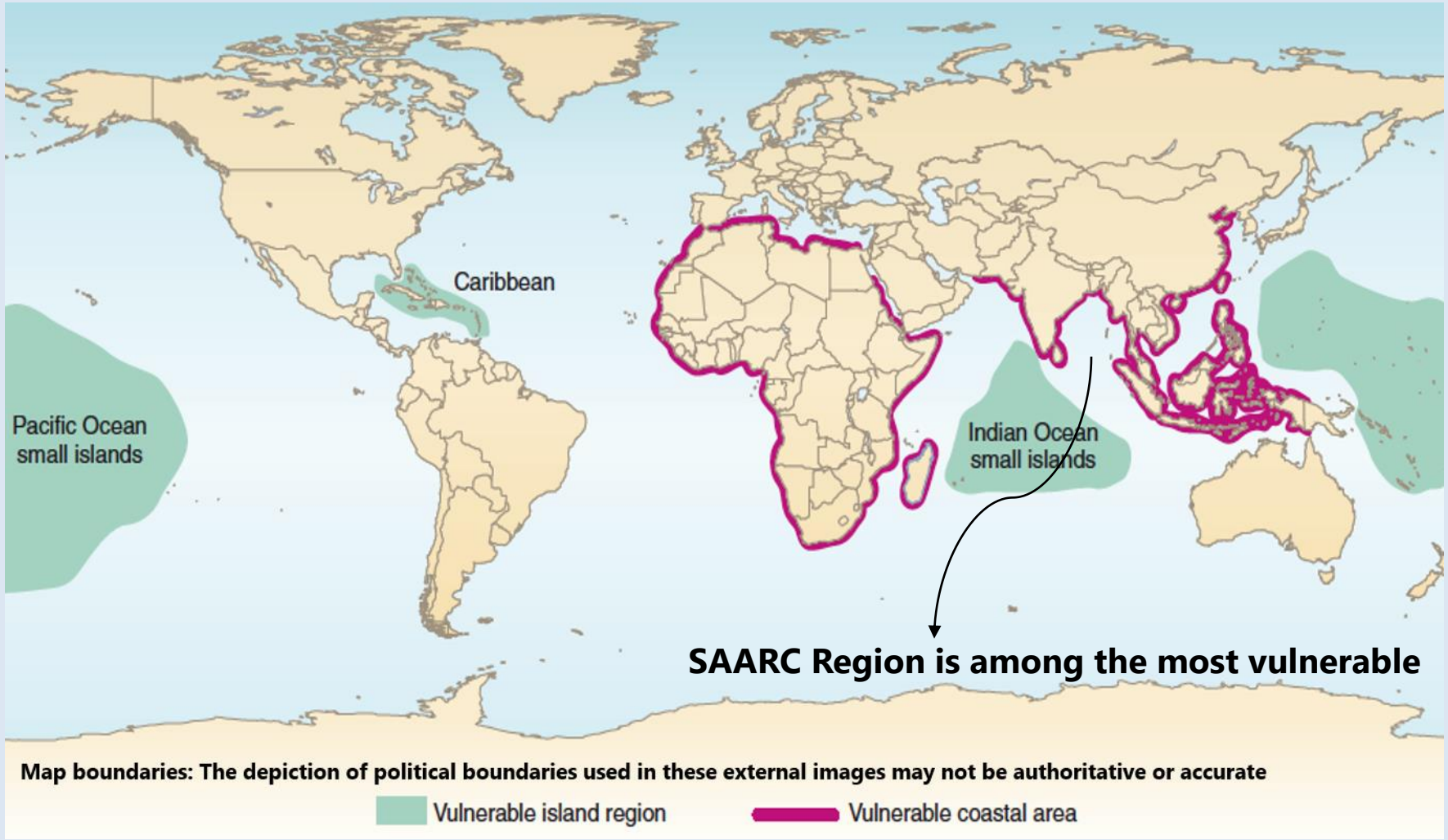
Climate Change and Extreme Weather Events in the SAARC region

SAARC region comprises nearly 23% of the world's population and is one of the most disaster-prone regions in the world.

Given the geographical location of the region and the cascading impacts of climate change, the extreme weather events are increasing in intensity and frequency.

These events include cyclones, excessive rainfall, heatwaves, drought conditions, locust attack, etc.



Roxy Mathew Koll
Indian Institute of Tropical Meteorology, Pune

SAARC
Disaster Management Centre

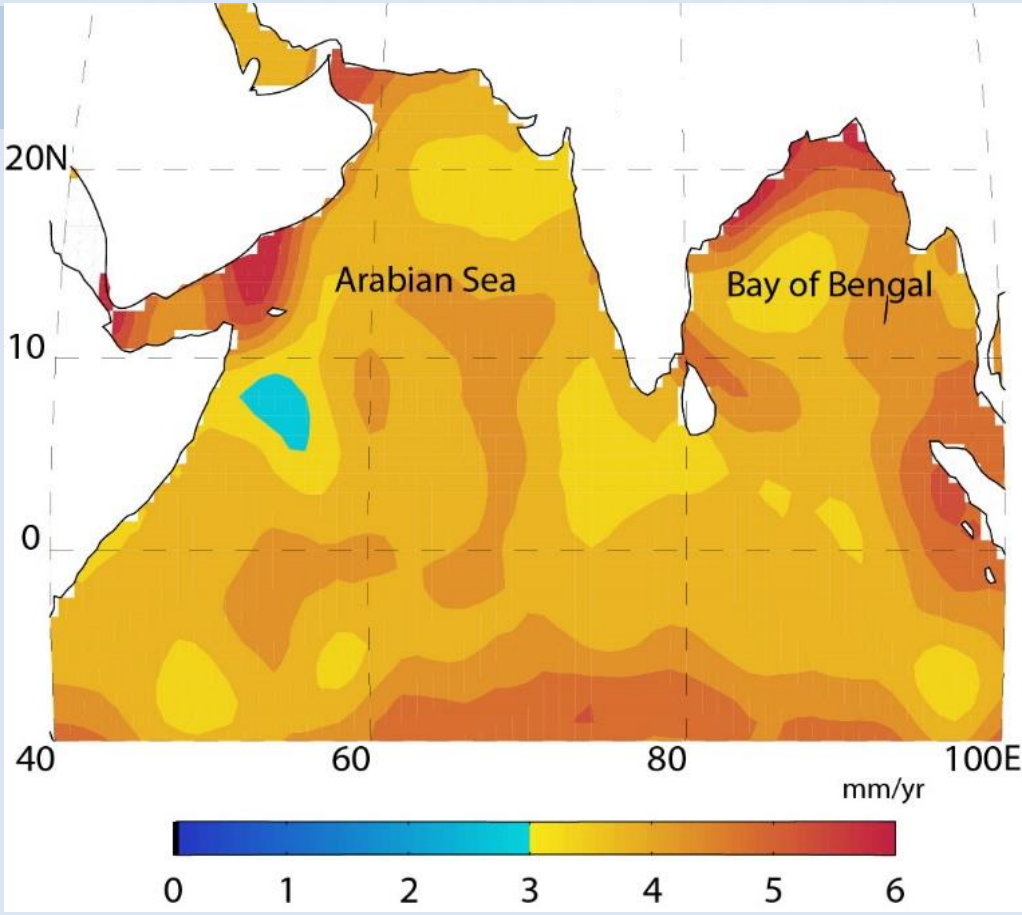
Sea Level Rise

During the 20th century, global sea level rose by about **15 cm**.

Sea level is currently rising more than twice as fast and will further accelerate reaching up to 1.10 m in 2100 if emissions are not sharply reduced.

Many low-lying coastal cities and small islands will be exposed to risks of flooding and land loss annually by 2050, especially without strong adaptation.

Rate of Sea Level Rise



Sea Level Rise at 3-6 cm per decade

Sea level changes are not uniform, some regions show more sea level rise than others.

Reason: Non-uniform ocean warming. Sea level changes happen due to melting ice/glaciers and ocean warming.

Water expands as it warms

Visible Impacts of Sea Level Rise in the Indian Ocean

Bramble Cay Melomy is the first species to be extinct due to anthropogenic climate change.

Sea level rise inundated the east Indian Ocean island where they lived.

Adapting and Mitigating @ Vaan Island — Seagrass and Coral restoration

Biodiversity has increased after seagrass restoration

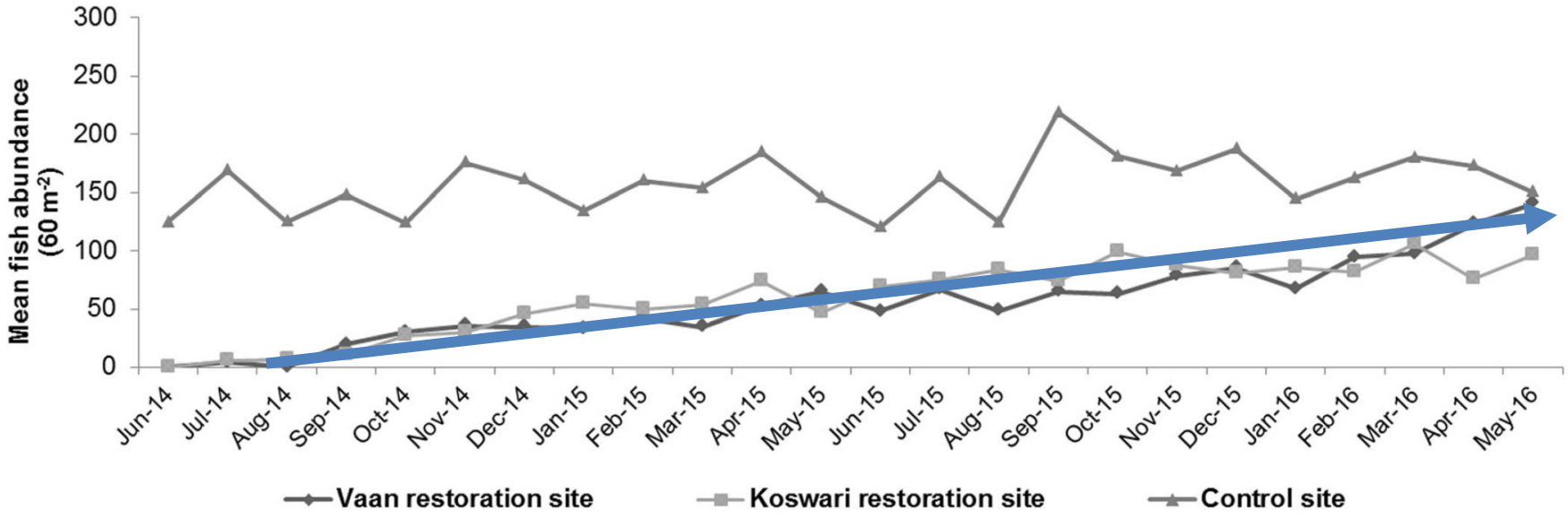


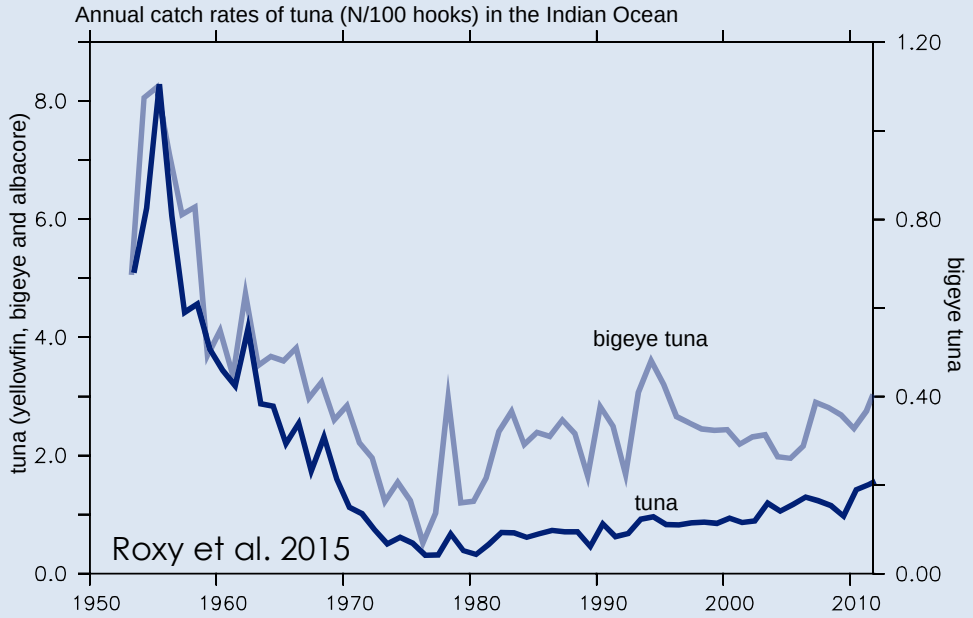
Fig. 9 Temporal variations in fish abundance in the restoration sites and control site (60 $m^{-2} \pm SE$)

Fisheries under Climate Change

Tuna catch rates have declined over time (1950–2015).

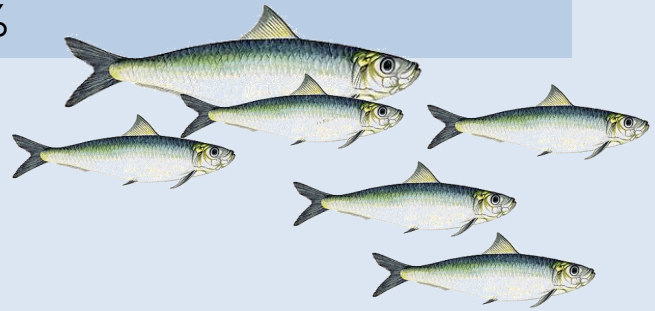
Largely due to largescale industrial fishing.

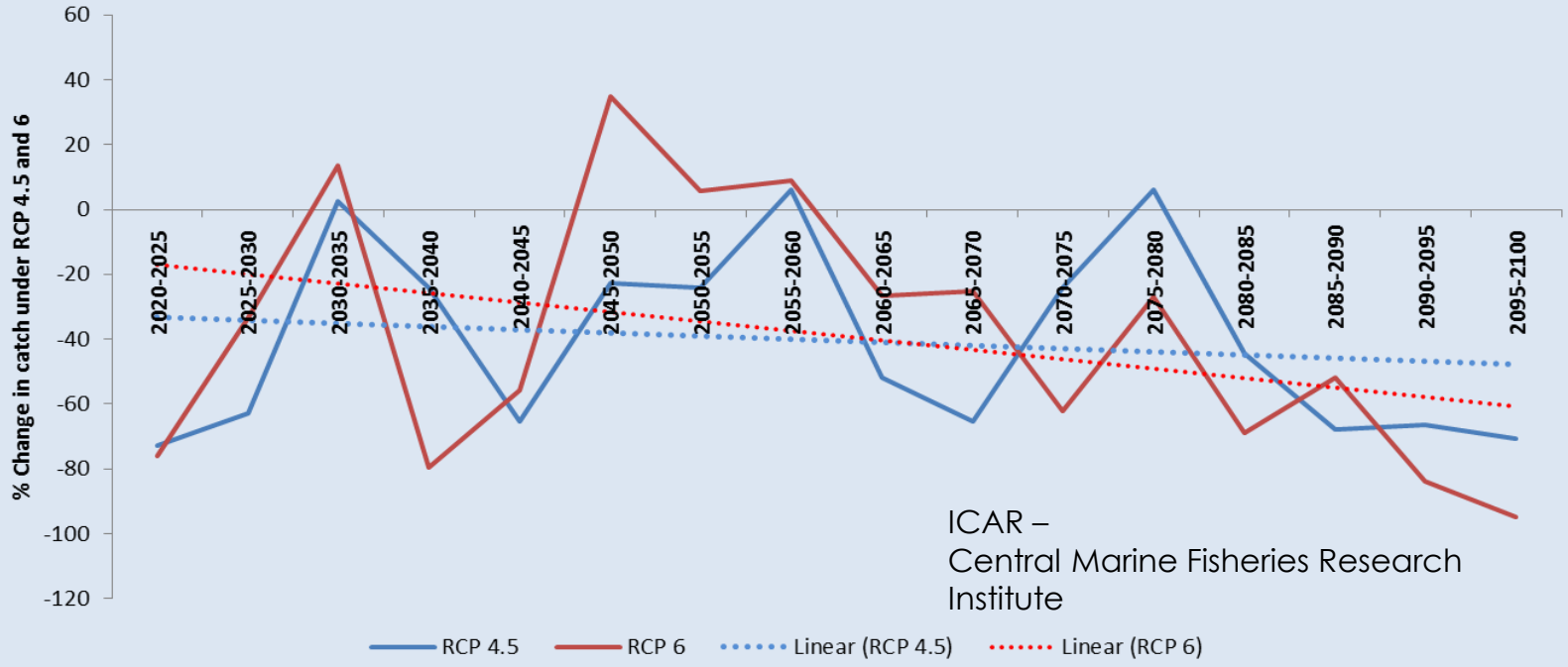
But **ocean warming and consequent decrease in phytoplankton production is an added stressor in the Indian Ocean**



Sardine catch rates are projected to decline in the future (2020–2100).

By 20–60%

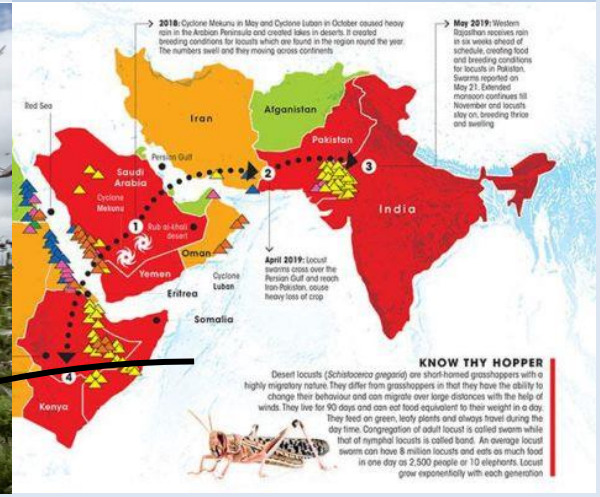




ICAR –
Central Marine Fisheries Research Institute

Locust swarms

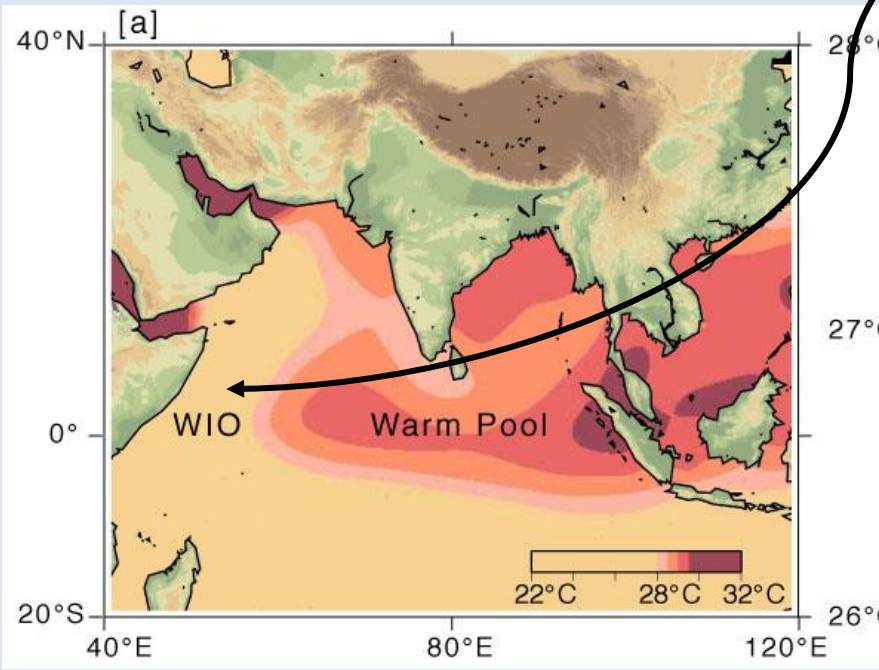
Locusts



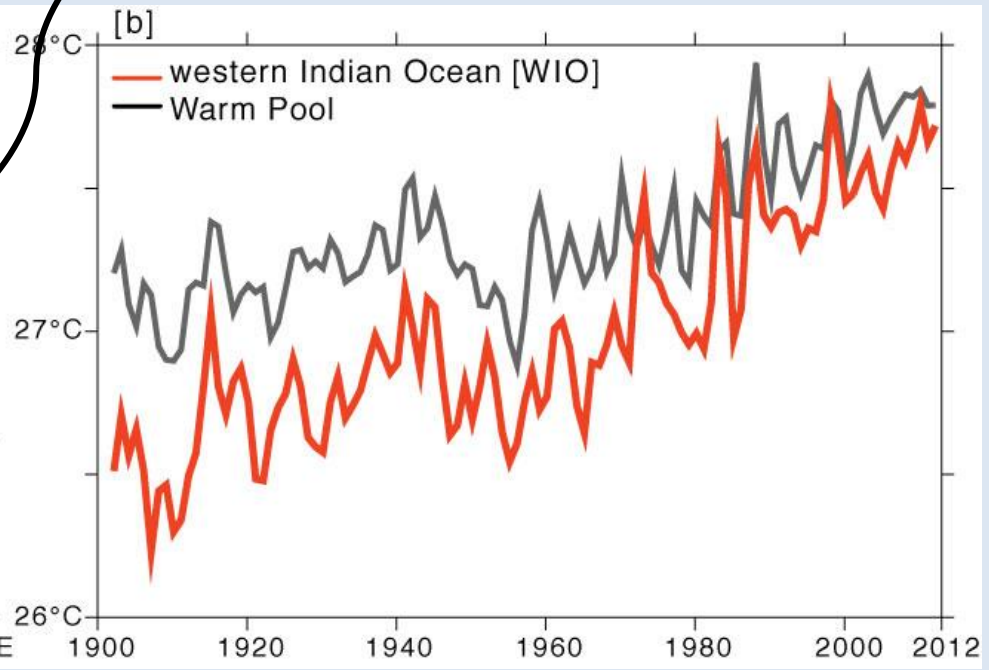
Locust swarms started in East Africa following heavy rains of 2018-2019.

Western Indian Ocean warming activated storms and rains in this region. This triggered vegetation over the deserts.

Normal Ocean Temperatures



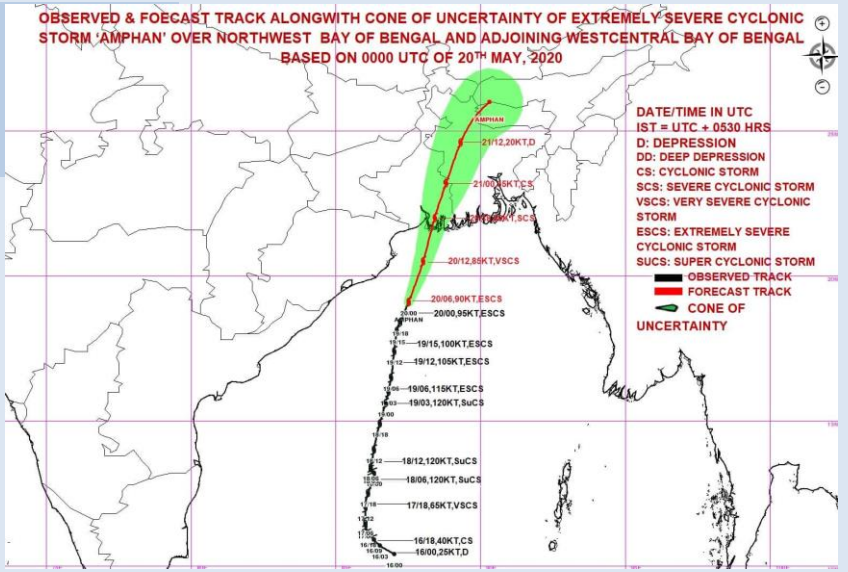
Change in Ocean Temperatures



Tropical Cyclones

	Odisha Super Cyclone 1999	Phailin Very Super Cyclone, 2013	Amphan Super Cyclone, 2019
Loss of human life	10,000+	21	118
Ex-gratia by Govt @ Rs 6 Lakhs	Rs 593 Crores	Rs 1.26 Crores	
Area of evacuation	500 km (approx.)	180 km	

Cyclone Amphan - Track and Forecast



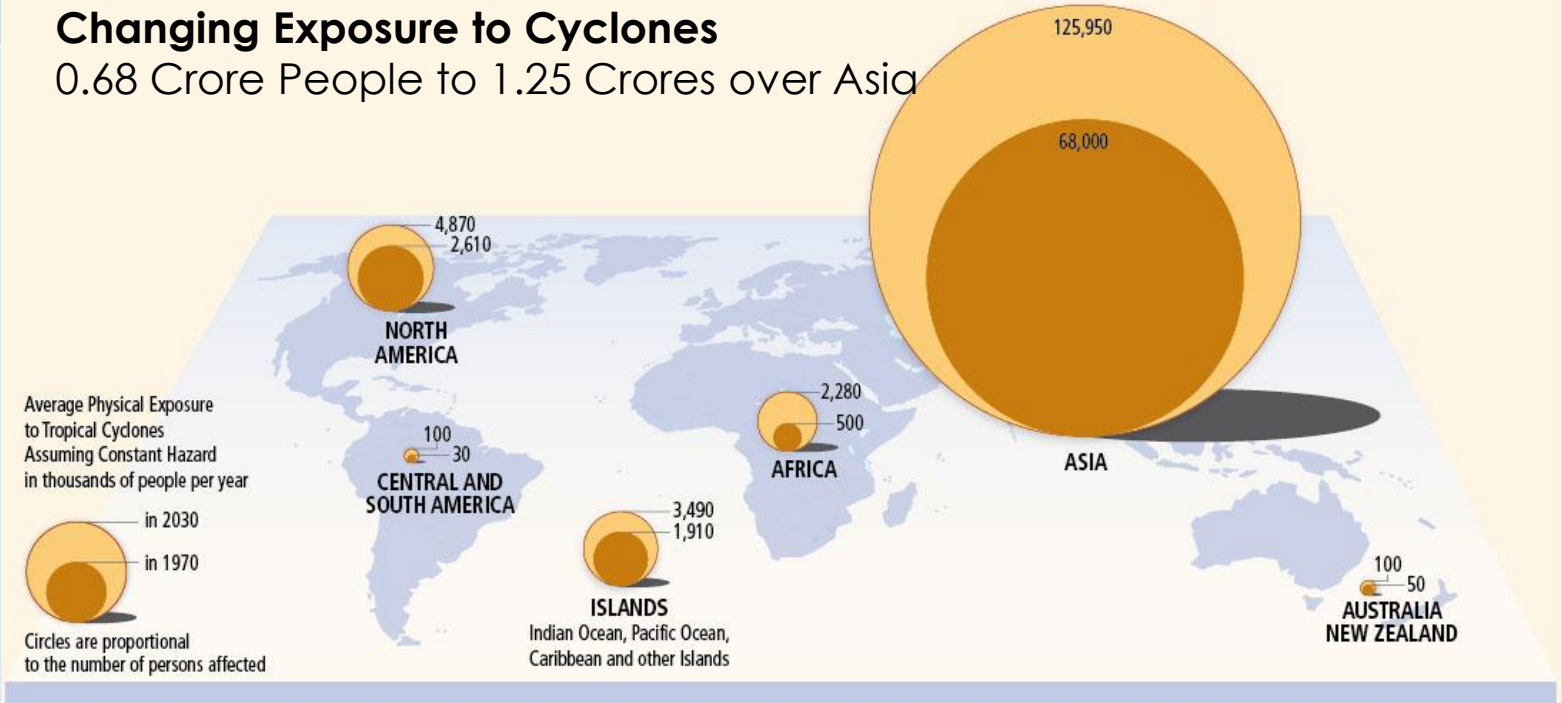
Arabian Sea and Bay of Bengal together contributes to only 6% of global cyclones, but 80% of fatalities.

Cyclone forecasts have improved, and lives are saved

but cyclone characteristics are becoming erratic and unpredictable

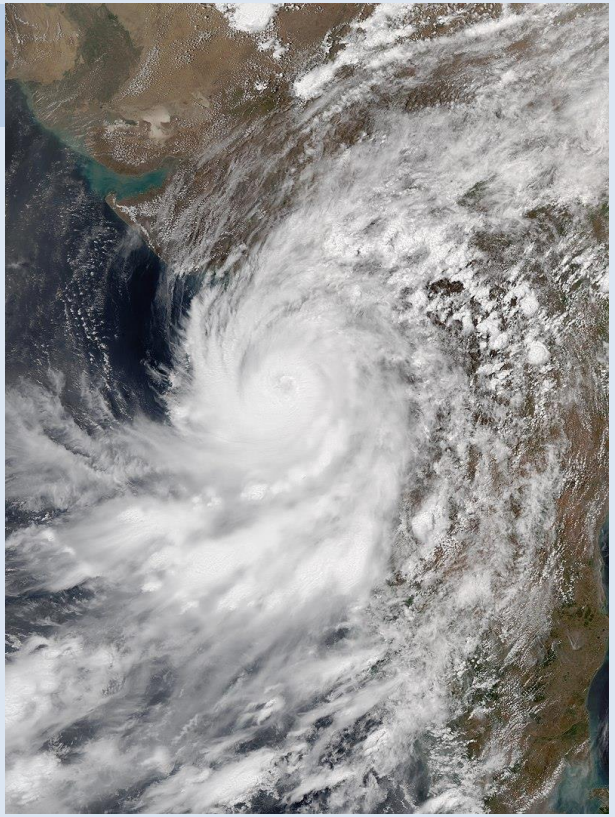
Changing Exposure to Cyclones

0.68 Crore People to 1.25 Crores over Asia

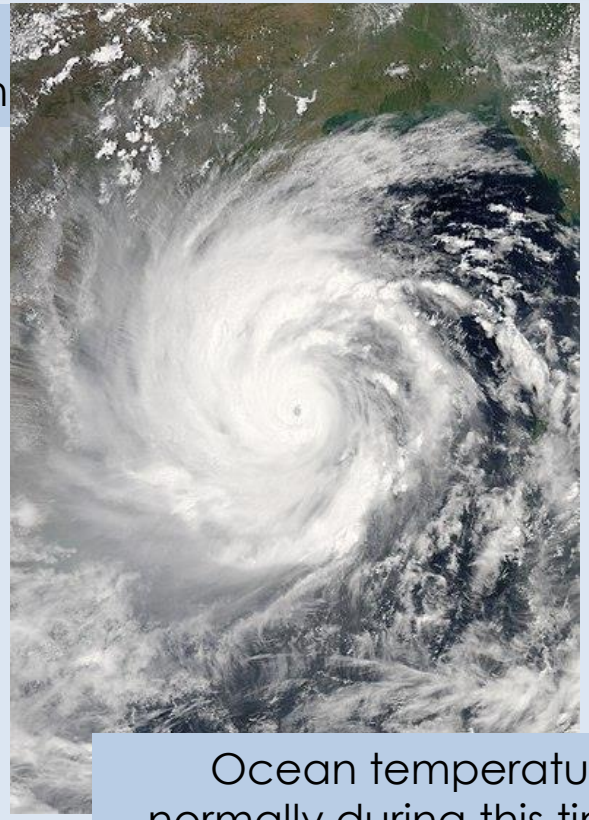


Rapid intensification of Tropical Cyclones due to ocean warming

Cyclone Nisarga



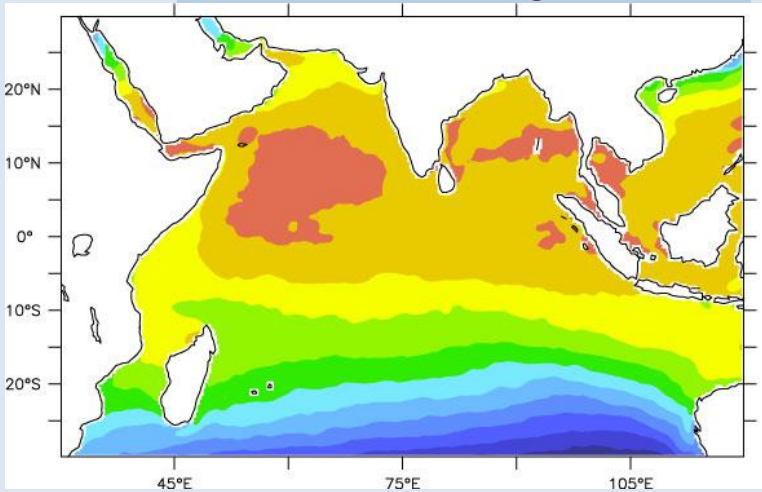
Cyclone Amphan



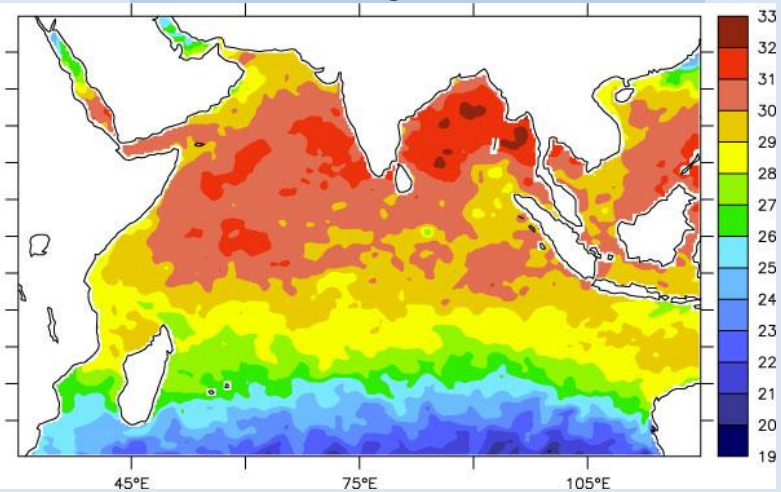
Cyclones are intensifying rapidly now. Amphan intensified from Cat1 to Cat 5 cyclone in 18 hours.

Predicting the rapid intensification of cyclones is a difficult task for weather models.

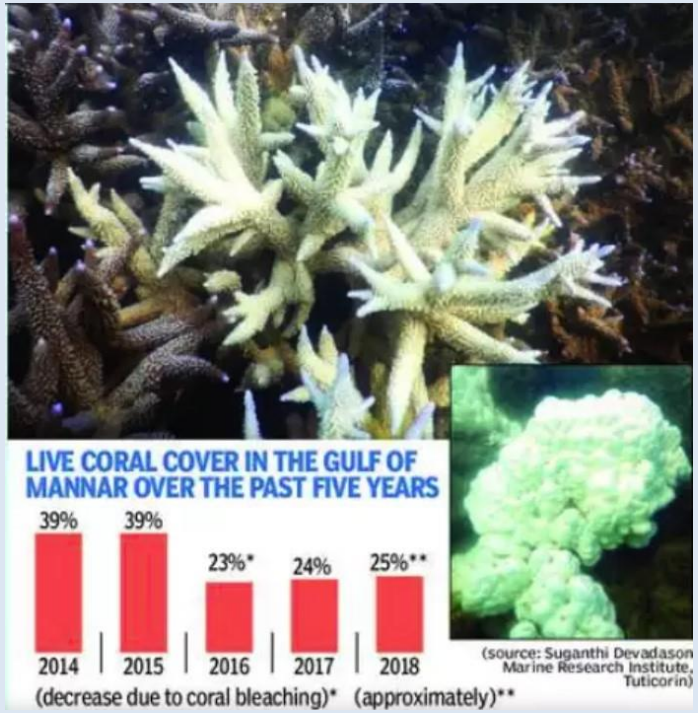
Ocean temperatures normally during this time



Ocean temperatures during the cyclones



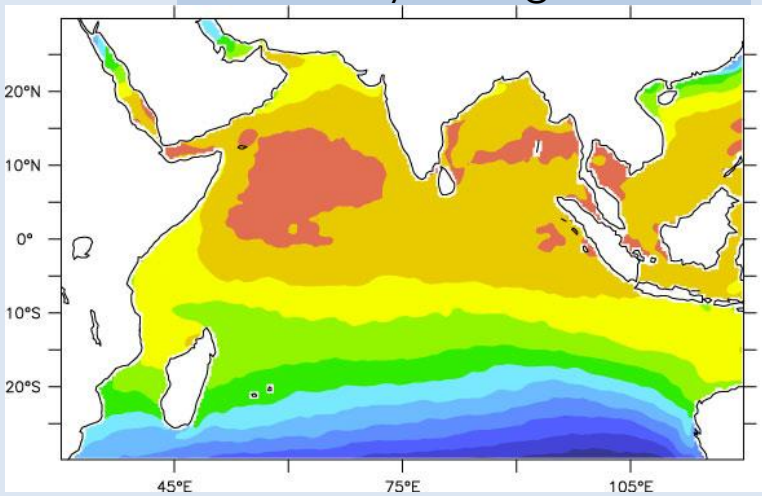
The same Marine Heat Waves drive Coral Bleaching also



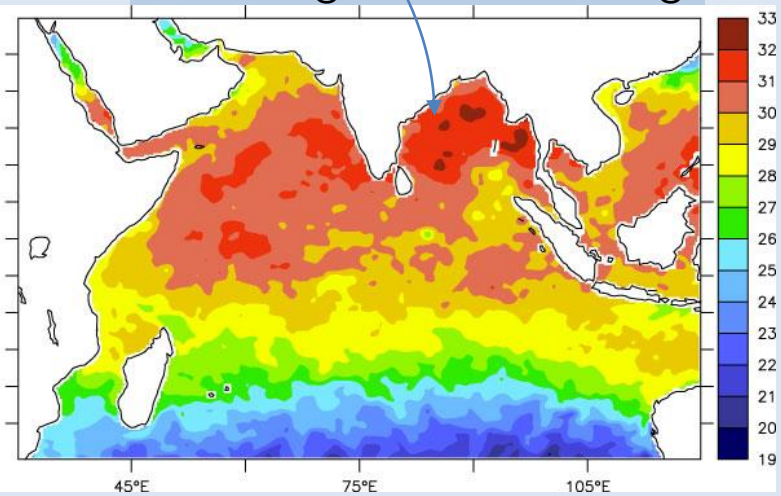
Corals have a mucus membrane — known as zooxanthellae — which acts as their shield and gives the color. Warm temperatures bleach it away.

The same ocean temperatures that intensified cyclone Amphan, led to coral bleaching in Gulf of Mannar also.

Ocean temperatures normally during this time

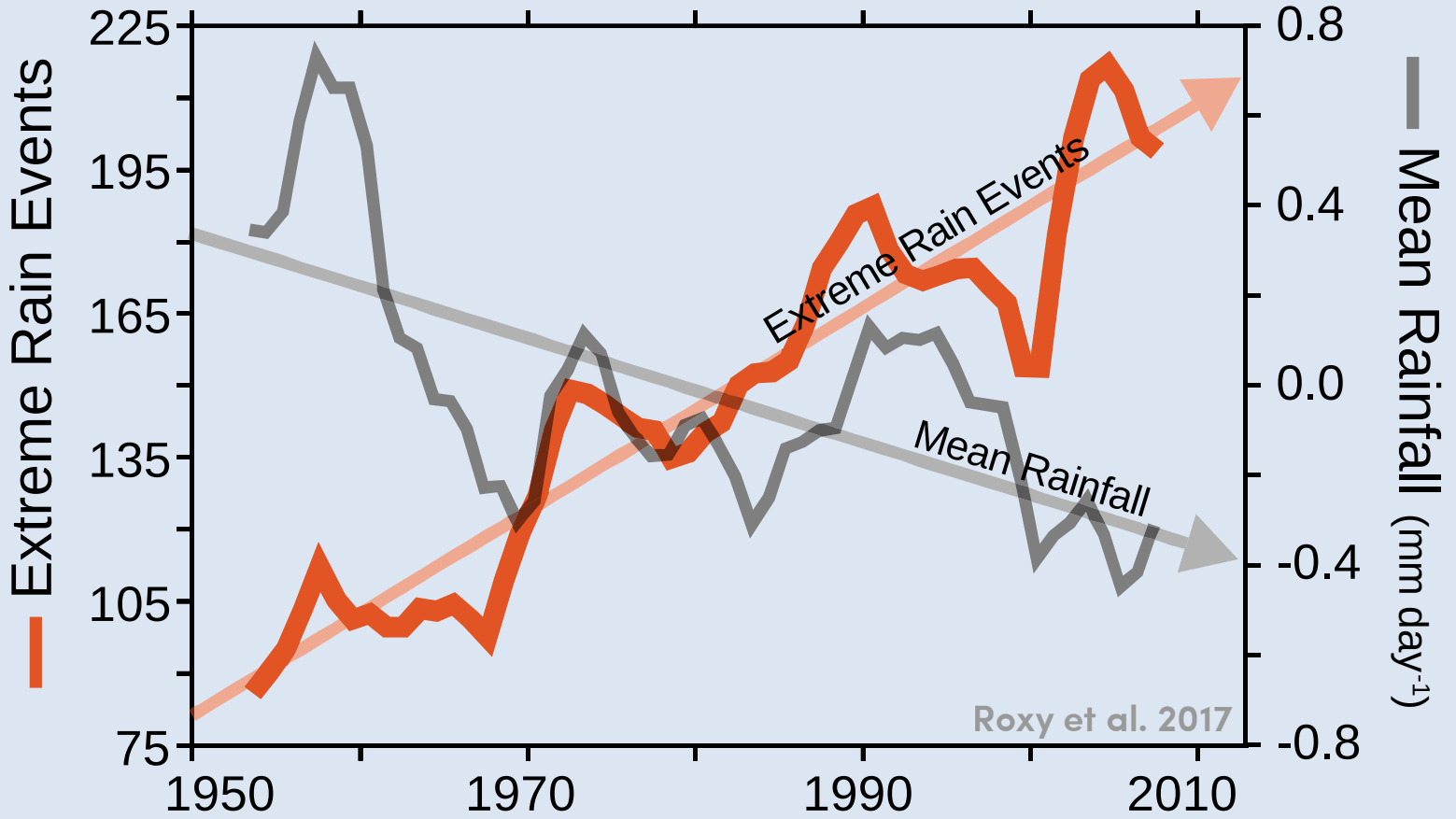


Ocean temperatures during Coral Bleaching



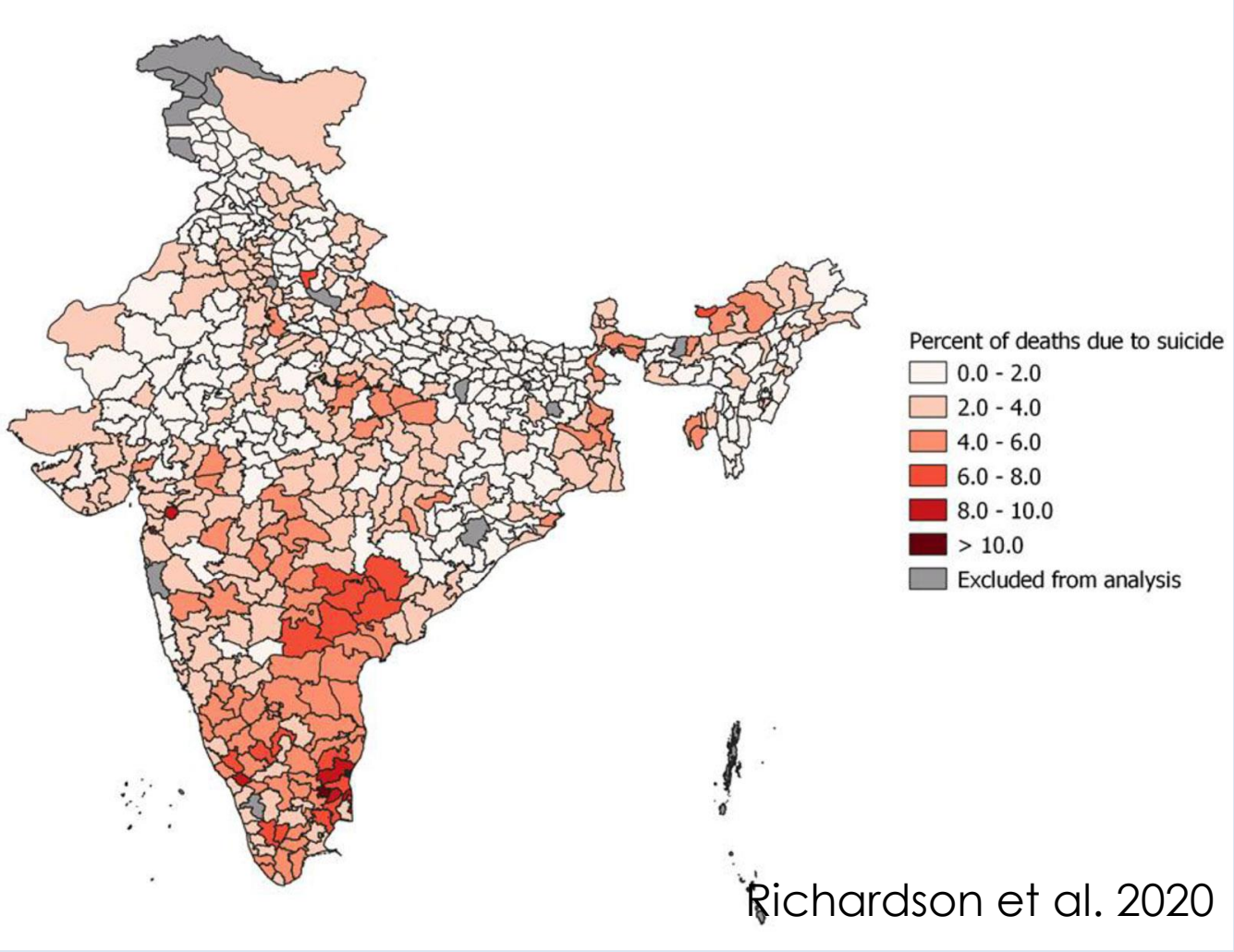
Monsoon changes across South Asia

While the total monsoon rainfall is decreasing, number of extreme rains (above 150 mm/day) are increasing

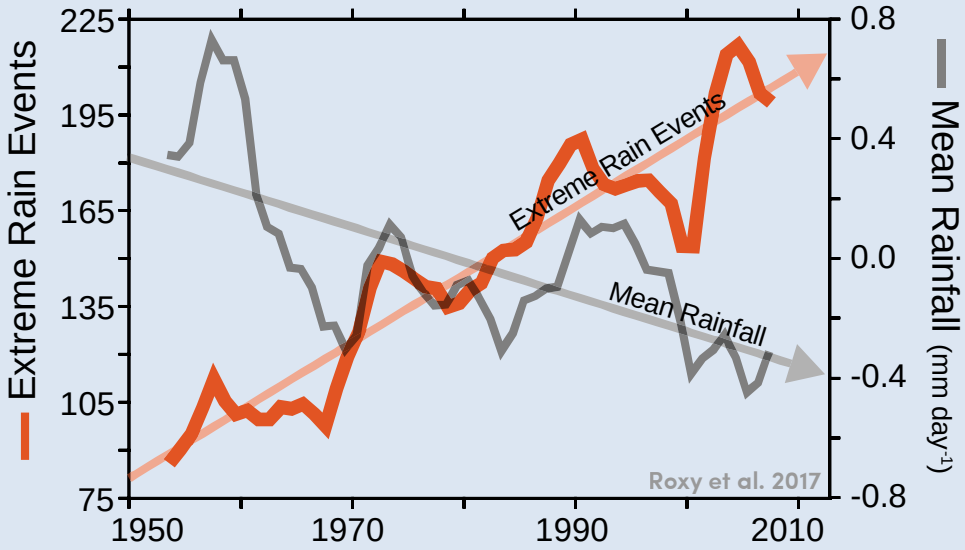


Impacts of Monsoon changes

In the rural areas, deaths due to suicide increased by 18.7% during floods and by 3.6% during droughts. Loss of property is larger during floods?



Richardson et al. 2020



Compound Events

Compound Events

Sea level rise, storm surge and waves, heavy rainfall, and a flooded river can overlap and damage a city and its outlying regions

Water scarcity due to a drought overlapping with heatwaves, and reduction of river flows caused by glacier loss and water use by upstream communities

Compound Events

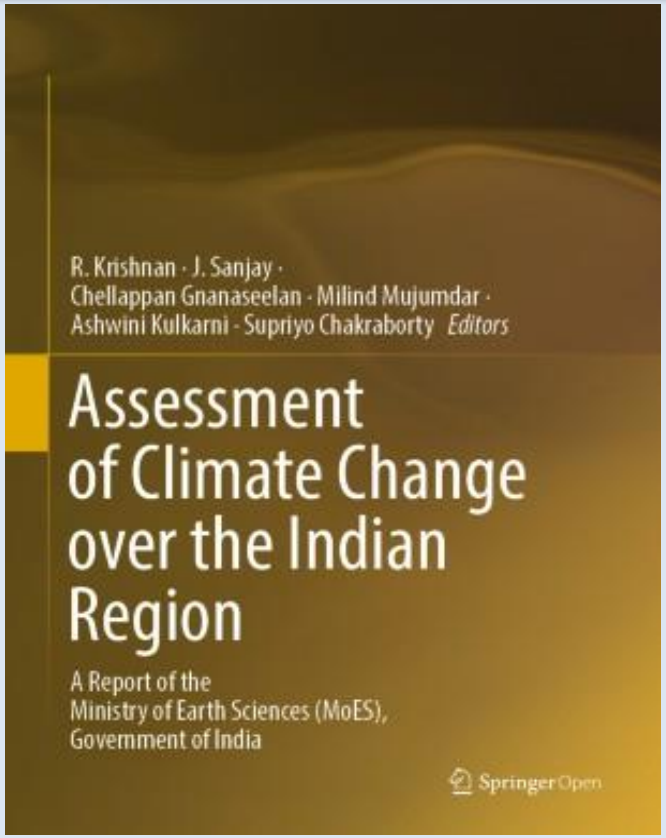
Before and after a cyclone

Before and after a marine heat wave

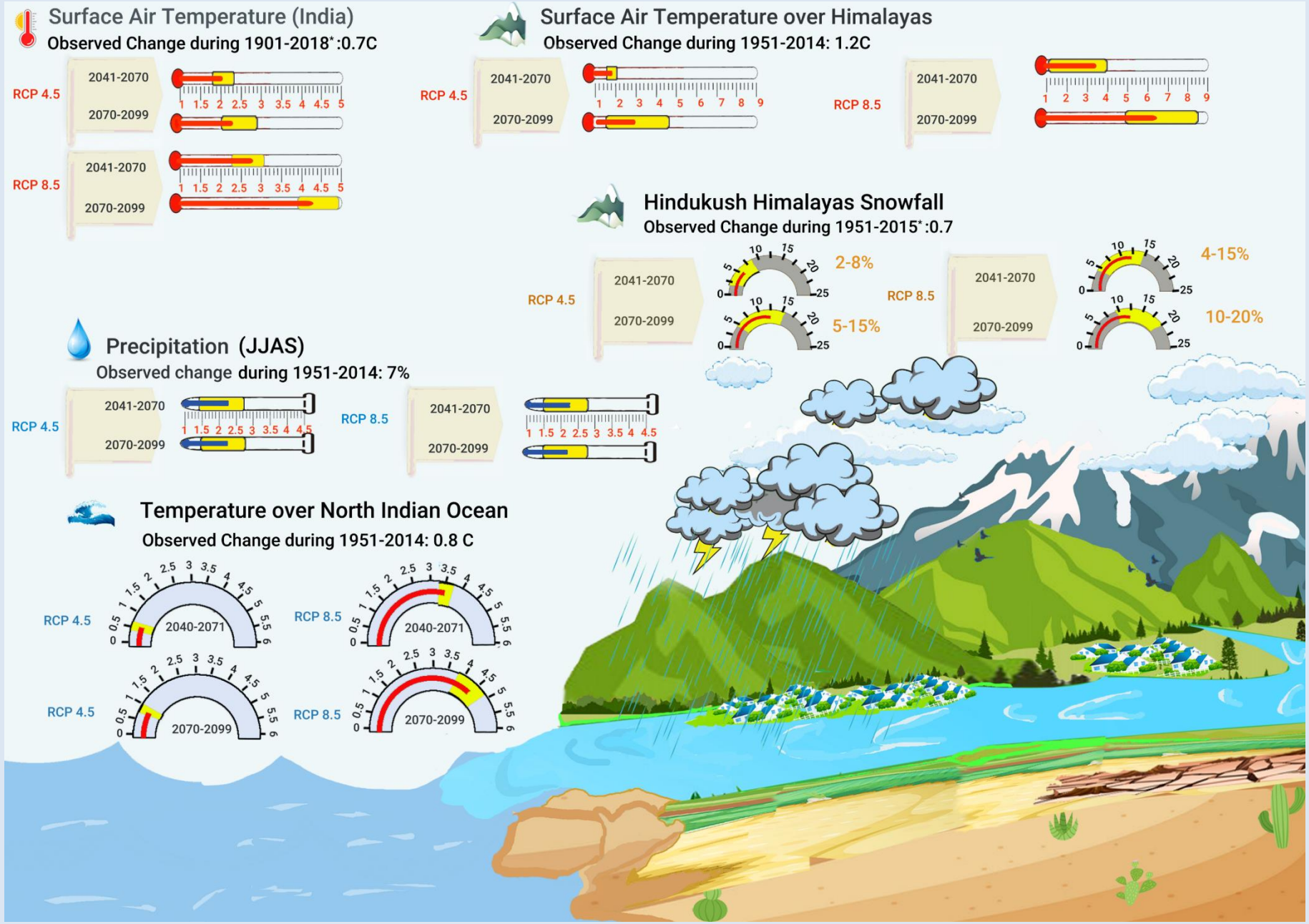
Unequal Scenes

Johnny Miller

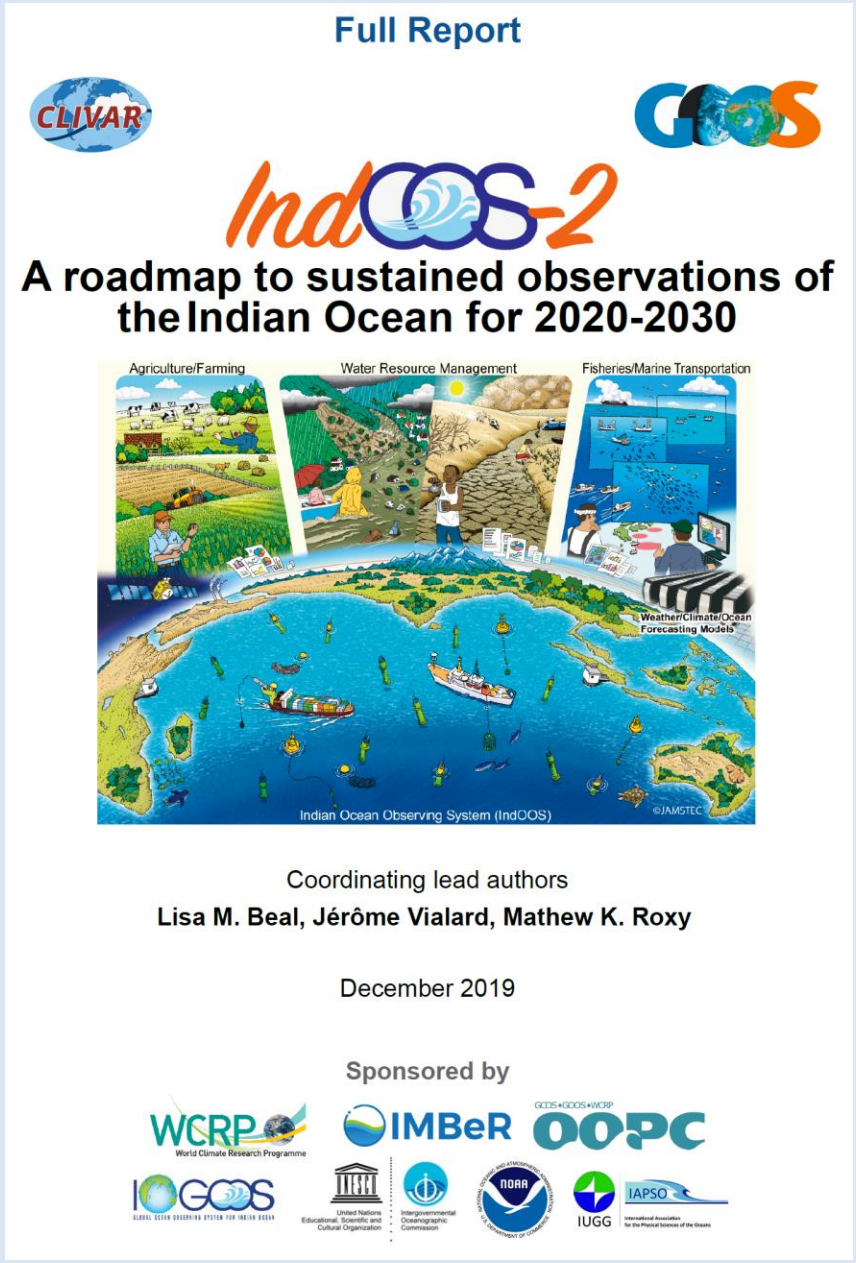
Climate Change Assessment Report



"With the temperatures projected to rise by 2.7degC by 2040 and 4.4degC by the end of the century, we should be ready to face a further increase in the intensity, frequency and extent of extreme weather events over Indian region."



Indian Ocean Review



"The Indian Ocean has accounted for 30% of the global oceanic heat content increase over the last two decades.

Cyclones, floods, droughts, and heatwaves are becoming more extreme around the Indian Ocean, with anthropogenic climate change increasingly impacting weather patterns and threatening marine and terrestrial resources."

Need to enhance the monitoring and forecasting capacities of the Indian Ocean.

#SROCC

"Extreme events such as tropical cyclones, marine heatwaves and El Nino events are becoming stronger and more frequent. For high levels of warming, extremes become more severe and the chance of abrupt change increases"

Flood Warning Systems — Local and at SAARC level

Hydrology and Water Resources Programme (HWRP)

Programmes > HWRP > floods > FFGS > Central Asia FFG

South Asia Flash Flood Guidance (SAsiaFFG) System

WORLD METEOROLOGICAL ORGANIZATION

IMD, BMC to bring in flood warning system

Richa Pinto | TNN | Updated: Dec 15, 2019, 11:30 IST, TIMES OF INDIA

....We needed local data for it, like topography, drainage system, water bodies in the city, tide levels and data from various rain gauges in the area. This was received from BMC. The system will forecast how much inundation can happen in different pockets. This will be very useful, especially if people need to be evacuated from low-lying areas as we will be able to forecast 12 hours in advance that a particular spot may get flooded"....

Dr. M. Rajeevan
Secretary, Ministry of Earth Sciences

Ministry of Earth Sciences
Government of India
Prithvi Bhavan, (Opp. India Habitat Centre)
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www.moes.gov.in
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सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES

Municipal Corporation of Greater Mumbai

iFLOWS-MUMBAI

INTEGRATED FLOOD WARNING SYSTEM FOR MUMBAI

A G2G Initiative Towards A Disaster Resilient India

MINISTRY OF EARTH SCIENCES

Economic Impact Assessment

Total investment: Rs. 1,000 crores,
for setting up National Monsoon Mission(NMM) and High Performance Computing (HPC) facilities

Total expected economic benefit (5 years): Rs. 50,000 crores

That is "Rs 50 for every rupee spent"
as per Ministry of Earth Sciences

Table III.9: Total operational cost saved due to use of OSF

Type of Boat	% of fishermen saving operational cost	No of trips saved in a year	Average operational cost per trip (Rs.)	Total Operational cost saved in a year (Rs crore)
Mechanised	97.5	2,829	39,859	11.27
Motorised	94.2	6,429	10,292	6.61
Non-Motorised	83.3	348	10,389	0.36
All	94.9	9,606	19,003	18.25

Some of the collaborators in this assessment

Climate Research Lab @ IITM

Indian Ocean Network

IPCC Team


Third Lead Author Meeting for the IPCC
Special Report on the Ocean and Cryosphere in a Changing Climate @ Lanzhou, China

UN Decade of Ocean

SAARC
Disaster Management Centre

Thank You