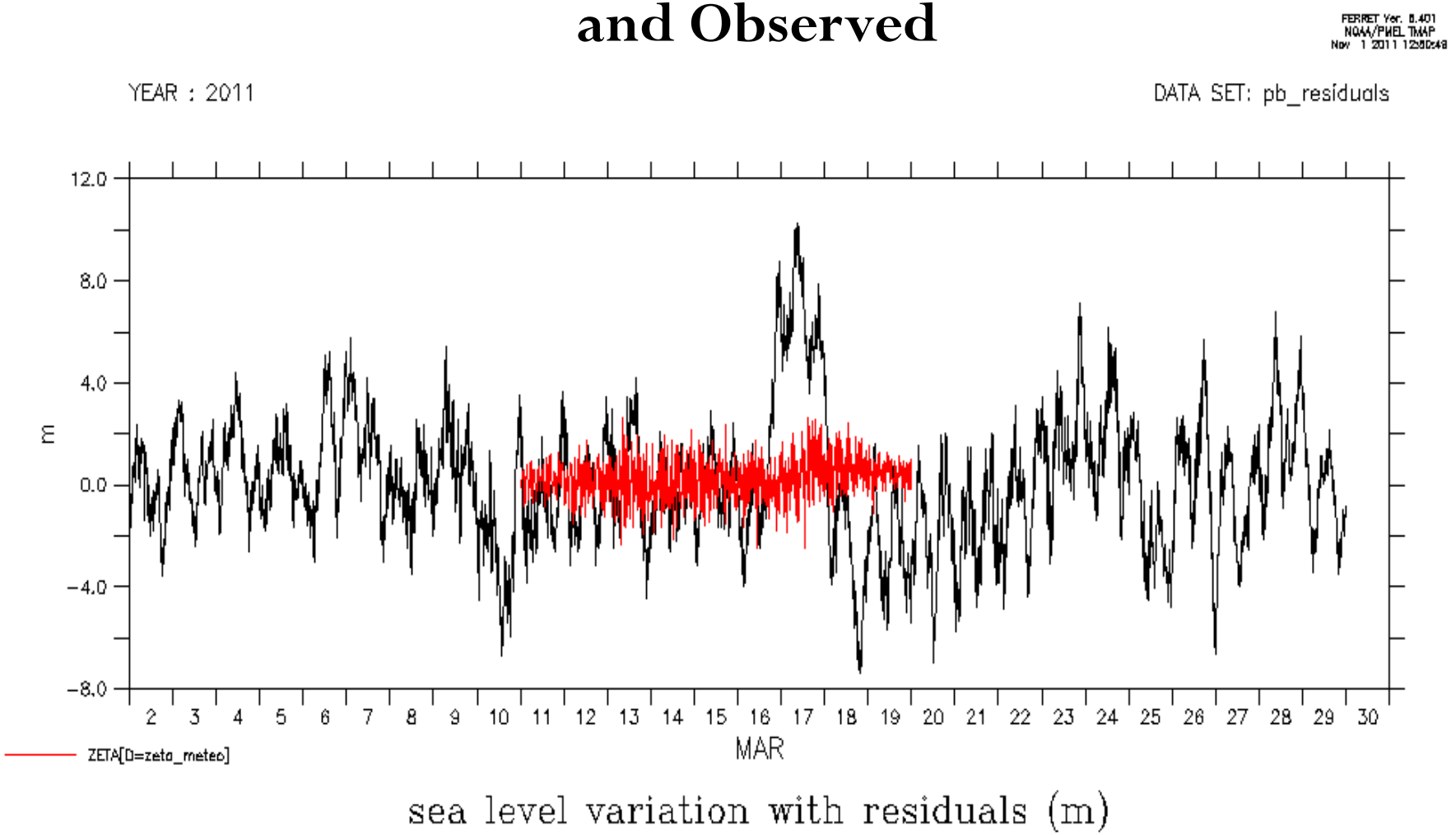
Comparison b/w modeled residulals and Observed



sea level variation with residuals (m)

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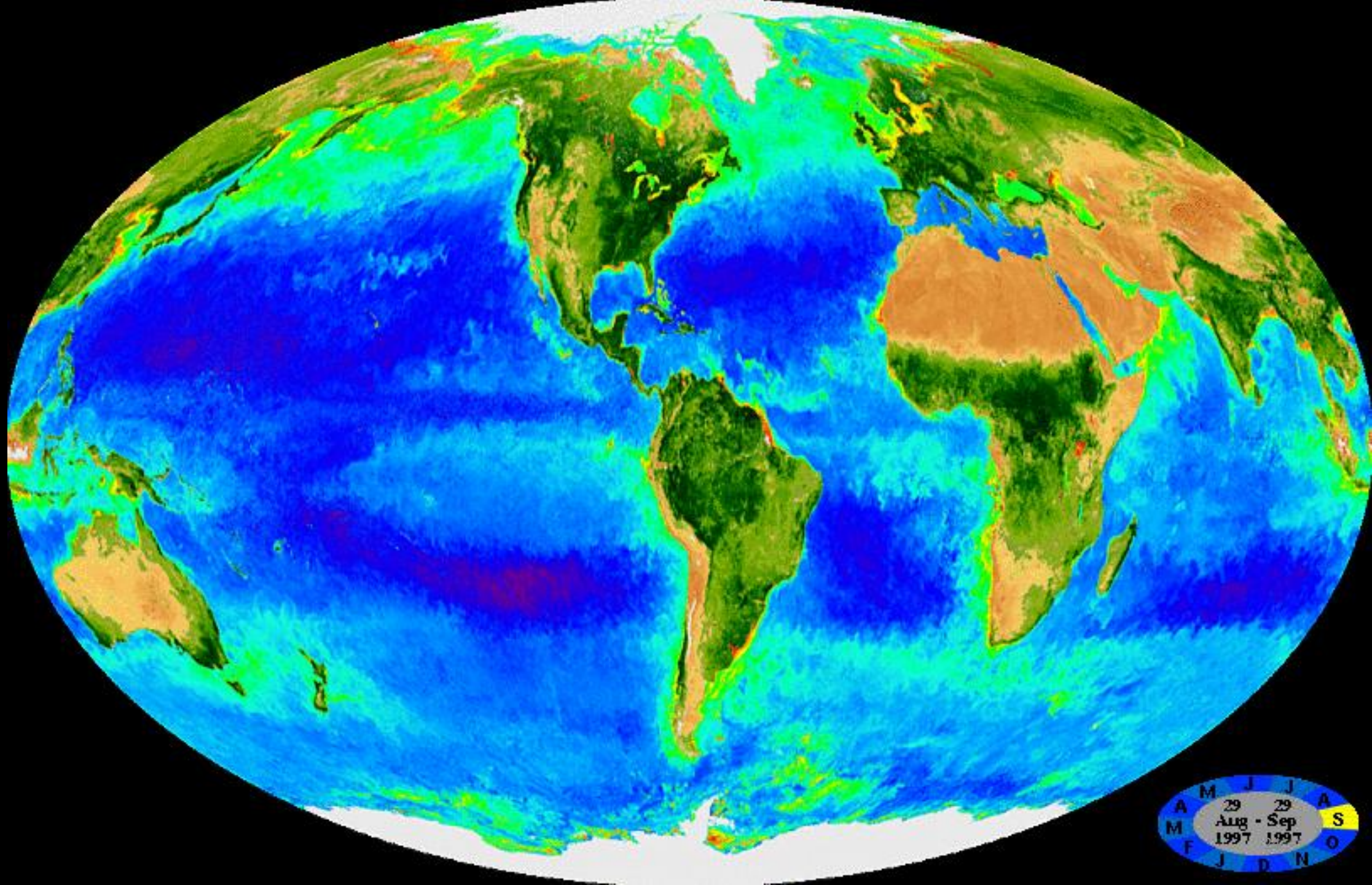
Methane Hydrate Signs

A global view of the ocean's flora



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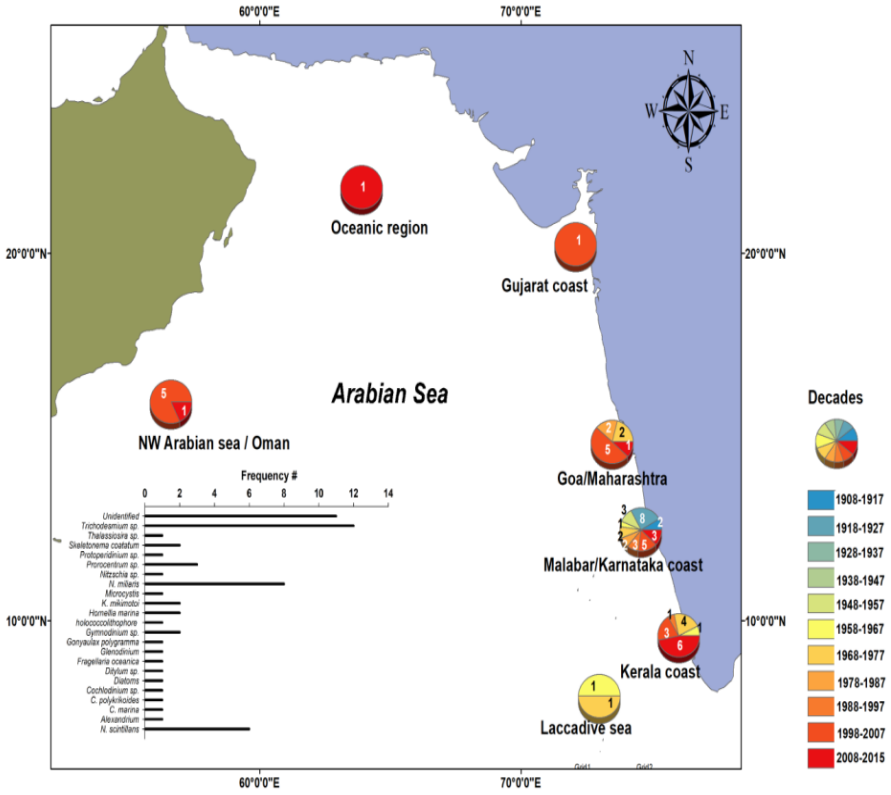
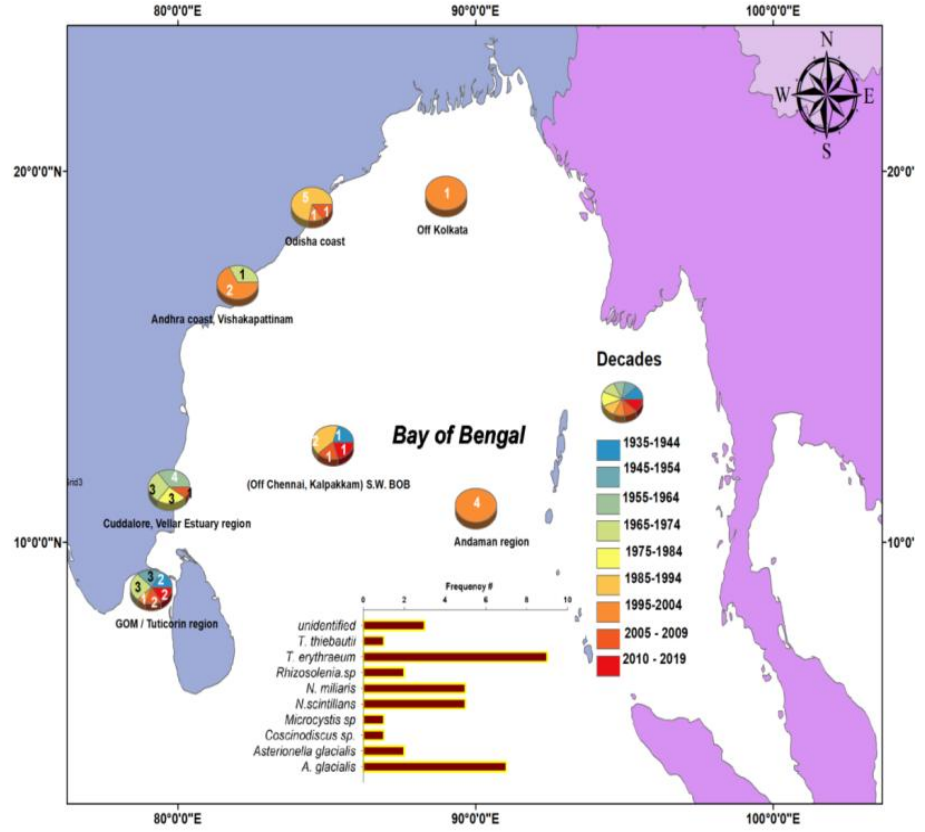
Secondary data of bloom events across Arabian Sea (AS) (1908 to 2015) and Bay of Bengal (BoB) (1935-2019) was catalogued to identify spatio-temporal variability.

Cataloguing HAB incidences in the Northern Indian Ocean (NIO) - Inset graph shows frequency of causative organisms.





- **In the AS**, approximately **three fold increase in HAB events** are reported during the **last two decades (31 HAB events) compared with the first 2 decades (10 HAB events)**.
- **In the BoB,** approximately **two fold increase in HAB events** are reported during the **last two decades (14 HAB events) in BOB compared to the first two decades (6 HAB events)**.

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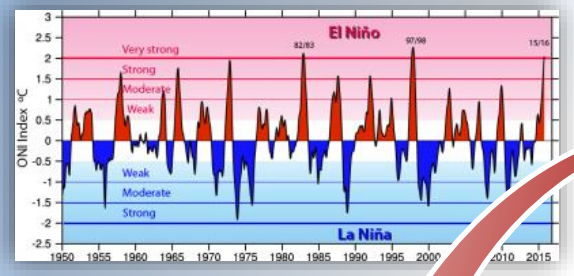
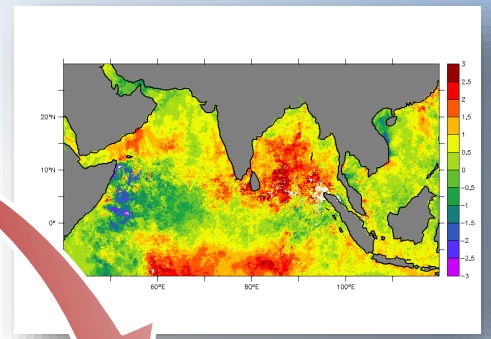
Oceanographic events

- *El Niño, La Niña*
- Indian Ocean Dipole (IOD)





- SST
- Rainfall patterns
- Upwelling/ Downwelling
- Plankton production pattern

Feeding (poor conditions)

Reproduction (SSB)

Distribution (Catch Rates)

Abundance of Oil Sardine

- Catch
- Catch rates
- Economic returns

Field Observations around Coral Islands

Coral Bleaching in Andaman Islands in 2010

(Contributed by collaborators at CARI, Port Blair)

1. **Bleaching in 2010 is higher than 1998**
   SST raised 2-3 deg C than 1998

2. Observed bleaching at Havelock Island (69.49%),
   South Button Island (67.28%),
   Nicolson Island (56.45%),
   Red Skin Island (43.39%),
   North Bay (41.65%) and
   Chidiyatapu (36.54%)

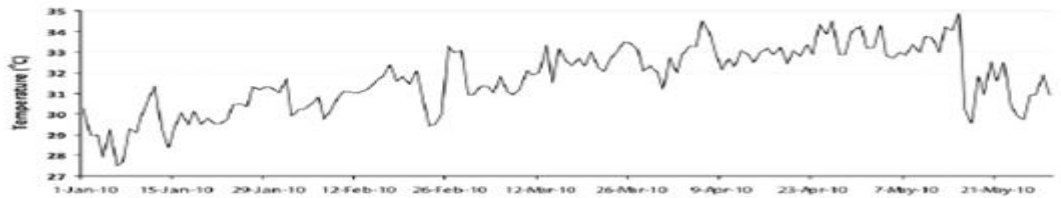
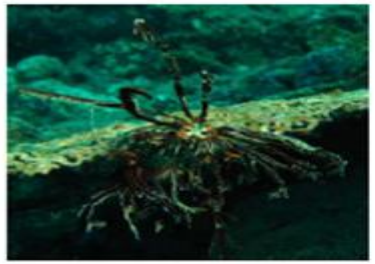


Fig. 1. Temporal variation in the maximum air temperature in Andaman

Bleached Sea anemone (*Heteractis magnifica*)

Bleached Giant Clam (*Tridacna* sp)

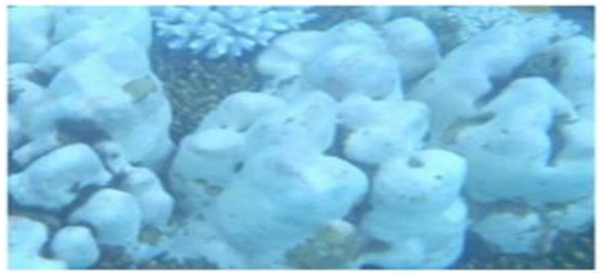


Withering Brittle stars

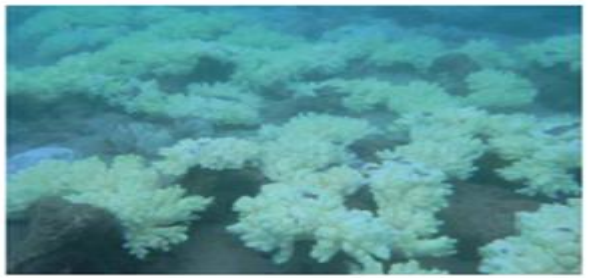
Plate 2. Reef associates affected by elevated SST during May 2010

Branching coral (*Acropora* spp)

Plate coral (*Echinopora lamellose*)



Massive coral (*Porites solida*)



Partially bleached soft corals (*Simularia* sp)

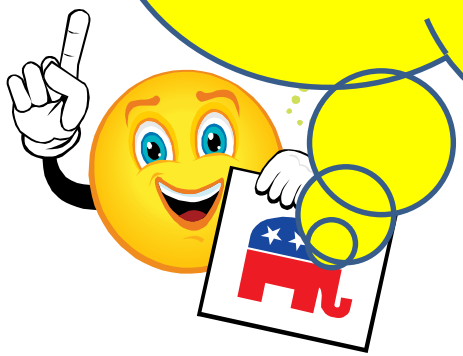
Plate 3. Corals in South Button Island showing the deposition of algae over the fully bleached corals (August 2010)

Comparison of *P.monodon* and *L.vannamei* farming systems (1 ton production) for their contribution to environmental burden (Characterisation)

Impact category	Unit	*P. monodon*	*L.Vannamei*
Abiotic depletion	kg Sb eq	9.55	10.18
Acidification	kg SO_2 eq	14.29	14.36
Eutrophication	kg PO_4--- eq	79.00	76.15
Global warming (GWP100)	**kg CO_2 eq**	**1817.83**	**2068.22**
Ozone layer depletion (ODP)	kg CFC-11 eq	0.001	0.001
Human toxicity	kg 1,4-DB eq	259.58	240.82
Fresh water aquatic ecotox.	kg 1,4-DB eq	40.39	37.93
Marine aquatic eco-toxicity	kg 1,4-DB eq	139911.81	130345.26
Terrestrial ecotoxicity	kg 1,4-DB eq	2.28	1.88
Photochemical oxidation	kg C_2H_4	0.41	0.44

- Global warming potential (GWP) was high in *L. vannamei* system compared to *P. monodon* and it is contributed mainly by use of aerators and production of feed in feed mill i.e., mainly by use of energy.

What is the future that beckons on us?



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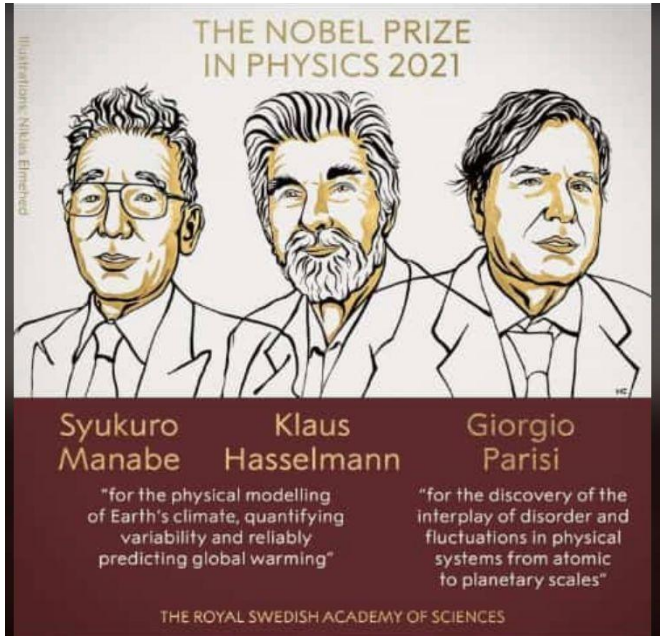
How we know the future of climate change?



Stochastic climate models

Part I. Theory

By K. HASSELMANN, *Max-Planck-Institut für Meteorologie, Hamburg, FRG*

(Manuscript received January 19; in final form April 5, 1976)

ABSTRACT

A stochastic model of climate variability is considered in which slow changes of climate are explained as the integral response to continuous random excitation by short period "weather" disturbances. The coupled ocean–atmosphere–cryosphere–land system is divided into a rapidly varying "weather" system (essentially the atmosphere) and a slowly responding "climate" system (the ocean, cryosphere, land vegetation, etc.). In the usual Statistical Dynamical Model (SDM) only the average transport effects of

Background & Objectives, Problem Description

Study Area Selection

Variable Selection

Literature Review

RCP 2.6,4.5,6.0 & 8.5

Resolution 2.8 × 2.8

MIROC-ESM-CHEM

(The University of Tokyo), and National Institute for Environmental Studies

Chlorophyll concentration and pH are available in yearly basis

Model

RCP 2.6, 4.5 & 8.5

Resolution 1.8 × 1.8

MPI-ESM-MR

Max Planck Institute for Meteorology

Precipitation details not available

RCP 6 not available for all variables

Data Collection and Evaluation

Result Analysis and Conclusion

SST Impacts

Extension of distributional boundaries of small pelagics: *Sardinella longiceps* and *Rastrelliger kanagurta* upto 22°N latitudes that were earlier restricted between 8° and 14°N latitudes and longitude 75° and 77°E

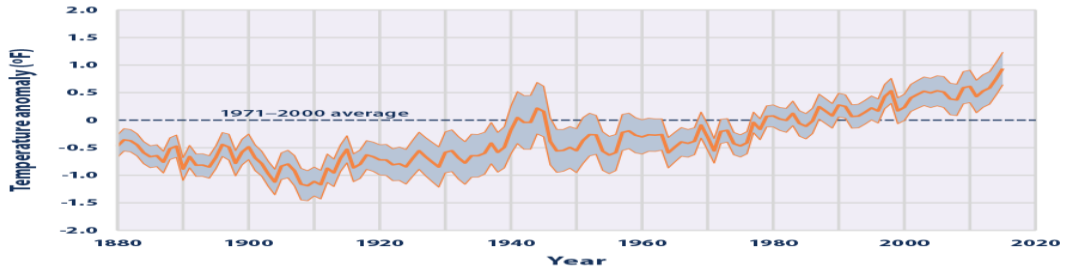
Changes in spawning seasons: Shift in spawning season of *Nemipterus japonicus* and *N. mesoprion* occurred from warmer months to cooler months.

Morphological and metabolic changes in fishes: Musculo-skeletal abnormalities of fingerlings of silver pompano, *Trachinotus blochii* occurred at higher temperature. Increase in O_2 consumption and metabolic rates by 11% observed for *P. loepardus*.

Reduction and Replacement in catch: 5.3% decline in overall catch happened in 2015 w.r.t 2014. Reduced catch of *Harpadon nehereus* (Bombay Duck), from 27.25% (2009–10) to 12.33% (2015–16) which was replaced by low priced species, *Secutor insidiator* (landings increased from 0.09% to 17.9% during 2015–16).

Coral bleaching: Along the Gulf of Mannar, Gulf of Kachchh, Palk Bay, Andaman Sea and Lakshadweep Sea, 29 widespread bleaching events occurred.

Global Annual Temperature Anomaly



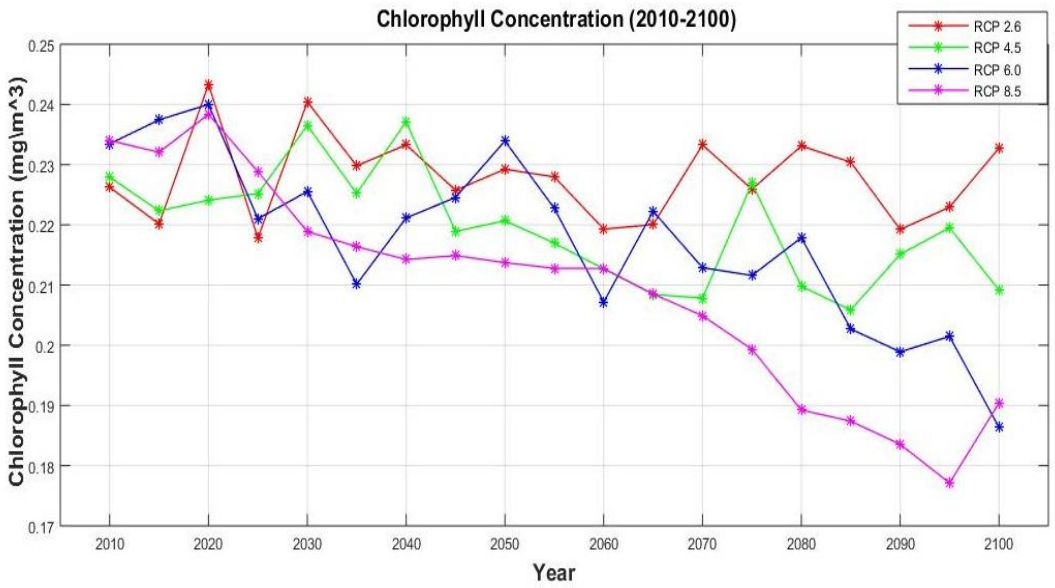
Chlorophyll Concentration Impact

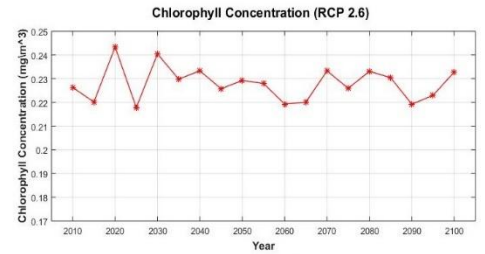
The abundance of many pelagic fish species and shellfish larvae is directly correlated with the abundance of phytoplankton and chlorophyll concentration.

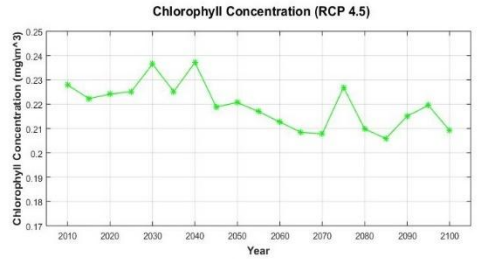
Changes in planktons induce change in diet compositions of Indian mackerel *Rastrelliger kanagurta* which is a diet dominant in phytoplankton consisting of *Coscinodiscus* sp. macroplanktons and fish larvae in 2014 whereas the diet during 1960-61 showed the dominance of zooplankton and copepods.

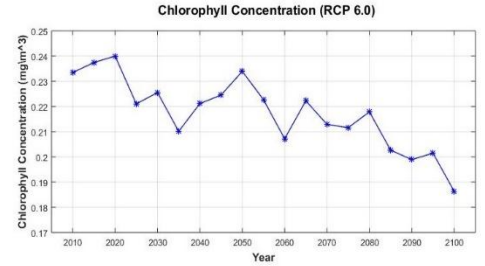
Reduced carbon sinks to deeper ocean as warmer waters that are stable near the surface contain phytoplankton of smaller cell size and are very efficient at recycling nutrients and biogenic material in the upper ocean.

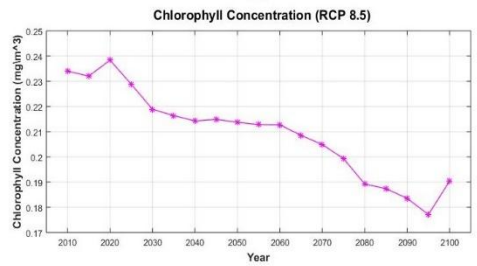
Chlorophyll Projections for RCP Scenerios











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SALINITY
Impacts

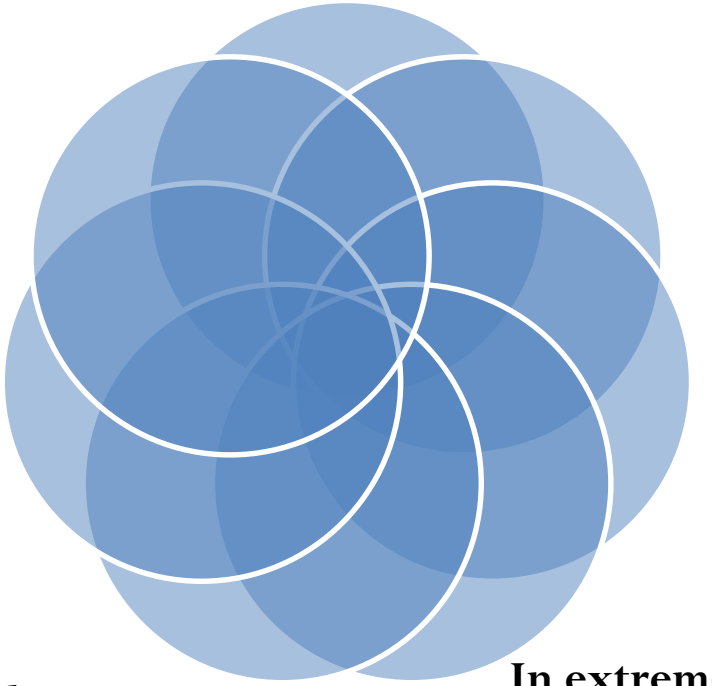
Indian ocean exhibits linear trends in increasing salinity at almost all latitudes from surface down to 150 m depth.

Increased precipitation leads to reduced salinity.

Impacts on swimming behaviour of milk fish *Chanos chanos* owing to the increased costs of metabolic activities and osmoregulation.

Reduced frequency of fertilization and embryo development for crown-of-thorns sea star when salinity was reduced below 29 ppt.

When the salinity drops to <11.5, buoyancy would be too low for cod eggs to remain floating.



Overall reduction in the surface density, that leads to increased vertical stratification and changes in surface mixing.

Disrupts the osmoregulation of marine species.

In extreme hypo-salinity condition corals showed necrotic tissues and bleaching.

pH / Ocean Acidification

Impact

Negative impact on corals and associated fishes.

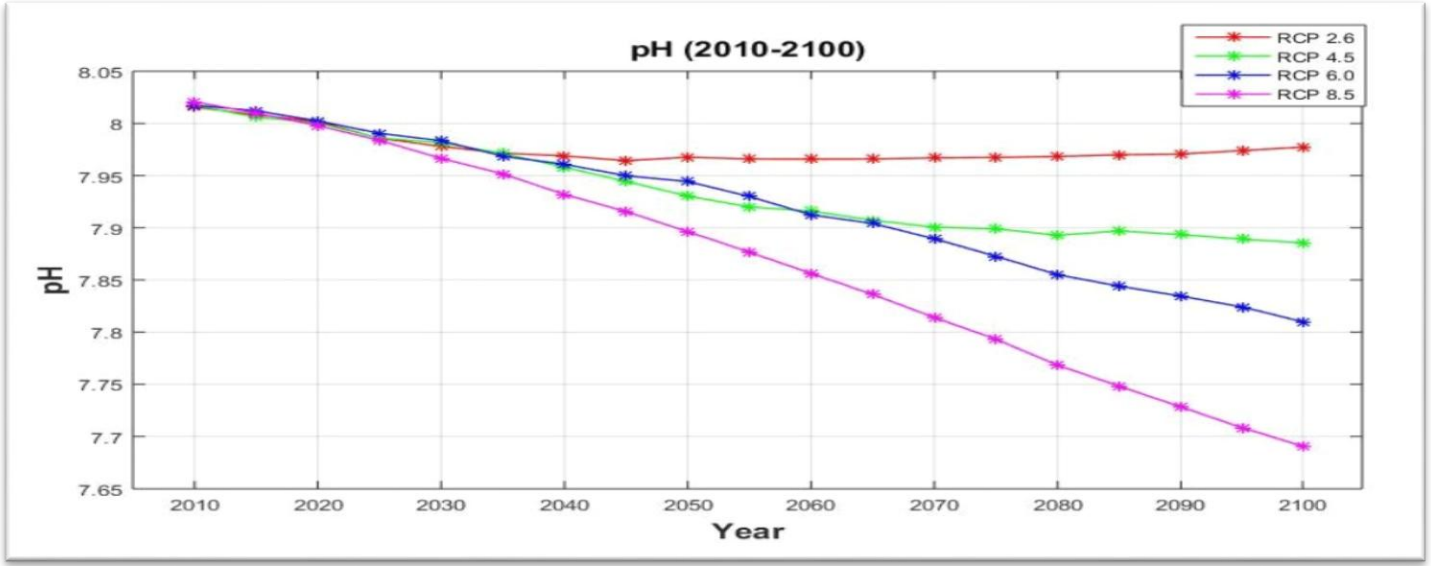
Organisms using calcite and aragonite for shell and skeletal growth, such as coral, mollusks, crustaceans, zooplankton and phytoplankton will be the mostly affected ones.

Loss of corals lead to local extinctions of reef specialists

Among the 66 coral species in 1997, only 40 species were observed in 2008 and the remaining 26 or more may be lost in the next 11 years, in the saint martin's island located in the Bay of Bengal.

Decreased shell thickness and rate of calcification in shellfish due to reduced availability of calcium carbonate.

pH Projections for RCP Scenerios



Sea Level Rise

Impact

Submerging of important coastal habitats such as mangrove forests, sea grass beds and salt marshes which usually acts as buffer for changes in environmental parameters.

Reduction and extinction of estuarine associated habitats.

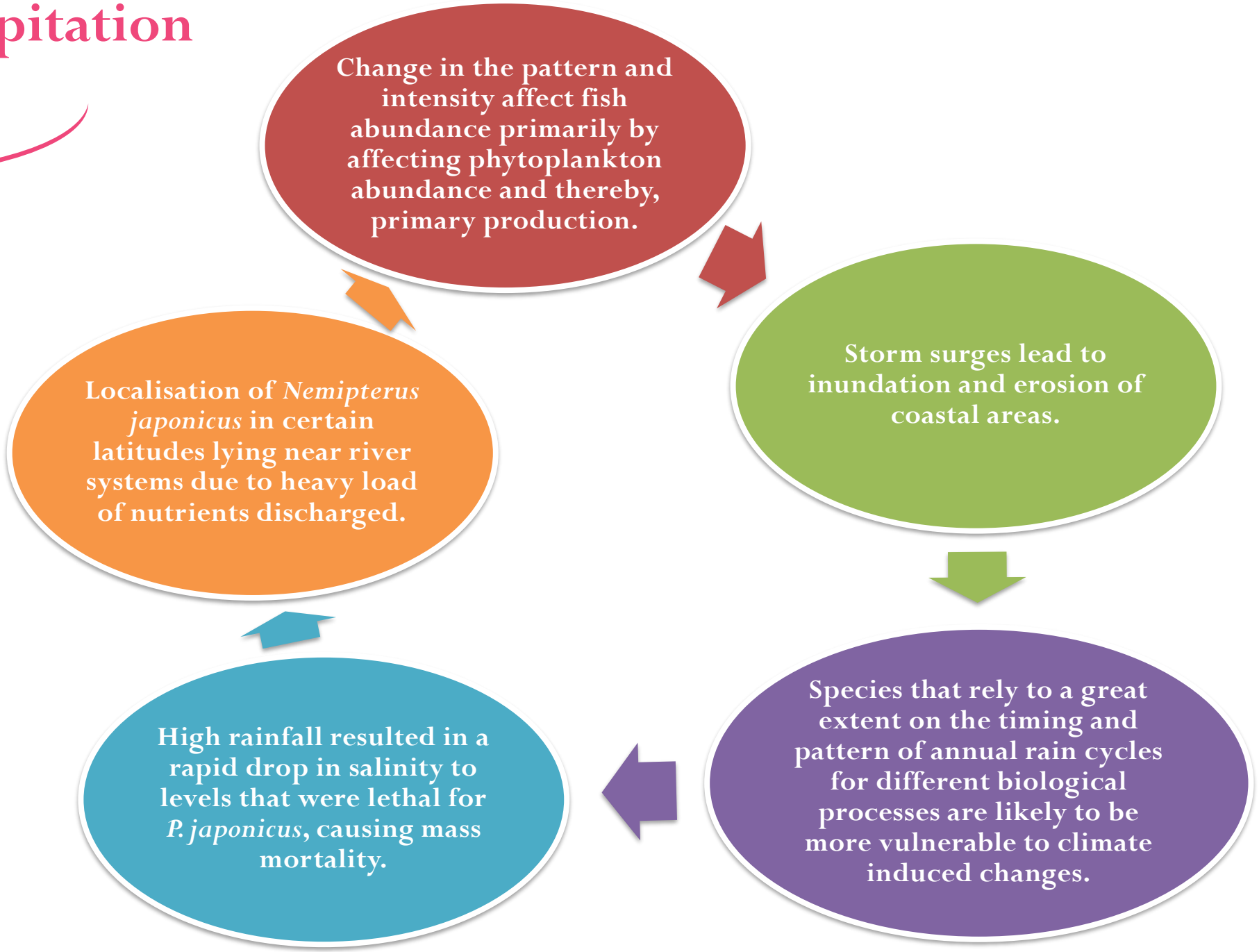
Disappearance of intertidal and shallow coastal habitats.

The erosion due to sea level rise for Cochin region is estimated to be 7125m^3 per year implying an erosion rate of 0.3x$10^6$$m^3$ per year that may be attributed to the effects of wave attack .

Reduction in land area of estuarine island system (around 86 km^2) in the Sunderbans and Sagar island due to loss by erosion and submergence with a sea level rise of 3.14 mm per year.

Rainfall/Precipitation

Impact



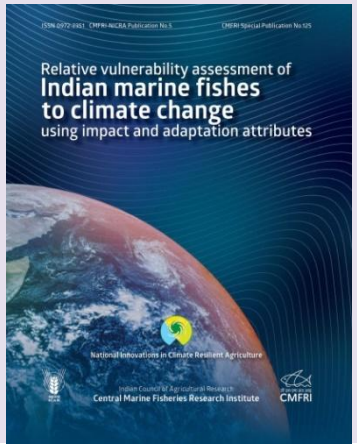
Relative Vulnerability Assessment of Indian Marine Fishes

Criteria for Relative Vulnerability Assessment

- ICAR-CMFRI developed criteria for vulnerability assessment of fish stock along Indian coasts and accordingly, vulnerable species were identified across four zones in Indian EEZ and the reasons for their vulnerability identified
- Mitigation options to combat vulnerability of the identified species have been suggested.

$$V=(E+S)-AC$$

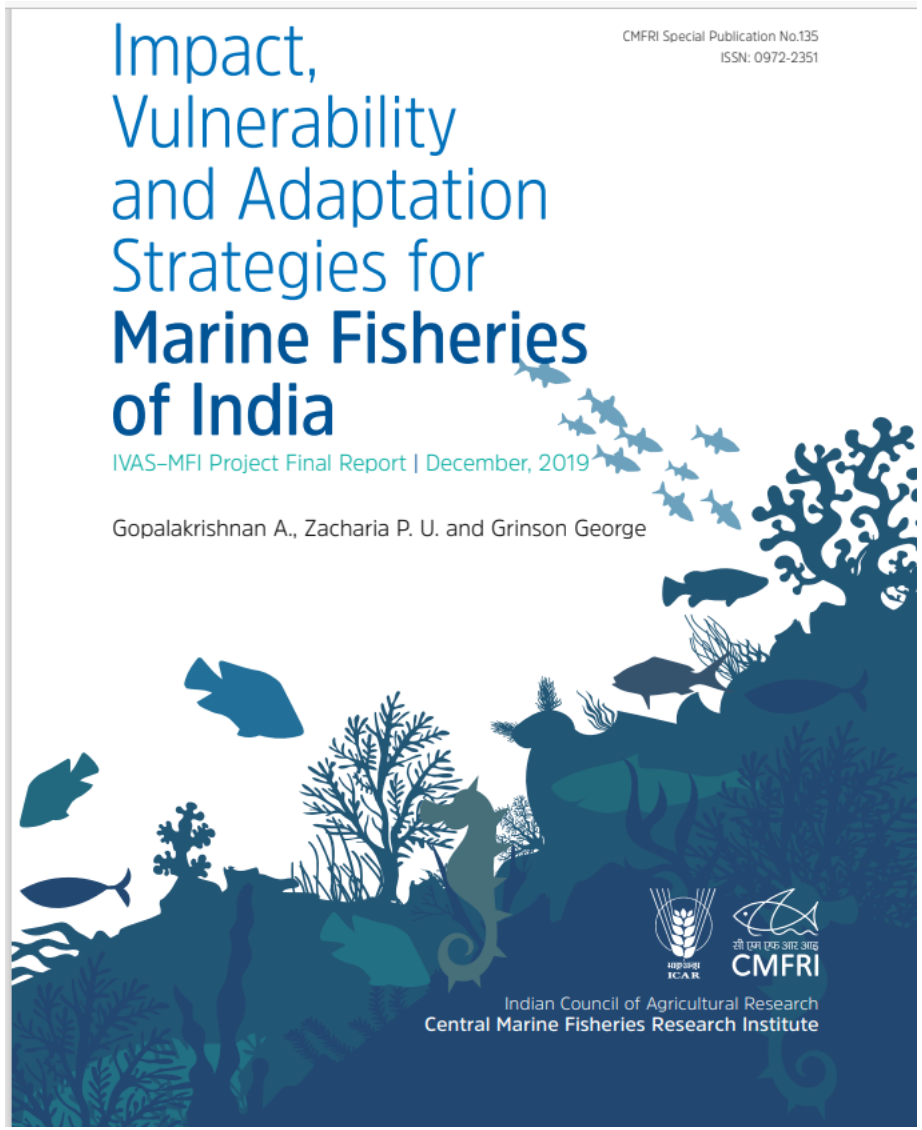
where:
V=Vulnerability
E=Exposure
S=Sensitivity
AC= Adaptive Capacity



Environmental criteria	Biological criteria	Fishery related criteria
Sea surface temperature	Fecundity	Anomaly in CPUE
Ocean current direction (S to N)	Complexity in early development	Exploitation rate
Ocean current speed	Growth coefficient	Price
Rainfall	Trophic level	Gear
Coastal upwelling index	Longevity/Life span	
Chlorophyll concentration	Lc/Lm	
	Horizontal distribution	
	Duration of spawning	
	Prey specificity	

Vulnerability assessment of resources

Zone	Vulnerability index	Pelagic	Demersal	Crustacean	Molluscs
Northwest zone	High	4	5	1	1
	Medium	4	6	7	1
	Low	2	2	2	1
Southwest zone	High	1	4	3	1
	Medium	4	8	1	1
	Low	5	1	1	0
Southeast zone	High	11	7	4	1
	Medium	3	1	2	0
	Low	1	0	0	1
Northeast zone	High	11	8	3	0
	Medium	1	3	0	3
	Low	0	0	2	0
Total		47	45	26	10



Dineshbabu AP, Zacharia PU, Sujitha T, Shoba JK and others (2020) Assessment of stock vulnerability of Indian marine fishes to past changes in climate and options for adaptation. Clim Res 79:175-192. https://doi.org/10.3354/cr01586

Impact of climatic variations on marine fisheries of India

Impacted variables	Intermediate biophysical process	Biological impacts	Fisheries impacts
Rise in SST	Change in El Niño & La Niña ; change in current and water mass movement, density	Changes in distribution and abundance of species, phenology, growing and breeding seasons, feeding habits and deformities.	Commercially important species may be replaced by low priced species
Changes in Salinity	Ocean acidification	Alters the nutrient composition, diatoms and	Reduction in overall catch of marine fishes
Decrease in pH	Alters the hydrology of estuarine ecosystems	Alters critical habitats and community structure	Affects the growth and catch rate of pelagic fishes
Changes in rainfall patterns	Destruction of corals, vessels, fishing equipment and infrastructure on the coasts, Breaking of vertical stratification where coastal upwelling is absent.		Economic drain on fisherman
Frequency of storms / cyclones	Coastal habitats such as mangroves, sea grass beds and algal biomass		Rehabilitation of fishermen into inland areas
Changes in chlorophyll composition	Inundation and physical impacts on coastal areas		
Rise in Sea level			

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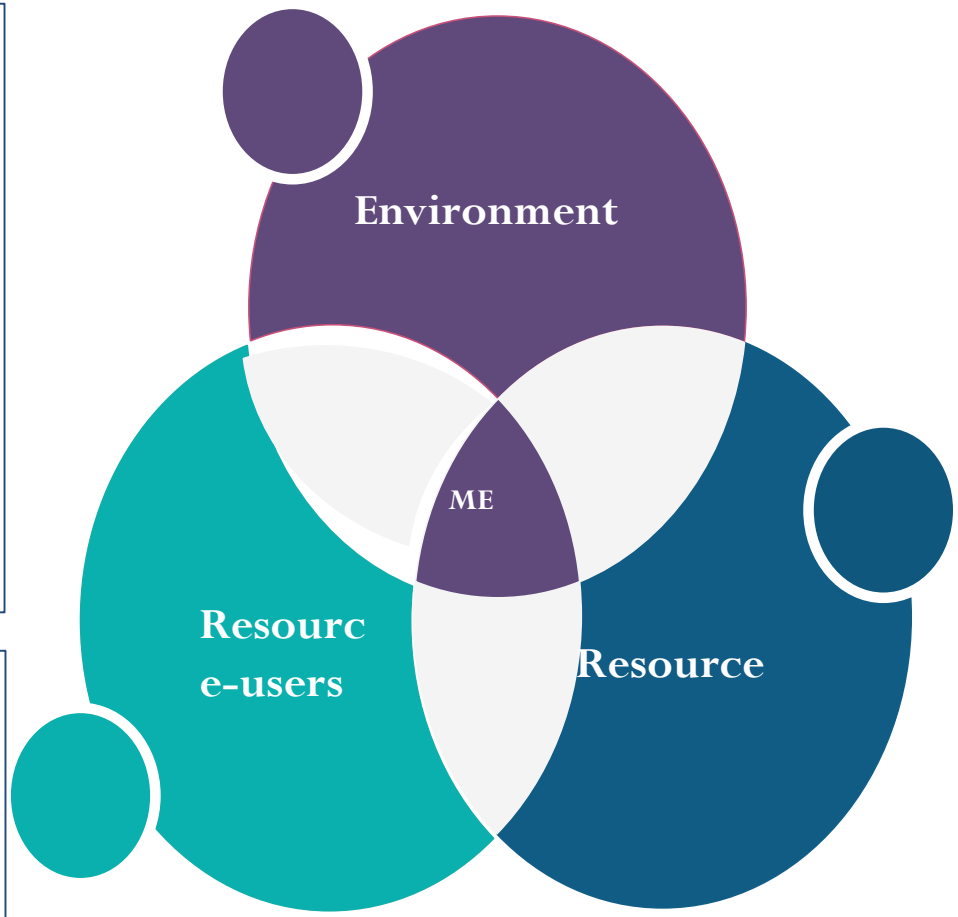
Impact on physical environment

Increased SST
Sea-level rise
Ocean acidification
Extreme weather events
Changes in rainfall and river run-off
Reduction in Oxygen levels

Impact on fishers safety at sea and livelihoods

Migration
Loss of income
Loss of Property
Health problems
Debt and Unemployment



Impact on marine resources

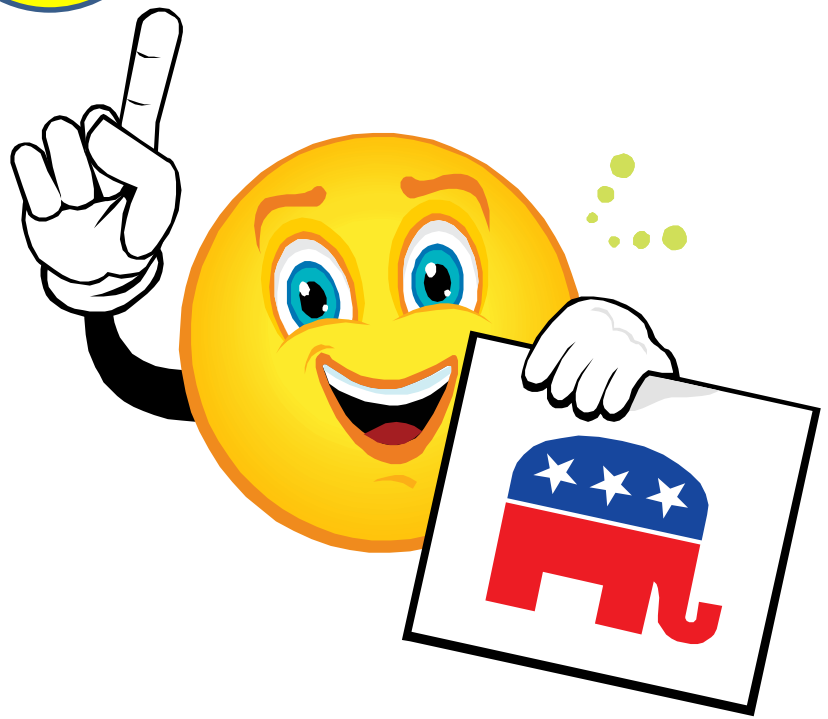
Distributional shifts of shellfish and finfish
Change in ocean and fish productivity
Coral reef habitat destruction
Changes in ocean fish productivity
Disappearance of coral reef ecosystems
Emergence/ exit of species

Credits: PUZ & SS, CMFRI

Shared Socioeconomic Pathways - SSPs

- Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation)
- Middle of the Road (Medium challenges to mitigation and adaptation)
- Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation)
- Inequality – A Road Divided (Low challenges to mitigation, high challenges to adaptation)
- Fossil-fueled development – Taking the Highway (High challenges to mitigation, low challenges to adaptation)

Do we have some strategies?



Adaptation framework for Marine Fisheries

Influencing parameters/ variables	Vulnerabilities	Adaptation Strategies
SST, Salinity, Sea Level Rise SST, Rainfall, Chlorophyll, Wind pattern pH SST GHGs emissions Wind pattern (Extreme events) Sea Level Rise	Ecosystem damage- Mangrove, Coral reefs, seagrass beds	• Habitat mapping, monitoring and management • Coastal wetland management and scientific fish farming • Vulnerability assessment and monitoring of fisheries resources • Potential Fishing Zone Advisories • Mariculture of climate resilient species • Preventive health management Seaweed farming and bioproducts development • Implementation of minimum legal size • Sustainable fisheries resource utilization • Algal Biorefineries Integration • Harvesting solar energy from oceans • Multivendor E-Commerce solutions for income improvement • Low cost fishing technologies development • Adoption to Integrated farming techniques • Enhancing preparedness of coastal population • Climate Resilient Coastal Village development
	Changes in distribution, abundance, phenology and trophodynamics	
	Ocean Acidification	
	Reduction in fecundity/size	
	Increased C footprint in fishing operations	
	Income loss due to decline in catch and loss of fishing days	
	Inundation and physical damages on coastal areas	

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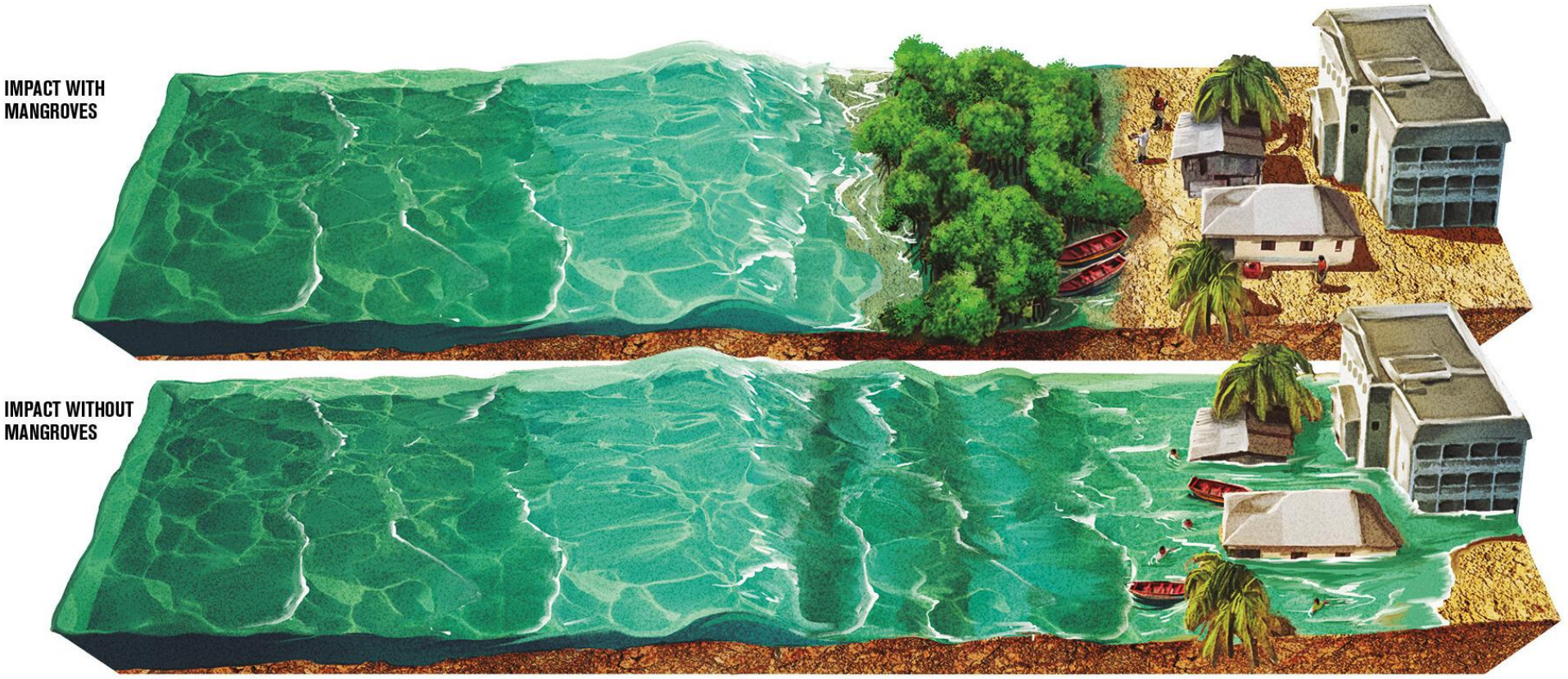
Mangrove restorations– global mitigation efforts



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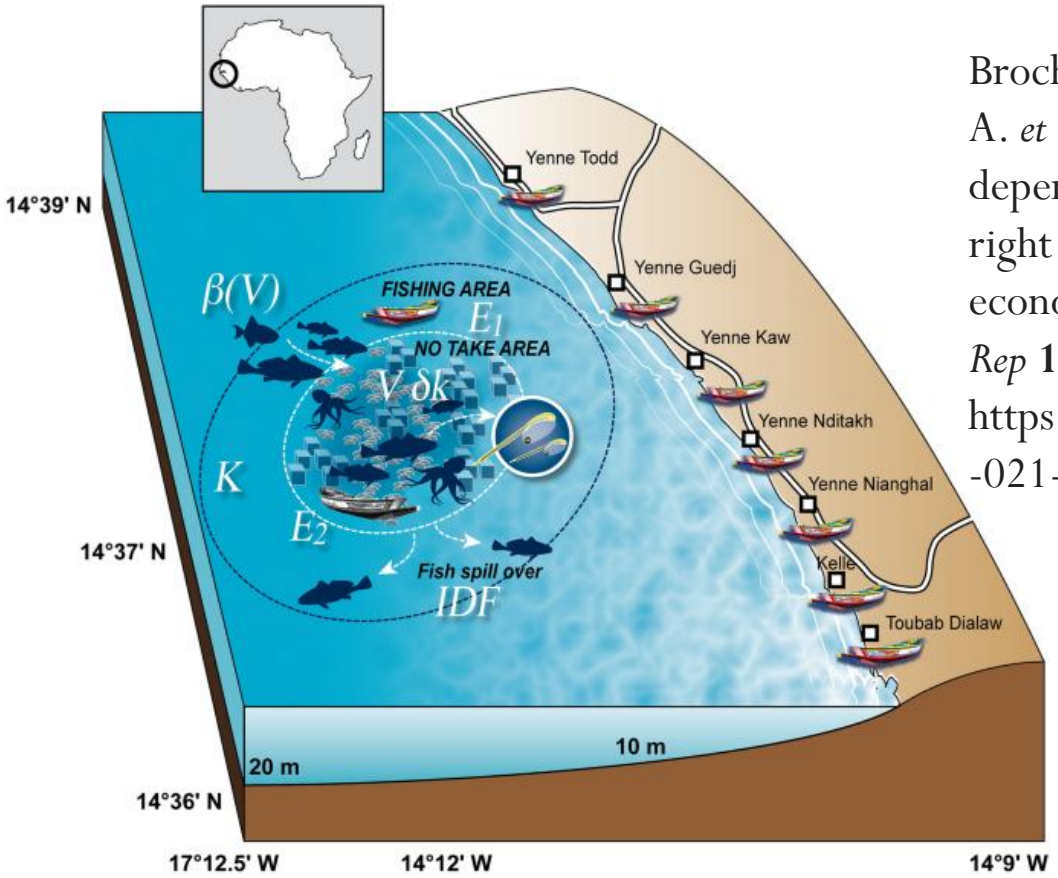
Credits: Dr Joe K Kizhakudan, CMFRI



Brochier, T., Brehmer, P., Mbaye, A. *et al.* Successful artificial reefs depend on getting the context right due to complex socio-bio-economic interactions. *Sci Rep* **11,** 16698 (2021). https://doi.org/10.1038/s41598-021-95454-0


8/27/2020 Artificial reefs to boost fishing in Pulicat - The Hindu

CHENNAI

Artificial reefs to boost fishing in Pulicat

SPECIAL CORRESPONDENT

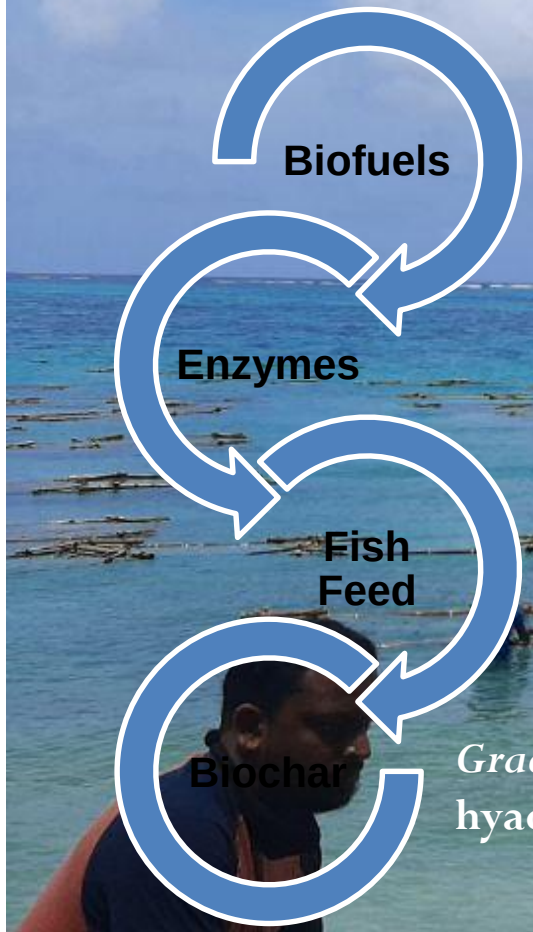
CHENNAI, JANUARY 22, 2018 00:26 IST
UPDATED: JANUARY 23, 2018 13:52 IST

CMFRI scheme to aid in breeding of fish and re-establish biodiversity in the area

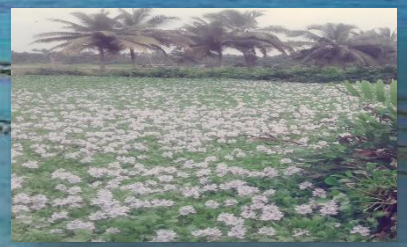
IMTA – credits Drs. R. Jayakumar & B. Johnson, CMFRI-Mandapam

Climate Resilient Products Development

- Seaweed farming and biorefinery integration
- Aquatic vegetation could be used as substrate for climate resilient product development
- Seaweed based bio-products and biorefineries can scale up farming
- Application of biochar as fish feed resulted in enhanced growth of Tilapia and increases the Pokkali growth



Gracillaria, Water hyacinth, *Sargassum*



Water hyacinth based biochar was produced in Muffle furnace

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Integrated farming Technologies

- To enhance the adaptability, profitability and sustainability of fisheries sector, proven integrated farming technologies could be utilized.
- The prospective techniques include ranching, integrated multi-trophic aquaculture (IMTA), Paddy-fish farming, and integration of renewable energy components. Indian coastal waters could be explored as zones for seaweed farming, which promises itself as a climate resilient strategy.

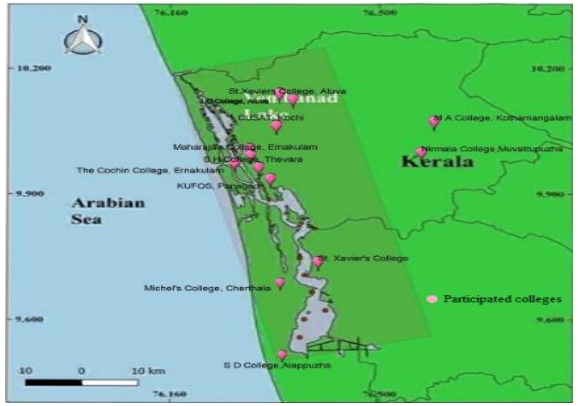
Measurement and monitoring of GHGs and C footprint

- ✓ Sampling through a fabricated floating chamber and simultaneous analysis of greenhouse gases (GHGs), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from the aquaculture ponds
- ✓ Continuous measurement of GHGs could be done to monitor the emission trends.
- ✓ The adaptation options in case of higher emissions could be microbial interventions, enhancing the carbon sequestration potential of shrimp culture pond sediment and biochar synthesis from aquaculture ponds

Floating chamber for collection of GHGs flux from aquaculture ponds

Water quality monitoring using Mini Secchi Discs

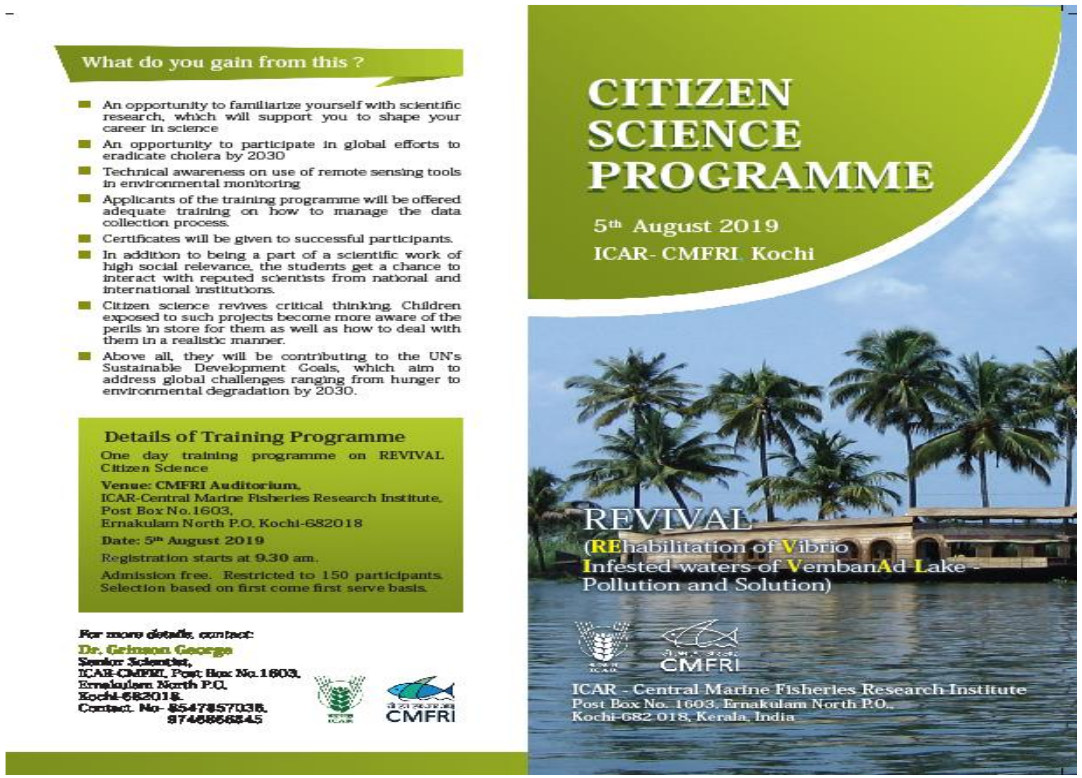
Colleges participated in citizen science



Mini Secchi Disc

Mobile app “TurbAqua

First step towards Citizen Science Programme…..



Students participate in Vembanad Lake mapping

TIMES NEWS NETWORK

R K Sreejith

Students collect data for a research project for optical mapping of Vembanad Lake, near Bolgatty Palace on Monday

Kochi: Around 250 students from 16 colleges joined a multi-institutional research project for optical mapping of Vembanad Lake on Monday as part of a campaign by the Central Marine Fisheries Research Institute (CMFRI) to promote citizen participation in scientific research.

The students started collecting data for the study using Secchi disc — a simple hand-held device to measure turbidity level of water — after undergoing training at the CMFRI. They were also trained to upload the collected data using a mobile app which was developed as part of the project. The students are from colleges in Ernakulam, Alappuzha and Kottayam.

The research project is aimed at understanding the extent of pathogenic vibrio pollution in the Vembanad lake, identifying their reservoirs in the ecosystem, mapping the distribution of vibrio carriers using remote-sensing techniques and developing forecast models that would serve to anticipate hotspots of microbial infection.

During the launch of the citizen participation initiative, CMFRI director A Gopalakrishnan said that massive participation of students would enhance the frequency and spatial extent of data collection, which is a crucial factor in a research initiative especially the study on Vembanad Lake.

The study is jointly carried out by CMFRI, National Institute of Oceanography (NIO), Nansen Environmental Research Centre-India (NERCI) and Plymouth Marine Laboratory, UK, under the India-UK Water Quality Initiative of the Department of Science and Technology, Government of India.

- 1st CSP- Students interaction
- Hosted on- 09th August 2019
- Participants- 250 students from16 colleges

Hands on training on Mini secchi disc & TurbAqua app.

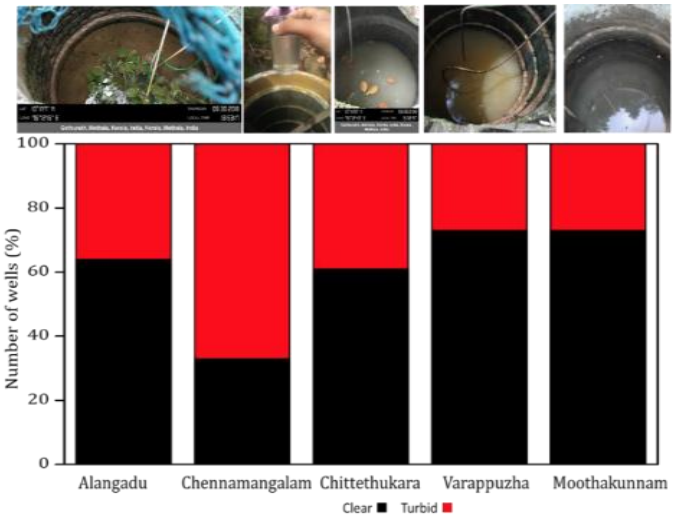
- **WP2:** Citizen Science
- WP5: User participation and engagement

- Joined hands with a team of experts from district administration, health department, WHO, UNESCO to take preventive measures to control disease outbreaks after the once-in-a-century flood happened in Kerala
- organized a well mapping mission, and supplied cleaning kits
- Water clinic was started to support analysis of well water samples from affected areas
- Conducted a training program for health inspectors of Ernakulam district

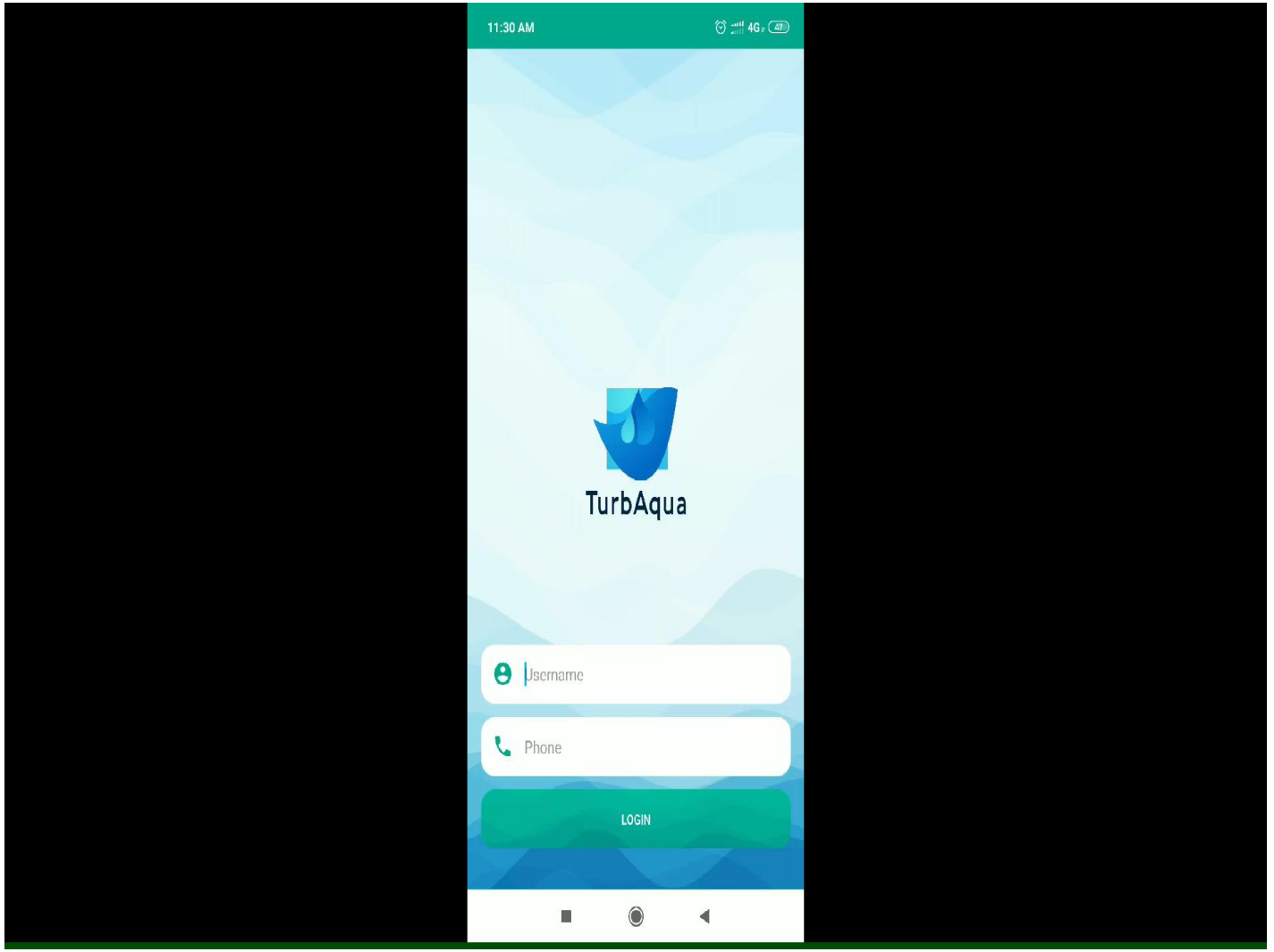
Now, a mission to categorise wells in flood-hit areas

THE HINDU, 6/9/18

Programmes to make well water potable in Paravur and Aluva



- **WP2: Citizen Science**
- **WP5: User participation and engagement**
  - **A Mobile application is designed for public participation in citizen science**
  - **Secchi disks are continuously used in our field work**
  - **Distributed to students from CUFOS Cochin and St. Xavier college Vaikom**



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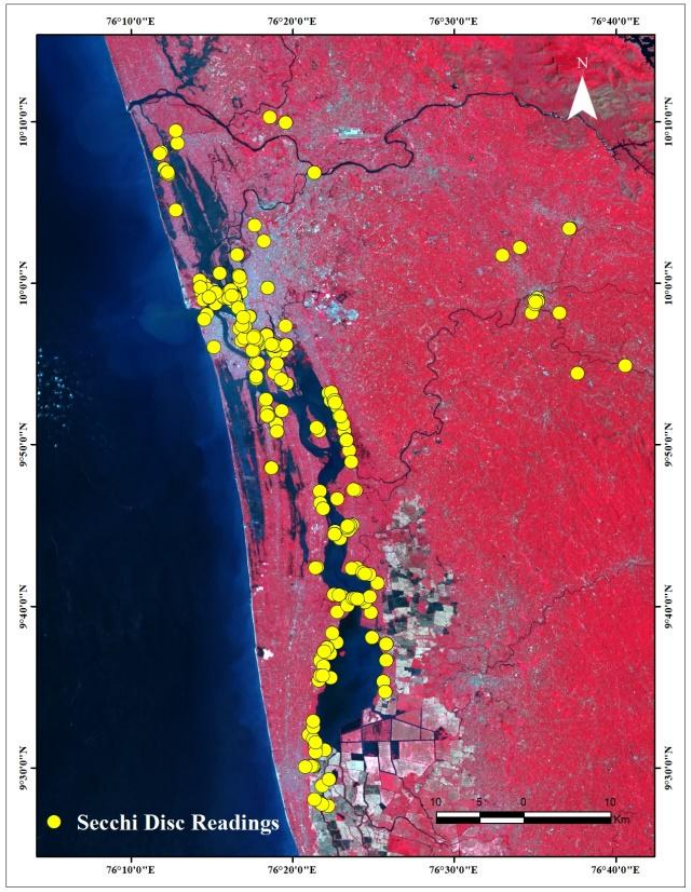
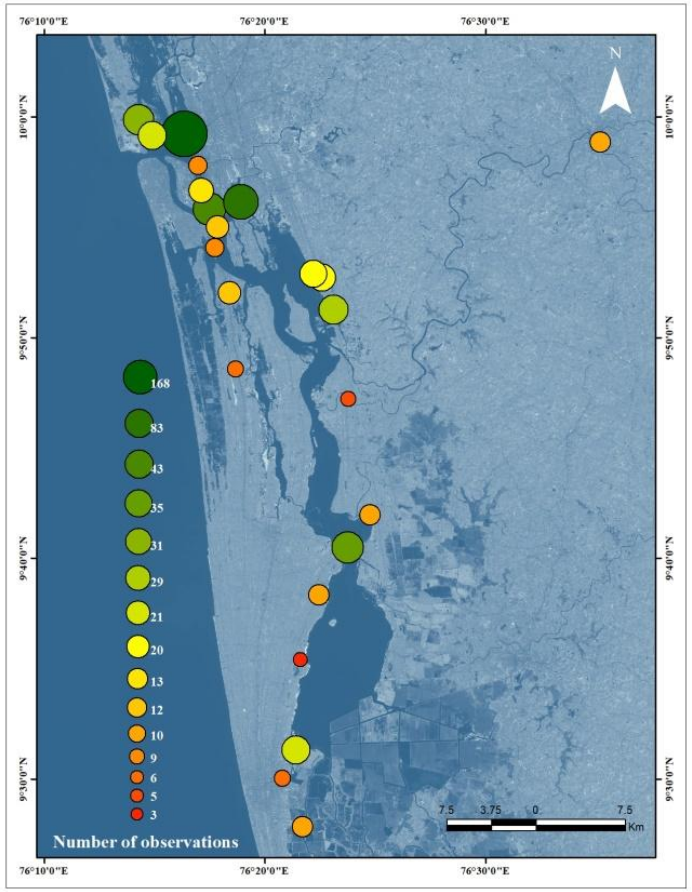
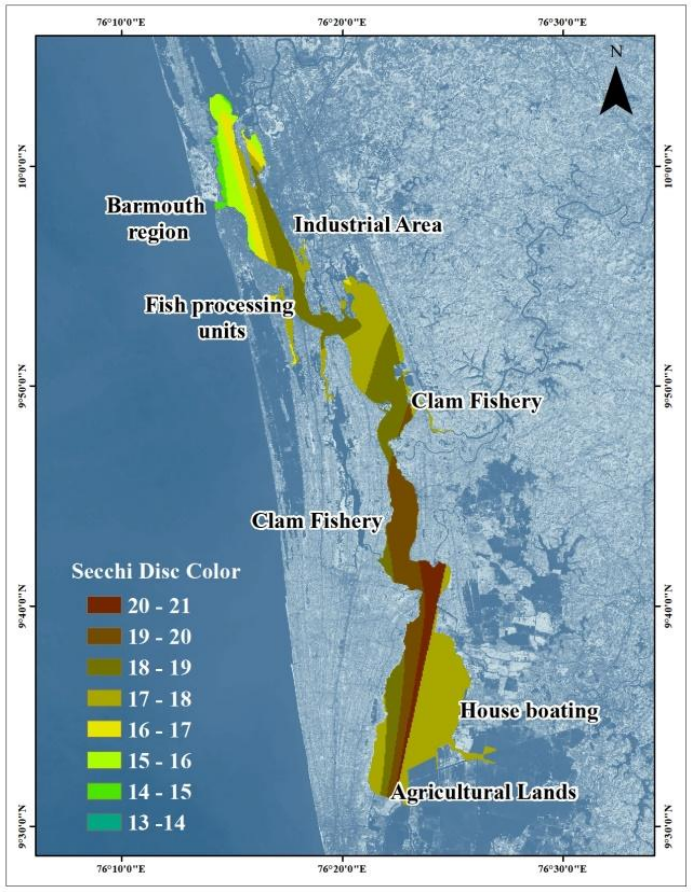
SECCHI DISC READINGS



CITIZEN SCIENCE OBSERVATIONS



SPATIAL PLOTS BASED ON LAKE UTIILIZATION



Climate Resilient Village Development

Income Improvement for Fisher Folks

Socio Economic Resilience

Components: Admin panel, Vendor panel, Store Front

Multivendor E-Commerce Framework to Enhance Coastal Fishermen Income

- **Support farmers to advance in supply chain**
- **Empower fisher youth in Aqua Entrepreneurship**

www.marinefishsales.com

Women selling fish in Kollam. They say they are targetted by the police and local officials despite following the COVID-19 guidelines. | Photo Credit: C. Sureshkumar

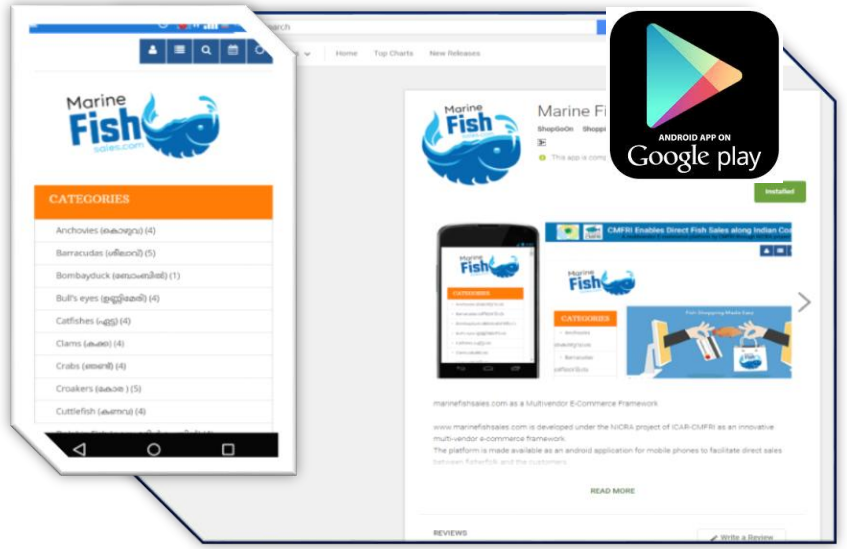
They are aghast at the lukewarm response of government to incidents of ill-treatment

COVID-19 related curbs, difficulty in commuting, and arrival of sophisticated supply chains and apps during the pandemic have made life difficult for women engaged in fish vending across the State.

While incidents of police brutality and ill-treatment by protocol enforcers are on the rise, the women say they are aghast at the lukewarm response of the government that considers safety of women a priority.

In contrast to typical e-commerce ventures where single firm/company as major profit beneficiary, www.marinefishsales.com engages multiple fishermen SHGs as beneficiaries.

Android App 'marinefishsales'
Available for Download in Google Play Store



Fish seller in Thiruvananthapuram claims police threw her fish in the dirt

Onmanorama Staff
Published: August 25, 2021 10:21 PM IST

THE NEW INDIAN EXPRESS

NATION | WORLD | STATES | CITIES | BUSINESS | SPORT | GOOD NEWS | MOVIES | PHOTO

STOCK MARKET BSE 60059.06 381.23(0.64%) NSE 17895.2

Home › Cities › Thiruvananthapuram

Municipal staff throw off fish kept for sale by woman

Visuals of incident go viral putting the government on the backfoot

Govt. of Himachal Pradesh allocated funds in state budget for implementing the same in their state; accordingly Training & Implementation Guidelines has been provided to Dept of Fisheries, HP.

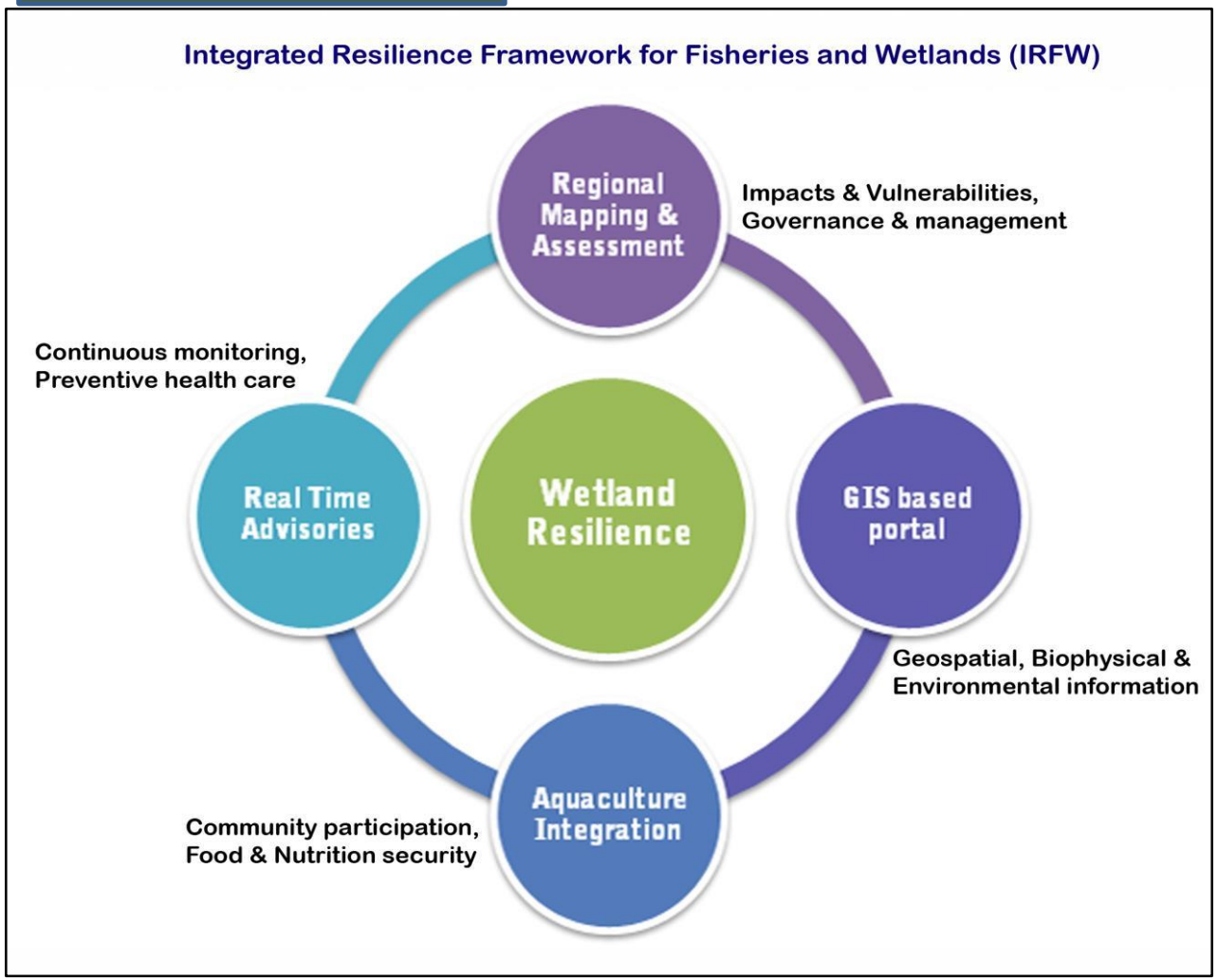
Ecological

Resilience

Eco Monitoring

Focus

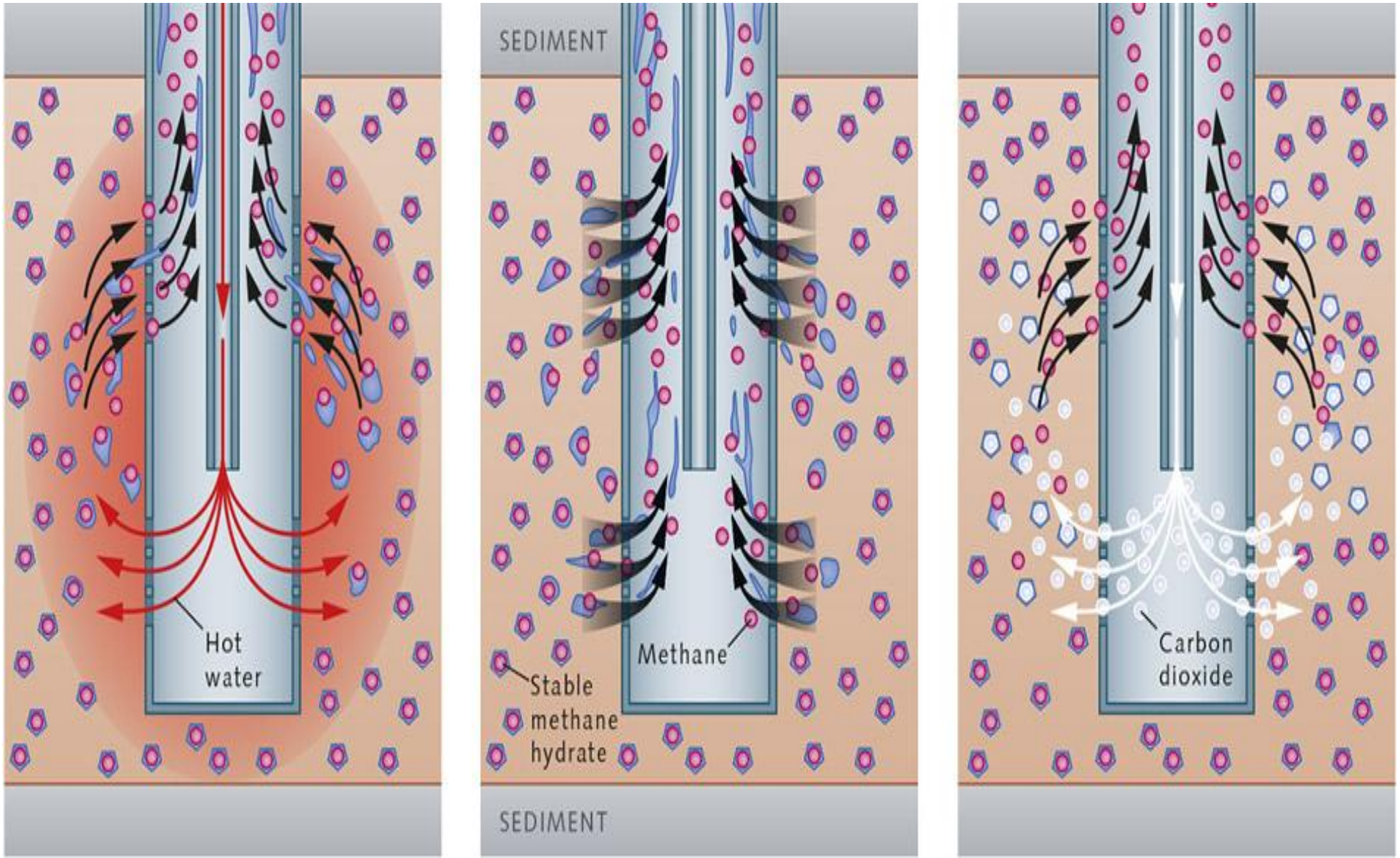
- **Monitoring GHG emissions from regional wetlands**
- **Generate continuous qualitative and quantitative data on small (<2.2ha) wetlands using aquaculture and geospatial monitoring**
- **Develop village level wetland advisories and continuous monitoring system**



Actions

- Location data on small wetlands obtained from Space Application Centre (ISRO), Ahmedabad
- **National wetland portal and Android App** being developed in association with SAC, Ahmedabad for wetland data collection and dissemination (physico-chemical and microbiological)
- MOU signing between ISRO and CMFRI on March 6th 2019

Methane Hydrate Mining using CO_2 Filler



Resilience Indicators for coastal fishermen community

Vulnerability in marine fisheries due to CC	Possible measures for resilience	Indicators of measurement of resilience
Reduction in livelihood options of coastal fishermen due to reduced catches	Low -cost cage farming (Both estuarine and mariculture) Pond culture silver pompano (Seed Bank) Empowerment of fishermen through CBA Integration of fish farming with saline tolerant pokkali paddy farming in the fields	1. Number of fishermen adopted the alternative options of livelihood 2. Area under cage farming/pond culture of silver pompano/ CBA 3. Increased income to fishermen/farmer 4. Increase in farming days/fishing days 5. Increased production from coastal area 6. Institutional support for alternative farming technologies 7. Tolerant varieties used by farmers (Saline tolerant silver pompano) 8. Seed availability 9. Feed availability 10. Availability of Institutional credit and advisories
Coastal village vulnerability	Development of Participatory Attitude on Preparedness, Adaptation and Mitigation (APAM) framework	1. Number of villages with such framework developed 2. Degree of awareness about CC among coastal villagers 3. Increase in infrastructure developed 4. Number of mitigation measures applied in the village 5. Adoption of alternate livelihood options suggested
Loss of livelihood due to natural hazards	Establishment of early warning systems. Installation of Automatic weather stations under NICRA, weather/catch forecast	1. Availability of early warning systems 2. Availability of weather forecast 3. Availability of PFZ advisories 4. Availability of community gathering centres 5. Awareness among fishermen about history of natural hazards
Reduced income to fishermen community	Multivendor E-commerce facility for fishermen SHGs for community empowerment and better income.	1. Increase in the share of fishermen in consumer rupee 2. Number of SHGs benefited 3. Increase in profit for fisheries stake holders 4. Number of such facility established

Policy strategies recommended by the fisheries section of SAARC

- Identification of problems and vulnerability issues
- Develop South Asian lab network for support & response on issues
- Scale-up best practices in fisheries & aquaculture compatible to climate change
- Alternate energy sources to reduce carbon foot print in fisheries and aquafarming
- Saline, temperature tolerant and fast growing species
- Seasonal aquaculture in perennial waterbodies, farming of carbon sequestering species
- Prioritize for market access, technology, management and operating environment
- Modern farming systems such as RAS, IMTA, cage farming, pen culture, raceway aquaculture and offshore aquaculture based on diversification needs
- Spatial mapping of aquafarming sites by identifying zones of suitable water quality and reducing conflicts among open water bodies and resources
- Ecosystem restoration for mangroves, reefs (artificial reefs) and similar

http://www.sac.org.bd/archives/Policy_Brief/SAC%20Policy%20Brief%20-%2012.pdf

3. Climate change impact on fisheries and Aquaculture: Making fisheries and aquaculture more adaptive to climate changes

Vulnerability of fishery and aquaculture in the South Asian Region

Bringing unutilized water bodies as horizontal expansion of aquaculture

Practicing seasonal aquaculture in water bodies as climate change adaptation strategy

SAARC Agriculture Centre conducted Regional Consultation on Climate change impact in fisheries and aquaculture

Take home message

- ✓ Climate change is certain and scientific evidences indicate some key issues related to marine ecosystems
- ✓ There are manifestations in different forms – extreme events, sea level rise, ecosystem changes and many more
- ✓ Adaptation strategies are developed with a national plan, let us abide and execute
- ✓ Resilient and diversified livelihood options can be a game changer
- ✓ Do remember that we have citizen science initiatives – join hand in hand with science for data collection and support

Acknowledgements


Afghanistan


Bangladesh


Bhutan


India


Maldives


Nepal


Pakistan


Sri Lanka

Ministry of Environment, Forest and Climate Change
Government of India

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

National Oceanic and Atmospheric Administration
U.S. Department of Commerce