Impact of Climate Change on Disasters

National Meet on Disaster Risk Management

Trends and Technologies: 27-28 February 2023

National Remote Sensing Centre (NRSC), Indian Space Research Organisation, Dept. of Space, Govt. of India

&

Ministry of Home Affairs, Govt. of India

Hyderabad International Convention Centre, Hyderabad

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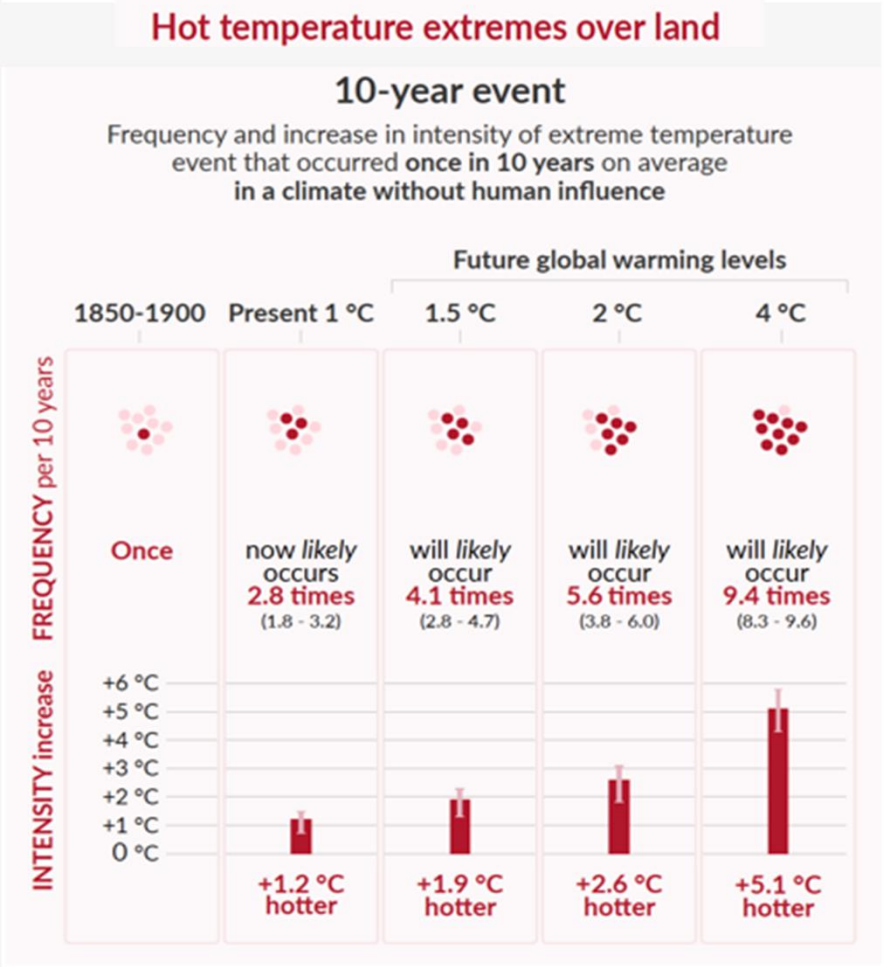
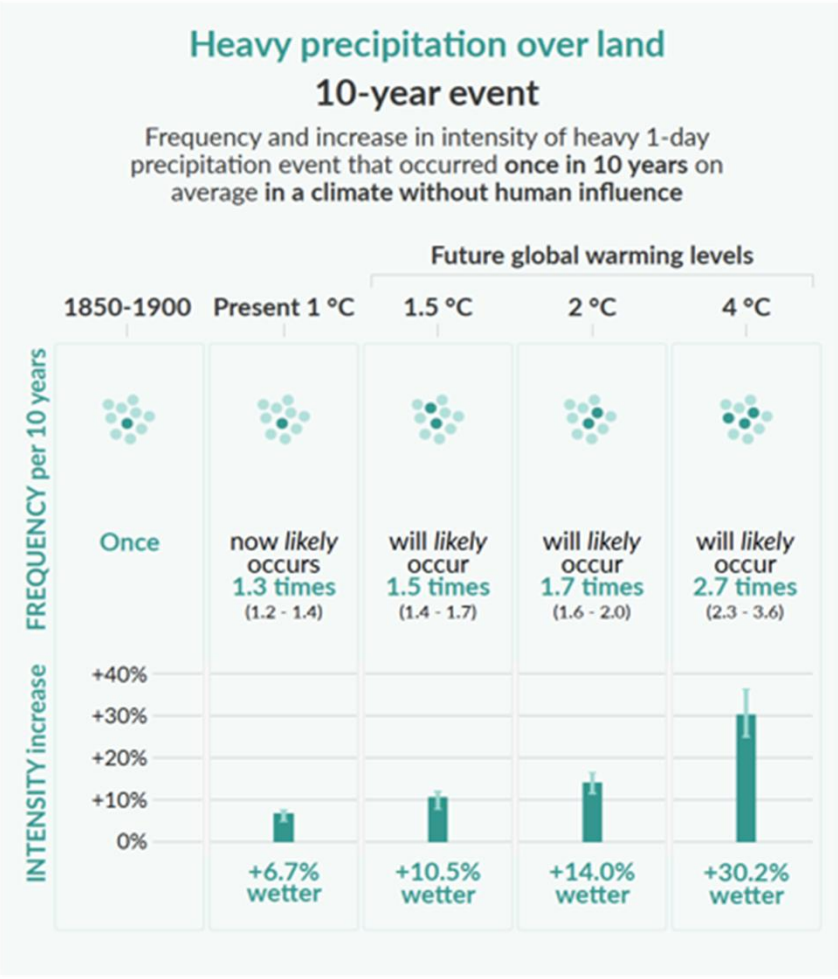
Indian Institute of Tropical Meteorology, Pune, India

Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming





Every additional 0.5°C of global warming causes clearly discernible increases in the intensity & frequency of hot extremes, including heatwaves (*very likely*) and heavy precipitation (*high confidence*)

The Water Vapor Feedback

Temp dependence of saturation vapor pressure

$$e_s: e^{-5400/T}$$

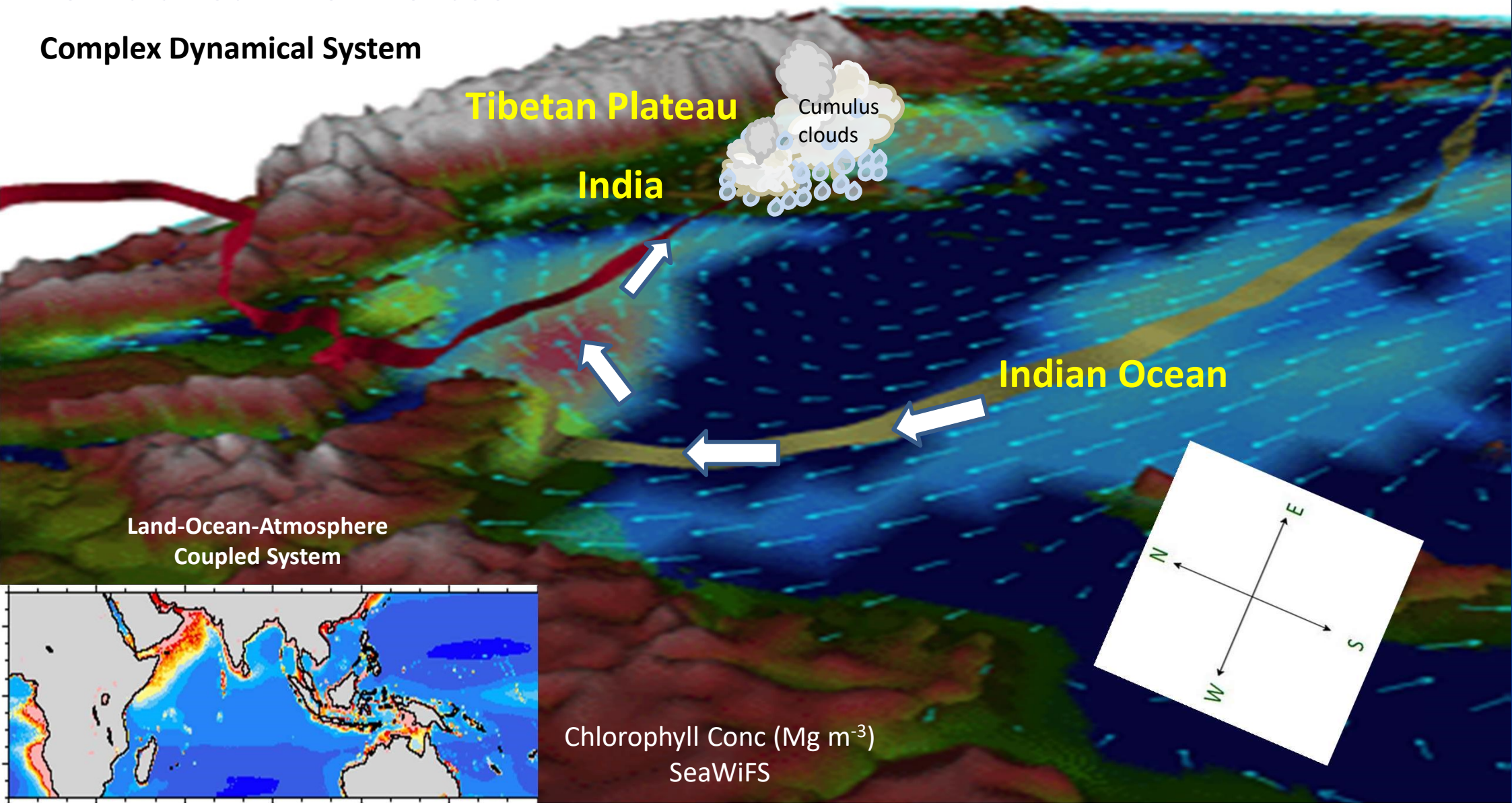
$$\frac{d \ln e_s}{dT} = \frac{5400}{T^2} \approx 0.06 \quad to \quad 0.1 \quad per \quad K$$

Direct consequence of global warming

Increase in the frequency of heavy precipitation events!

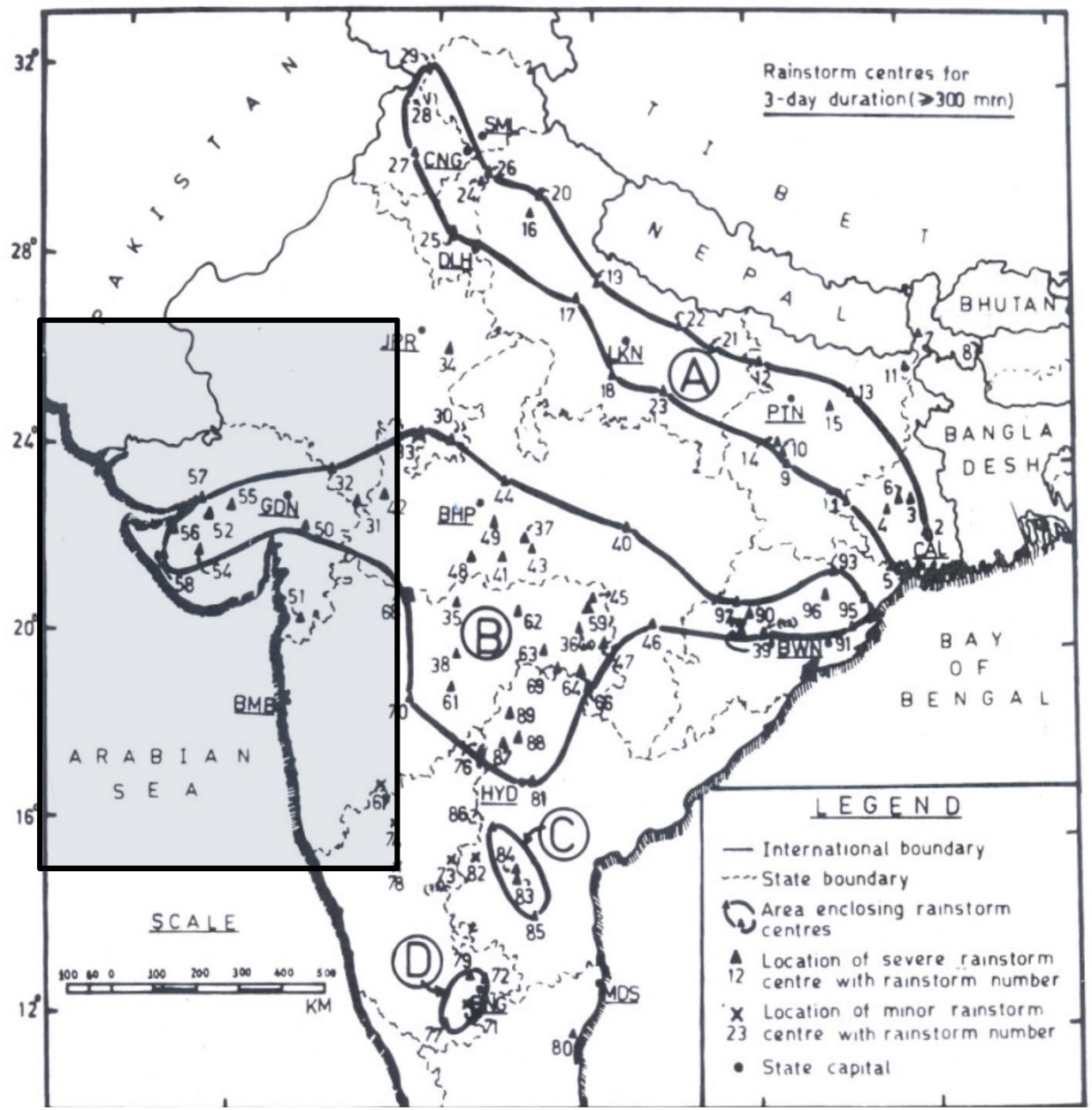
The Indian Summer Monsoon

Complex Dynamical System



Heavy precipitation during the summer monsoon season

- Heavy rainfall and floods
    - June 2013 Uttarakhand floods
    - July – August 2010: Floods in Upper Indus basin, Leh flash floods
    - Kerala floods 2018, 2019
    - May – June 2022: Northeast India (NEI)
    - Southern slopes of **Northeast Himalayas** during breaks in the Indian monsoon
    - Devastating floods in Pakistan during 2022 summer monsoon season
    - **Rainstorms** – Very important element of heavy monsoon precipitation
- Impact of climate change on monsoon rainstorms?



Zones of concentration of rain centres (≥ 300 mm) of severe rainstorms of 3-day duration (1880-1990) - Adapted from **Dhar and Nandargi (1993).**

Rainstorms should have a closed isohyetal pattern of point rainfall ≥ 200 mm on a maximum of day 1 and the rainstorm centre should have a cumulative rainfall ≥ 250 mm and ≥ 300 mm on a maximum of days 2 and 3, respectively

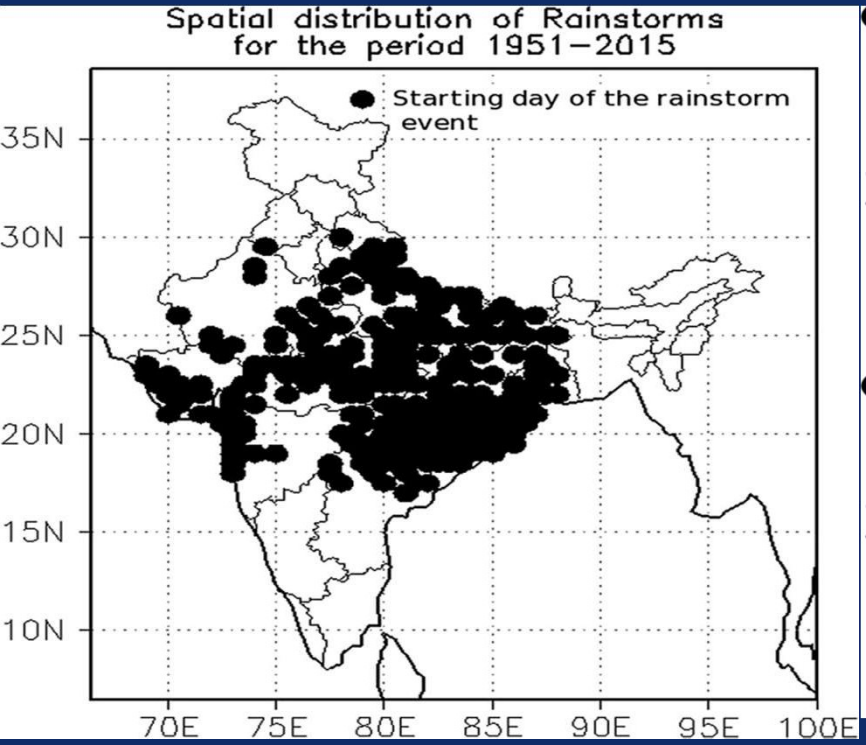
The extent of rain area around the heavy rain centre should be of the order of 50000 km^2 or more for each of the 1-, 2-, and 3-day durations of the rainstorms.

Heavy-rain centres of severe rainstorms have preferred areas of zones, where they frequently tend to occur.

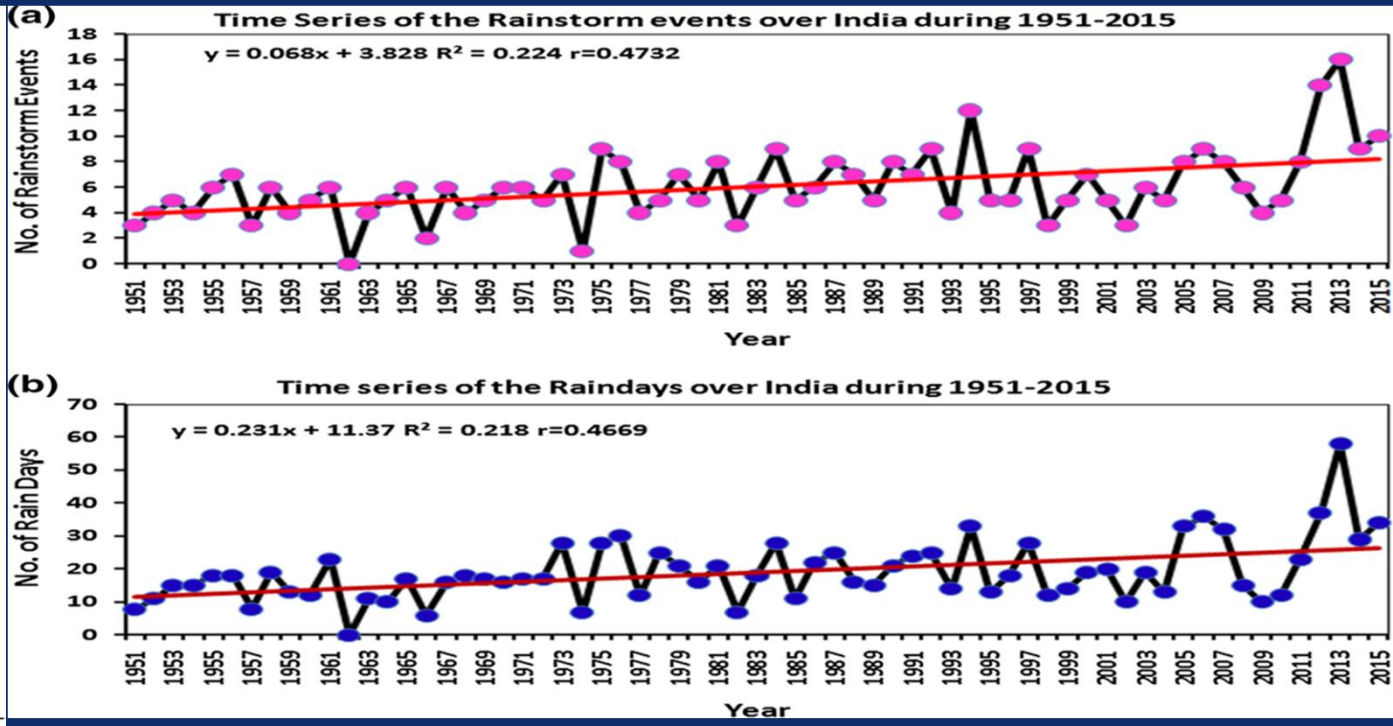
It was reported that 231 severe rainstorms affected India during this 110 year period (1880-1990) (Dhar and Nandargi, 1995).

S. Karuna Sagar, M. Rajeevan, S. Vijaya Bhaskara Rao (2017): On increasing monsoon rainstorms over India. Nat Hazards , 85:1743–1757, DOI 10.1007/s11069-016-2662-9

Rainstorms: Rainfall of 125 mm per day or more at the centre, cover minimum 50,000 sq.km in area with rainfall of 25 mm or more and sustain for at least two consecutive days.

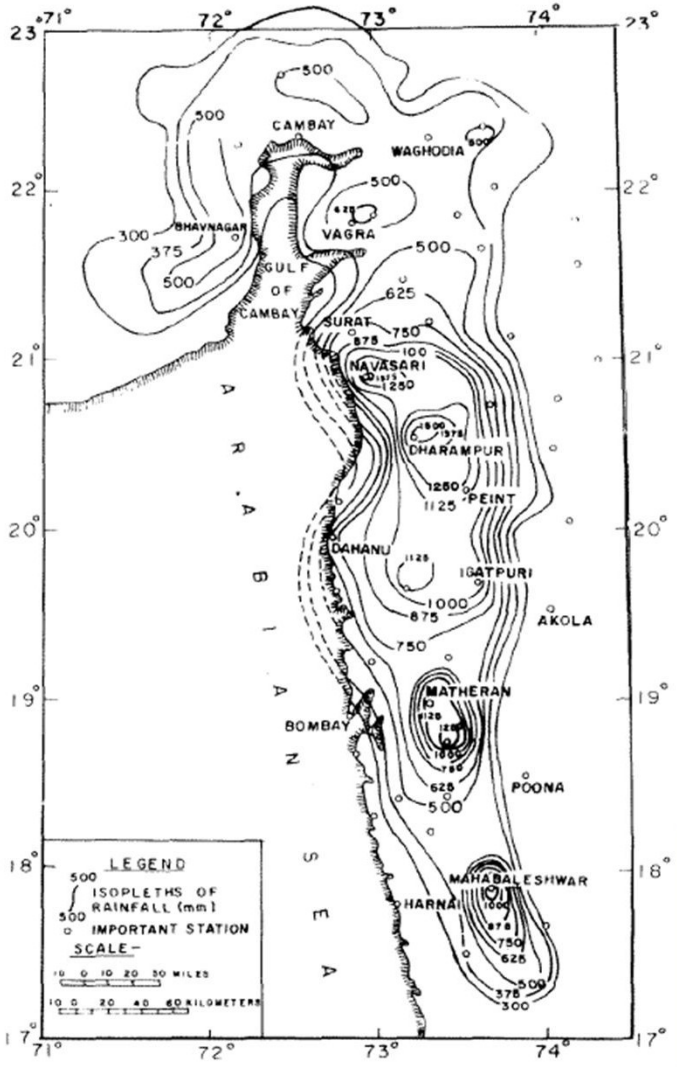


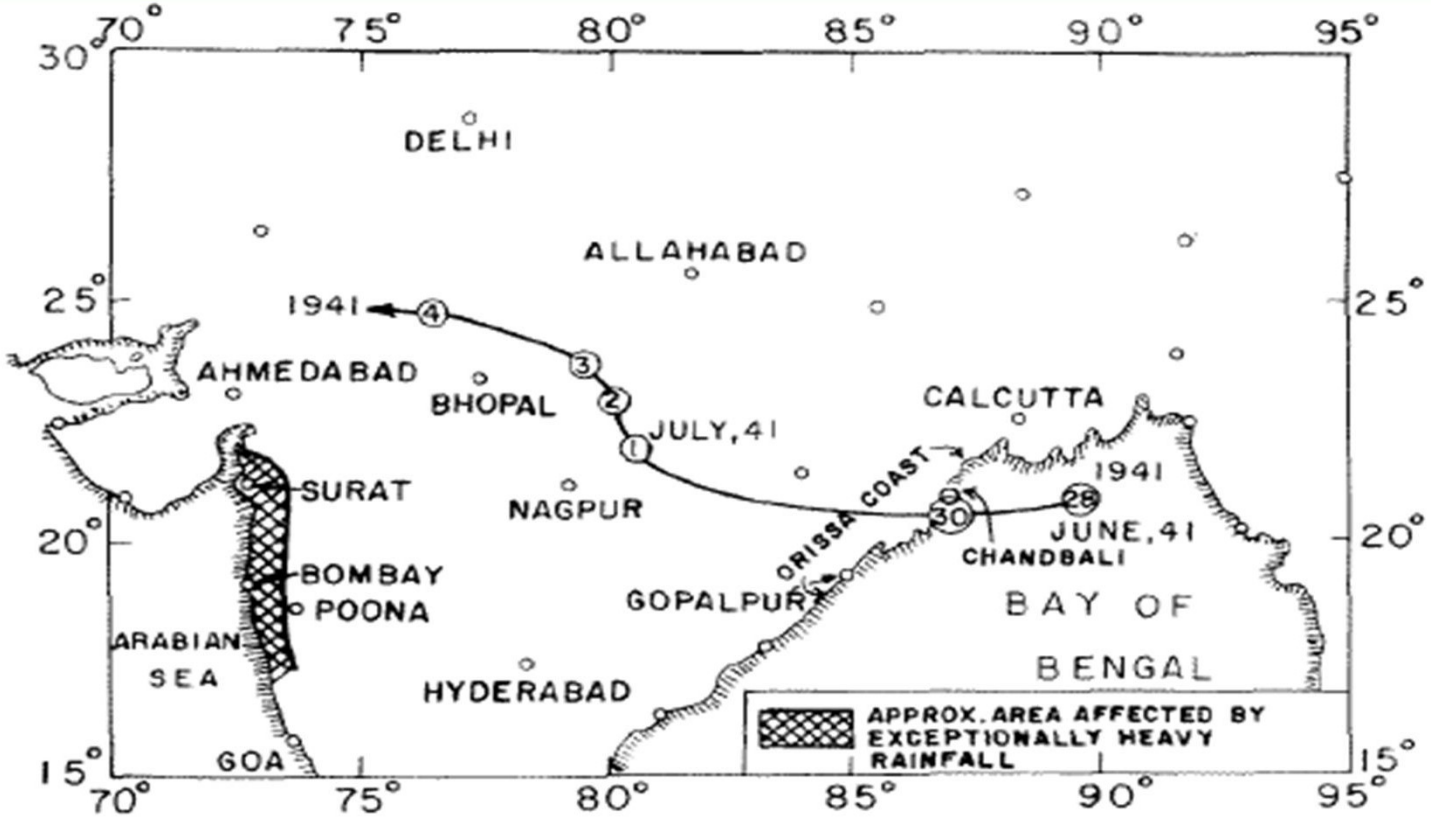
Position (latitude and longitude) where the rainstorms are observed for the first time over land. Period 1951–2015



Time series of a frequency of rainstorms formed over northern parts of India during the period June–September, 1951–2015, b duration of rainstorms over the northern parts of India during the period June–September, 1951–2015. The trend line is also shown in the figure.

Dhar, O.N., Kulkarni, A.K. and Mandal, B.N., 1984. The most severe rainstorm of India – a brief appraisal. Hydrol. Sci. Journal. 28:2, 219-229, DOI: 10.1080/02626668409490935.



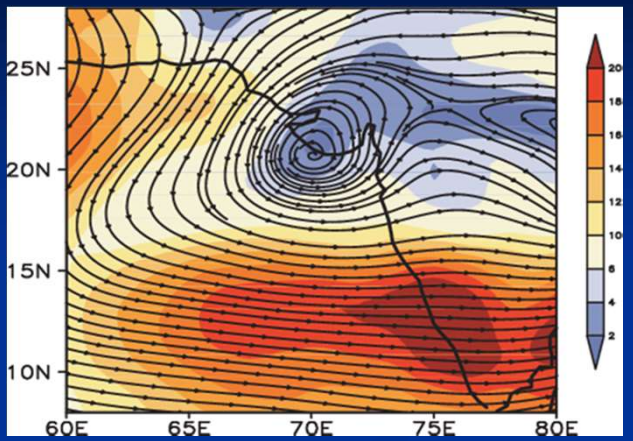


(a) Isyohetal pattern of the 1-5 July 1941 rainstorm over the south Gujarat – north Konkan region of India *(b)* Track of the July 1941 monsoon depression. Adapted from **Dhar et al. (1984).**

Mid-Tropospheric Cyclones (MTC) of the Indian summer monsoon

- MTCs identified by Miller and Keshavamurthy (1968) during the IIOE
- Vorticity structure maximum 700 – 500 hPa, horizontal scale ~ 1000 km, vertical scale 6 – 8 km
- Strong mid-level convergence, upward vertical velocities – with cold (warm) temperature below (above) 500 hPa

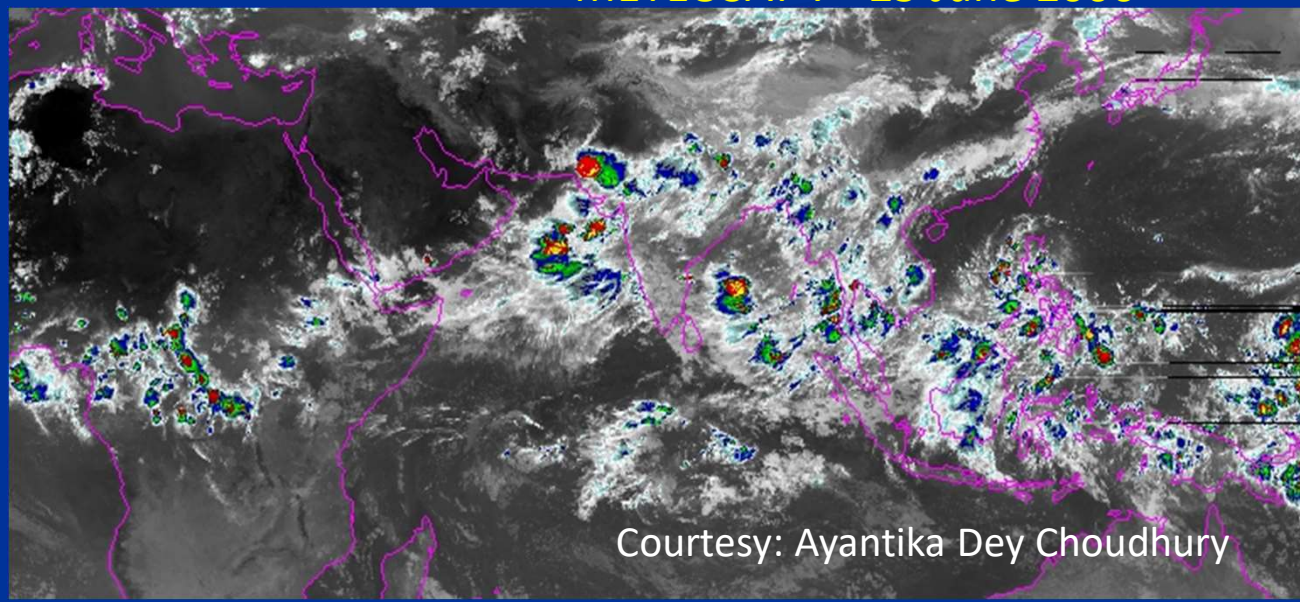
31 Jul-7 Aug 2007 (streamlines 600 hPa)



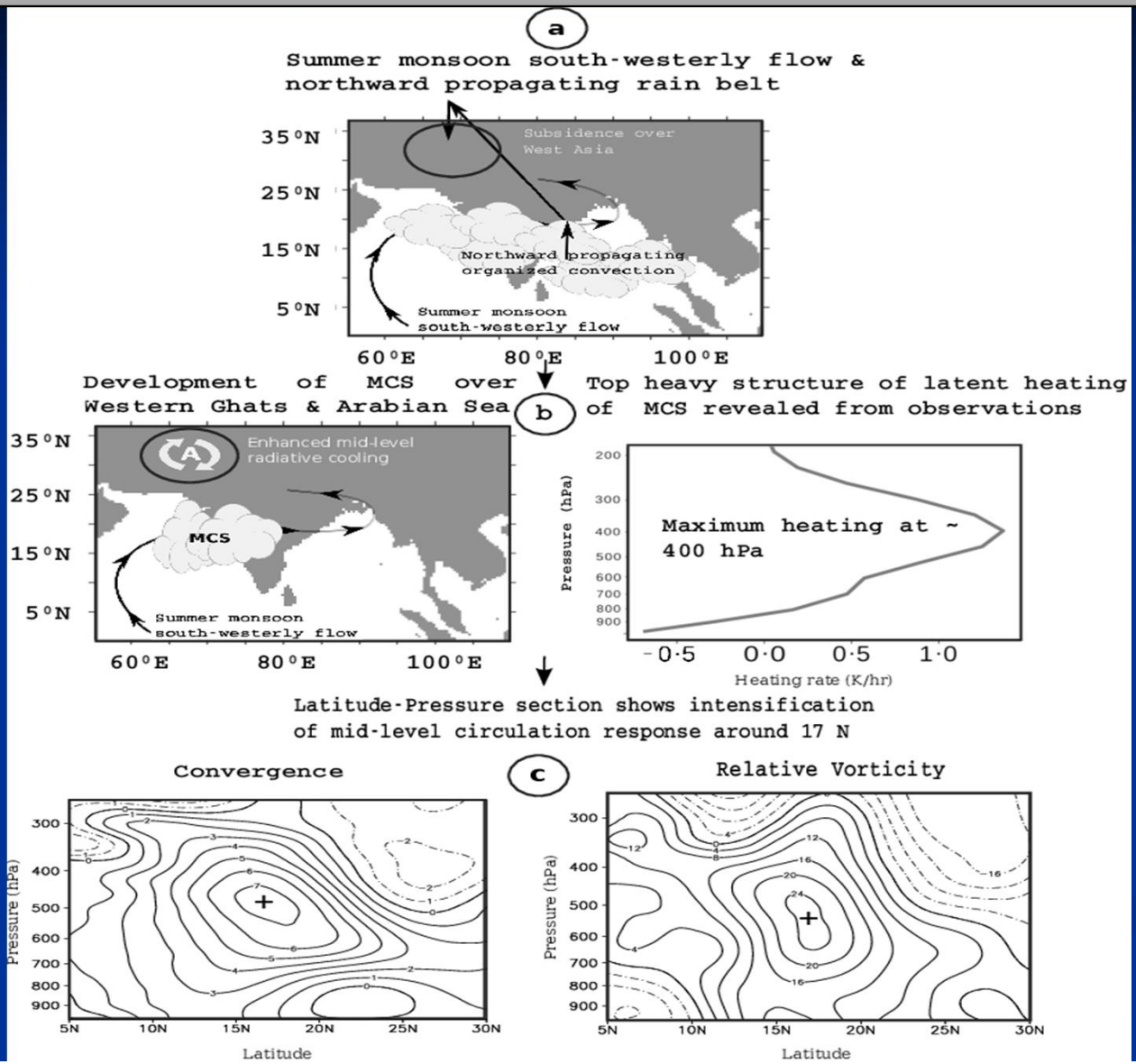
Heaviest 3-day precipitation accumulations (exceeding 300 mm) over western India during 1998–2007 identified frominteractive web atlas (Mapes 2011). Also shown are the central locations, time, and date for the 3-day-period events

Lon (°E)	Lat (°N)	3-day Rain Accum (mm)	Date and Time of Event
72.7	20.87	700	28 Jun 2005 1600 UTC
73.0	20.62	650	28 Jun 2005 1600 UTC
73.5	22.12	550	29 Jun 2005 0000 UTC
73.0	22.62	500	30 Jun 2005 1800 UTC
71.5	19.62	350	03 Jul 2006 2000 UTC
72.2	18.87	400	03 Jul 2006 2000 UTC
73.5	21.87	450	04 Jul 2006 0400 UTC
69.7	20.87	350	05 Aug 2007 1800 UTC
70.5	20.37	400	05 Aug 2007 1200 UTC
72.0	23.37	400	07 Aug 2007 0400 UTC

METEOSAT-7 25 June 2006



Sequence of mechanisms /processes leading to development of MTC

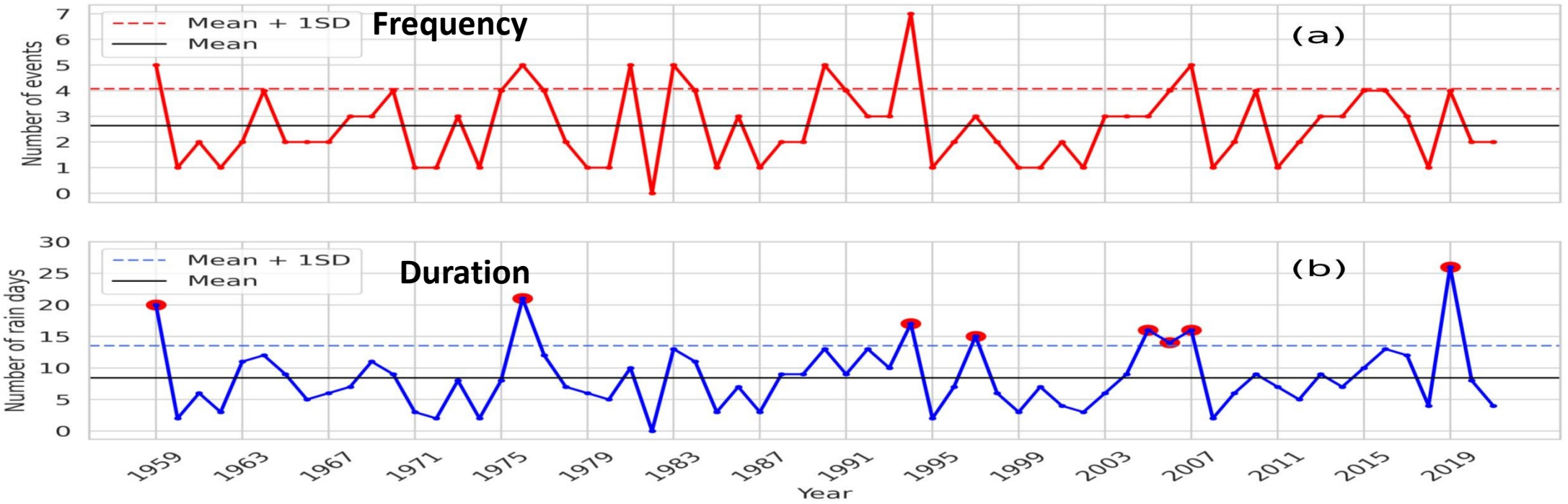


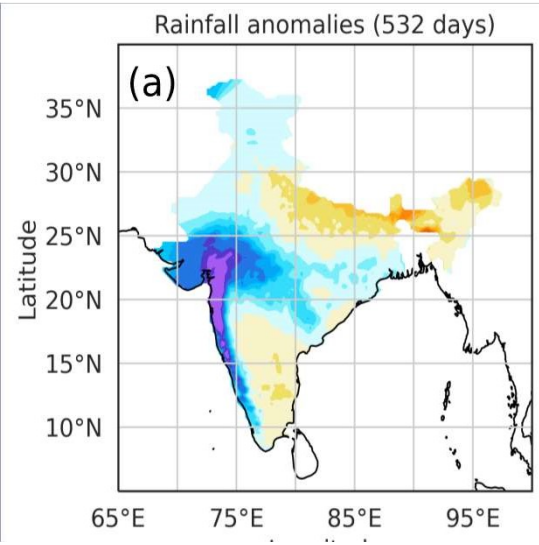
Formation of MTCs have a dependence on slow northward propagating monsoon rain belt enriched with mesoscale precipitating systems

Top heavy heating from stratiform precipitating systems is crucial for genesis of the MTC

Maximum vertical gradient of heating at mid tropospheric levels generate a mid tropospheric cyclonic vortex directly, thereafter intensification occurs through mid-level convergence and stretching

Ref: Choudhury, A.D., R. Krishnan, M.V. Ramarao, R. Vellore, M. Singh, and B. Mapes, 2018: A phenomenological paradigm for mid-tropospheric cyclogenesis in the Indian Summer Monsoon *J. Atmos. Sci.*, **75**, 2931–2954

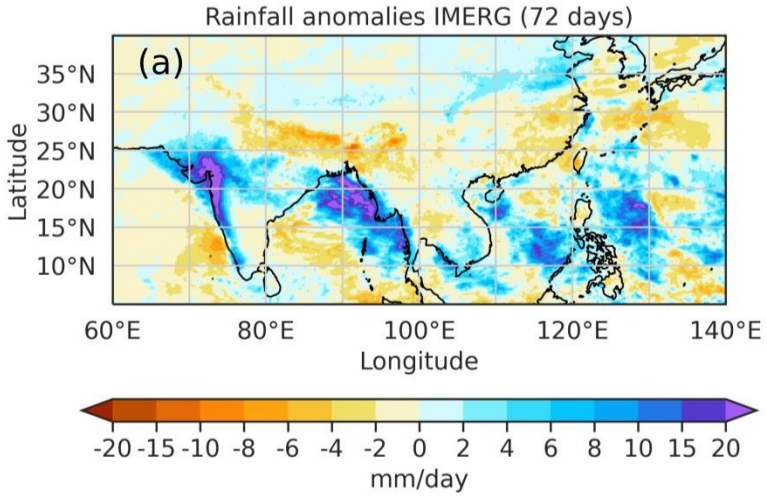


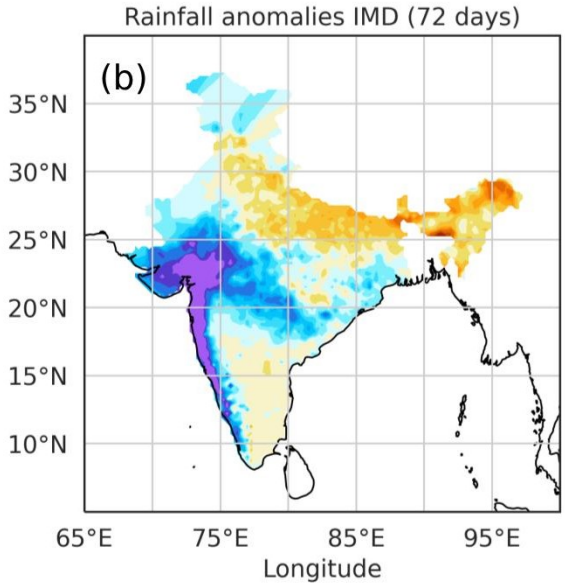


(a) Time series of number of rainstorm events during JJAS over WI (red line), solid black line represents the mean over the period (1959-2021), dotted red line represents the (mean + 1 std.dev) threshold of **4 rainstorm events per JJAS season.** *(b)* Time series of number of rain days (blue line). Black line is the mean and the dotted blue line is the (mean + 1 std.dev) threshold of **13.5 days per JJAS season**. The red circles correspond to the 8 years when the duration of rainstorms per JJAS season exceeded the 13.5 days threshold.

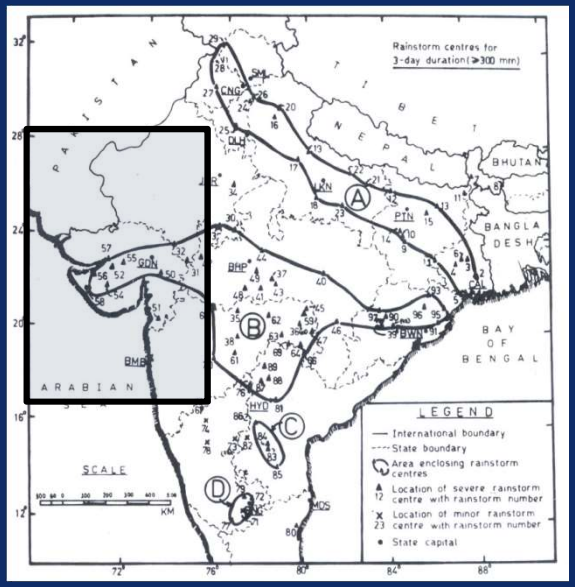
Composite map of daily IMD rainfall anomalies (mm d^{-1}) for all the rainstorm days (532 days) for the period 1959-2021.

Krishnan et al. 2023





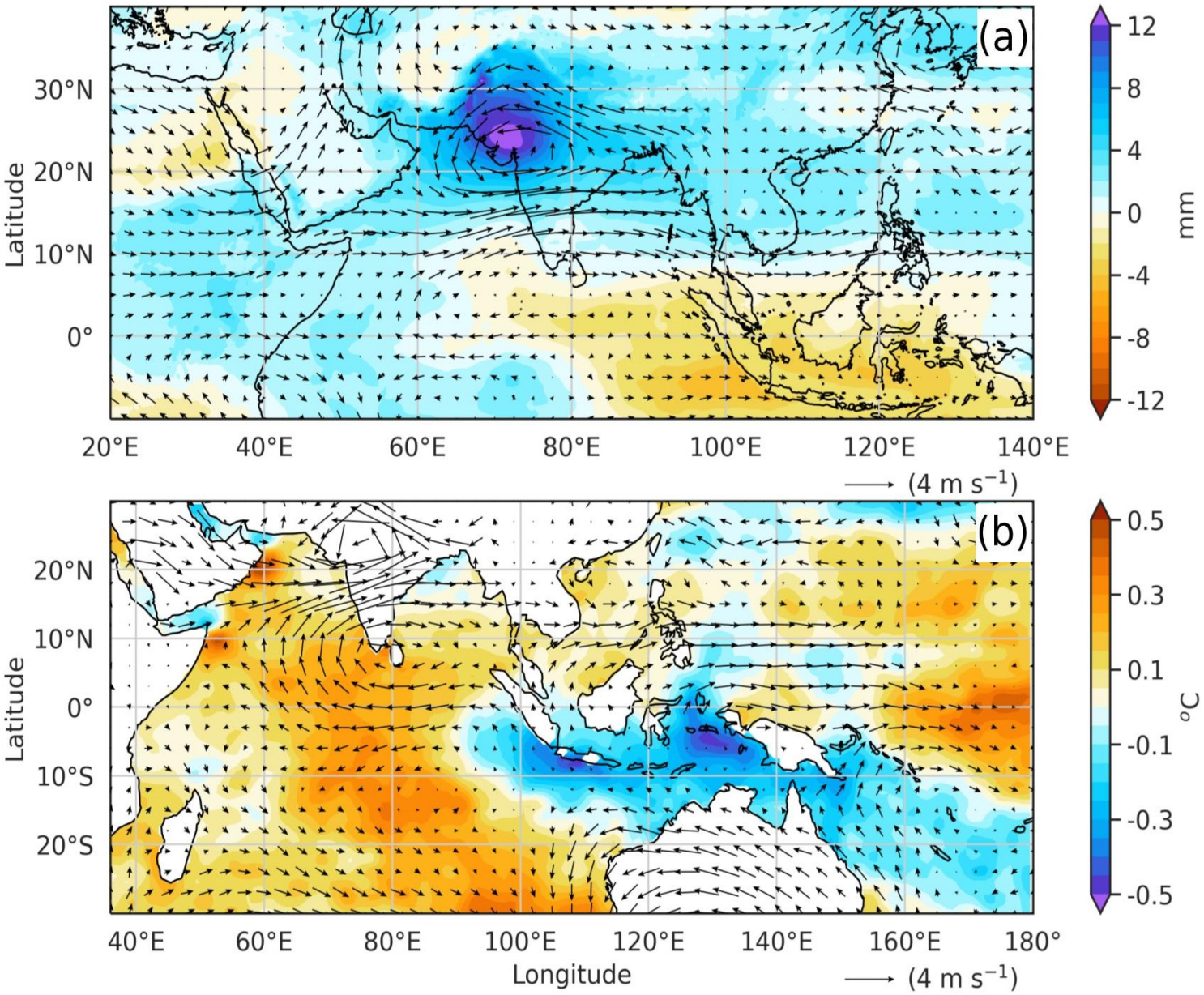
(a) Composite of daily IMERG rainfall anomalies (mm d^{-1}) based on 72 rain days corresponding to the years (2005, 2006, 2007 and 2019). The IMERG data is available from 2000 onward. *(b)* Same as in (a) except for the IMD dataset.



No.	Long monsoon rainstorm events (duration ≥ 7 days)	Duration	Accumulated rainfall over WI
1	20 July 1959 - 29 July 1959	10 days	198 mm
2	10 August 1963 – 16 August 1963	07 days	124 mm
3	13 August 1992 – 19 August 1992	07 days	109 mm
4	04 July 2000 – 10 July 2000	07 days	113 mm
5	25 June 2005 – 04 July 2005	10 days	235 mm
6	05 August 2006 – 12 August 2006	08 days	233 mm
7	26 July 2019 – 11 August 2019	17 days	447 mm

Table 1. List of long monsoon rainstorm events (duration ≥ 7 days) over WI during 1959-2021. Also shown are the duration of the events and accumulated rainfall (mm) spatially averaged over WI (Indian land points only). Note that the IMD gridded rainfall dataset is constructed using station data only over the Indian land region (Pai et al., 2014).

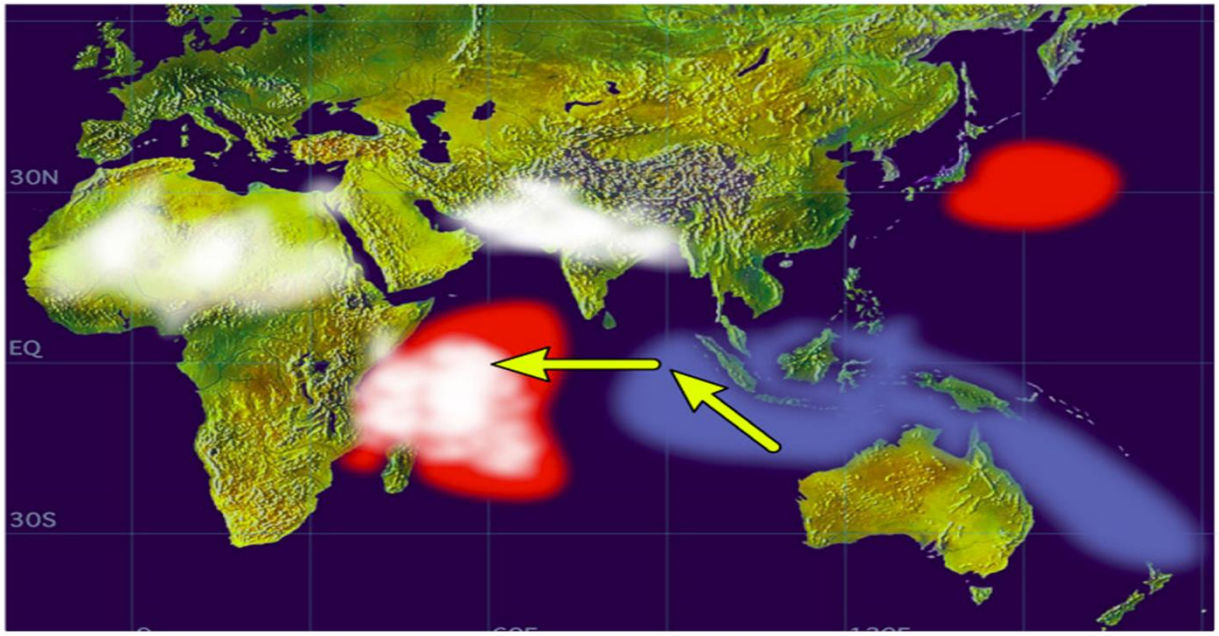
Krishnan et al. 2023



(a) Composite map of daily anomalies of precipitable water (PWAT, mm) and 500 hPa circulation (m s^{-1}) based on the 145 rain days for the 8 years when the number of rain days per JJAS season exceeded the 13.5 days threshold. *(b)* Composite map of JJAS sea surface temperature (SST °C) and 850 hPa wind (m s^{-1}) anomalies, based on the 8 years with number of rain days per JJAS season exceeded the 13.5 days threshold.

Krishnan et al. 2023

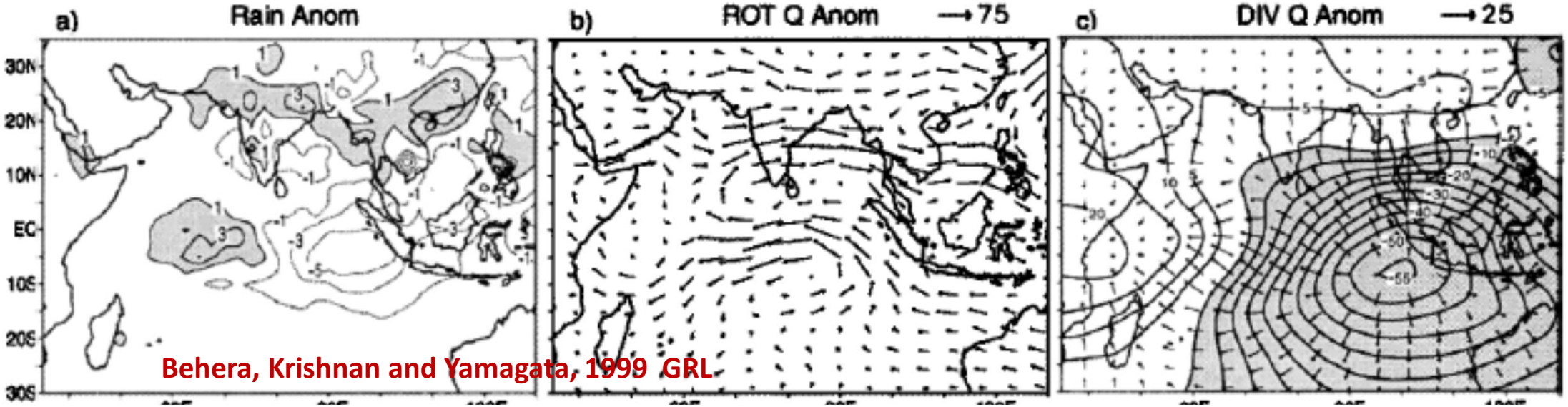
Positive Dipole Mode



Indian Ocean Dipole - Saji et al., 1999

Schematic: SST anomalies (red - warming; blue - cooling) during positive IOD. White patches - increased convective activity.

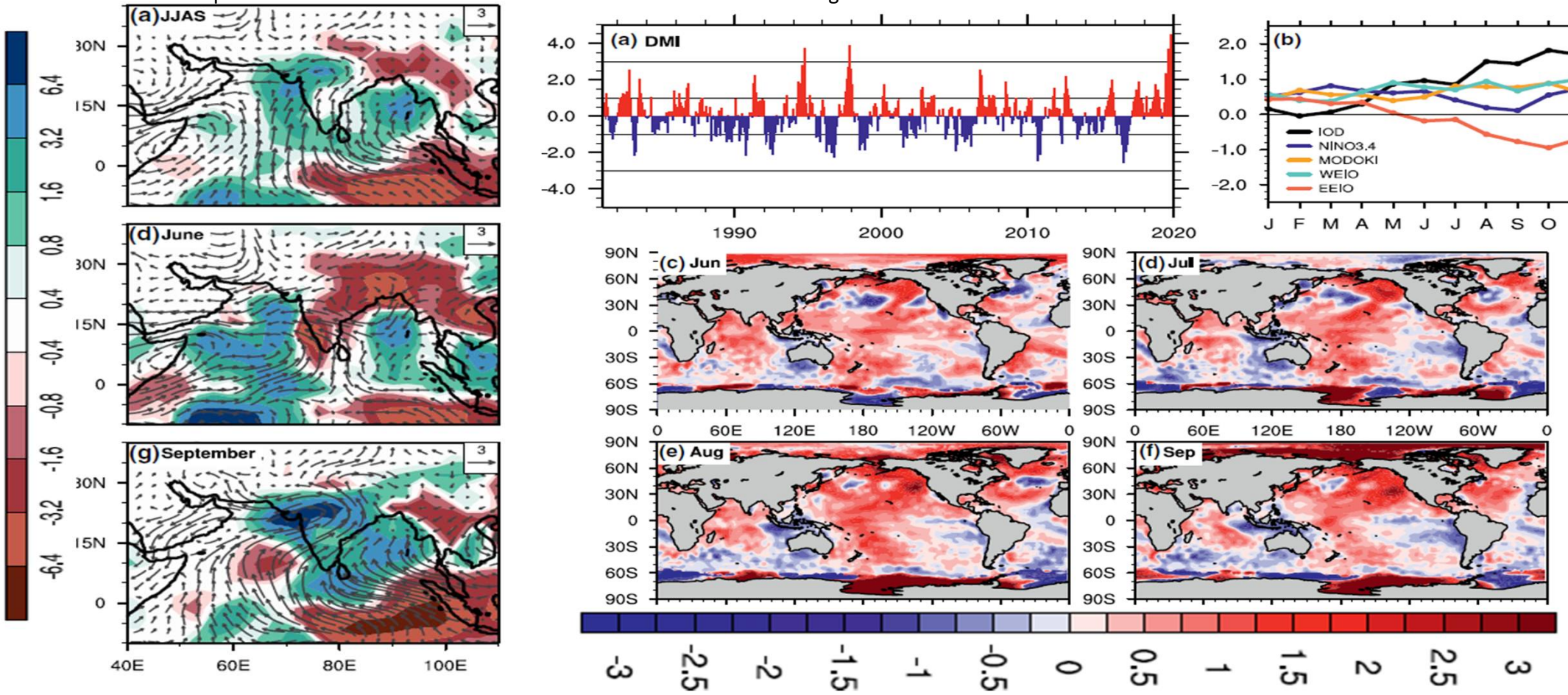
- Enhanced monsoon precipitation over India during positive IOD events - **e.g., 1994, 1961, 2019**
- Intensified **cross-equatorial transport of moisture** from the Southeastern equatorial Indian Ocean (SETIO)



Behera, Krishnan and Yamagata, 1999 GRL

The extreme positive IOD of 2019 & associated Indian summer monsoon rainfall response - Satyaban Ratna et al. (2020)

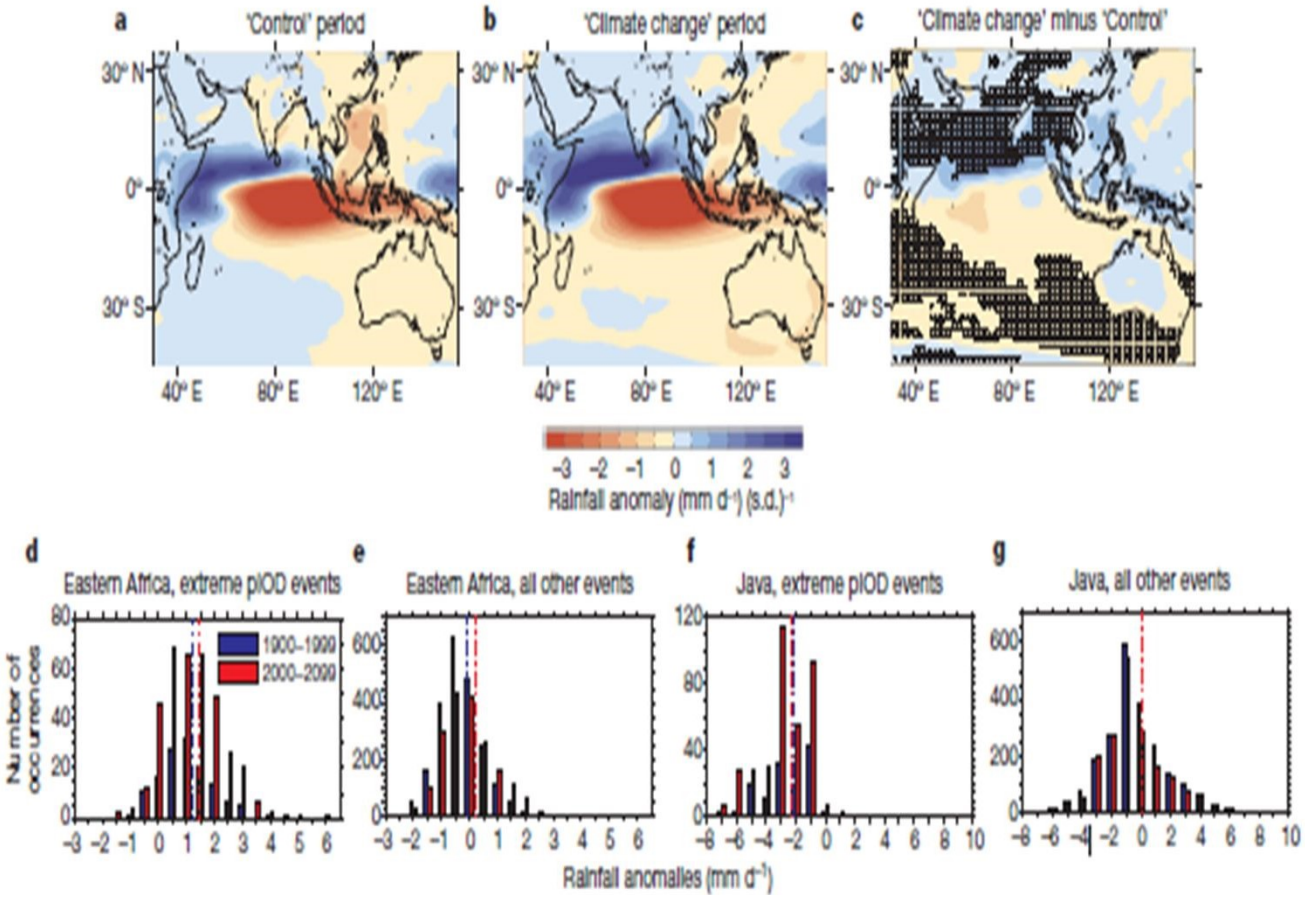
The positive Indian Ocean Dipole (IOD) event in 2019 was among the strongest on record, while the Indian Summer monsoon (ISM) was anomalously dry in June then very wet by September. We investigated the relationships between the IOD, Pacific sea surface temperature (SST), and ISM rainfall during 2019 with an atmospheric general circulation model forced by observed SST anomalies. The results show that the extremely positive IOD was conducive to a wetter-than-normal ISM, especially late in the season when the IOD strengthened and was associated with anomalous low-level divergence over the eastern equatorial Indian Ocean and convergence over India. However, a warm SST anomaly in the central equatorial Pacific contributed to low-level divergence and decreased rainfall over India in June. These results help to better understand the influence of the tropical SST anomalies on the seasonal evolution of ISM rainfall during extreme IOD events.



Increased frequency of extreme Indian Ocean Dipole events due to greenhouse warming

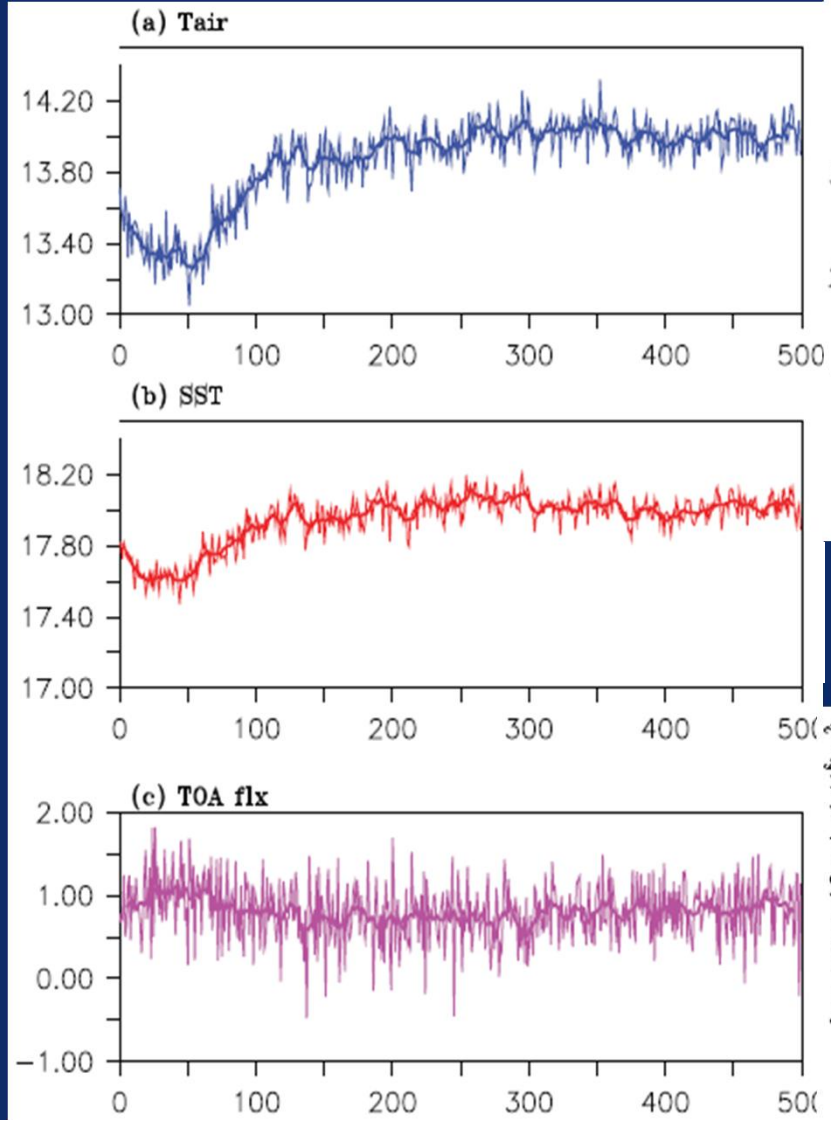
Nature 2014

Wenju Cai[1,2], Agus Santoso[3], Guojian Wang[2,1], Evan Weller[1], Lixin Wu[2], Karumuri Ashok[4], Yukio Masumoto[5,6] & Toshio Yamagata[7]



The Indian Ocean dipole is a prominent mode of coupled ocean–atmosphere variability[1–4], affecting the lives of millions of people in Indian Ocean rim countries[5–15]. In its positive phase, sea surface temperatures are lower than normal off the Sumatra–Java coast, but higher in the western tropical Indian Ocean. During the extreme positive-IOD (pIOD) events of 1961, 1994 and 1997, the eastern cooling strengthened and extended westward along the equatorial Indian Ocean through strong reversal of both the mean westerly winds and the associated eastward-flowing upper ocean currents[1,2]. This created anomalously dry conditions from the eastern to the central Indian Ocean along the Equator and atmospheric convergence farther west, leading to catastrophic floods in eastern tropical African countries[13,14] but devastating droughts in eastern Indian Ocean rim countries[8–10,16,17]. Despite these serious consequences, the response of pIOD events to greenhouse warming is unknown. Here, using an ensemble of climate models forced by a scenario of high greenhouse gas emissions (Representative Concentration Pathway 8.5), we project that the frequency of extreme pIOD events will increase by almost a factor of three, from one event every 17.3 years over the twentieth century to one event every 6.3 years over the twenty-first century. We find that a mean state change—with weakening of both equatorial westerly winds and eastward oceanic currents in association with a faster warming in the western than the eastern equatorial Indian Ocean—facilitates more frequent occurrences of wind and oceanic current reversal. This leads to more frequent extreme pIOD events, suggesting an increasing frequency of extreme climate and weather events in regions affected by the pIOD.

IITM Earth System Model for long term climate studies – the first from India



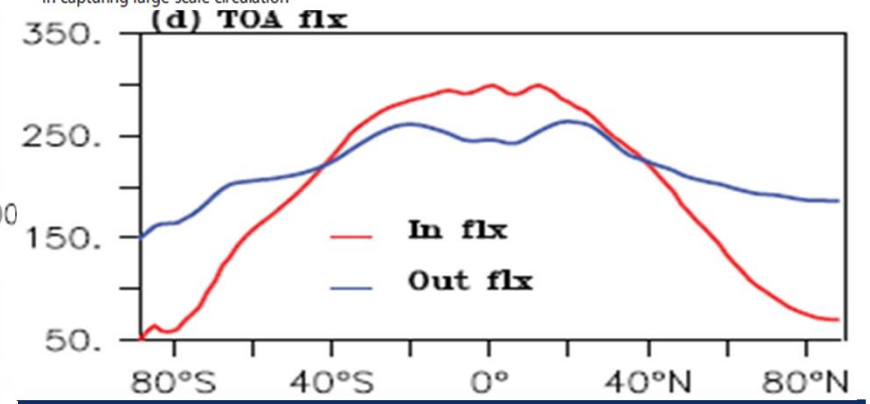
Journal of Advances in Modeling Earth Systems

RESEARCH ARTICLE
10.1029/2017MS001262

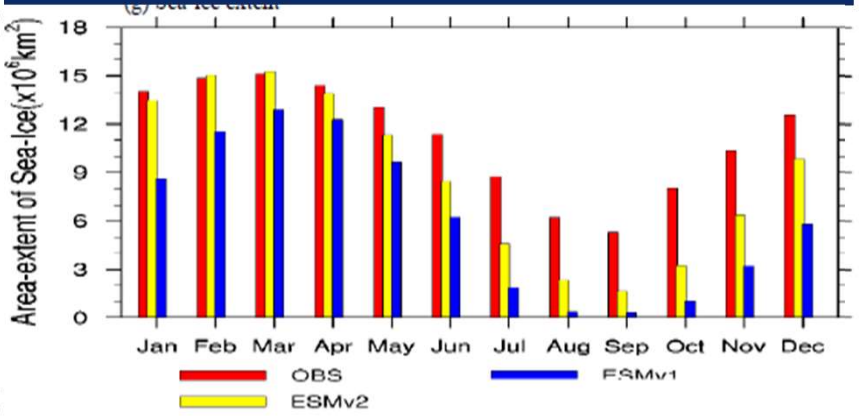
Long-Term Climate Simulations Using the IITM Earth System Model (IITM-ESMv2) with Focus on the South Asian Monsoon

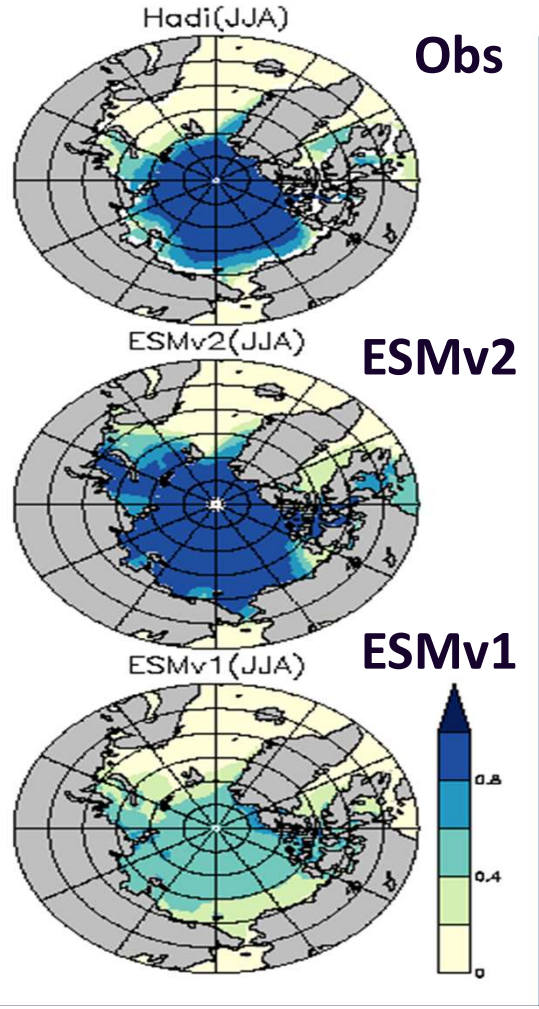
P. Swapna[1], R. Krishnan[1], N. Sandeep[1], A. G. Prajeesh[1], D. C. Ayantika[1], S. Manmeet[1], and R. Vellore[1]

Key Points:
- IITM-ESMv2 simulations show fidelity in capturing large-scale circulation

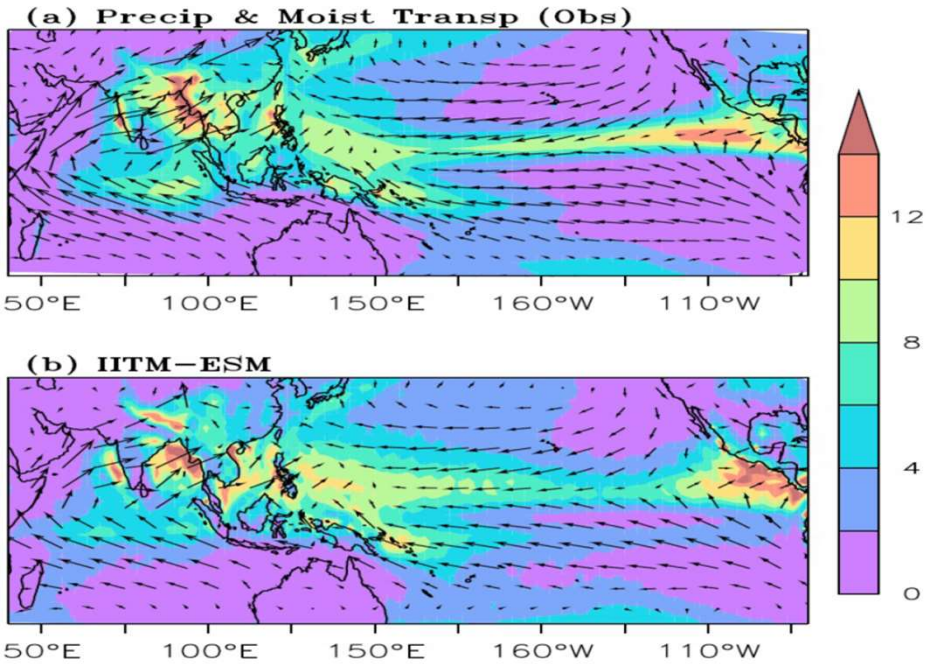


Improved simulation of sea-ice

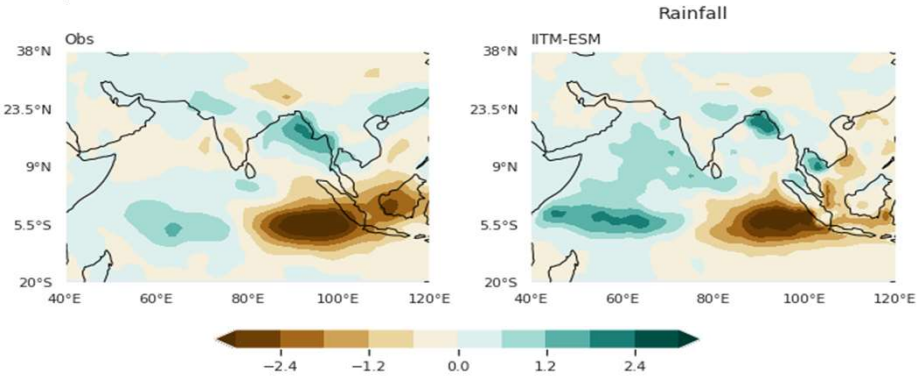




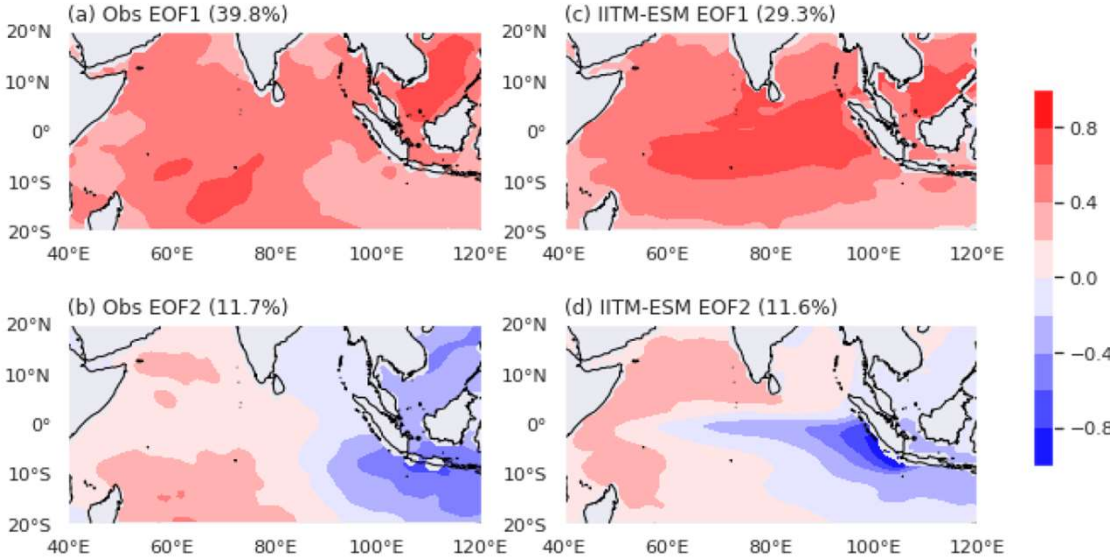
JJAS mean rainfall (mm/day) & moisture transport (kg/m2/s)

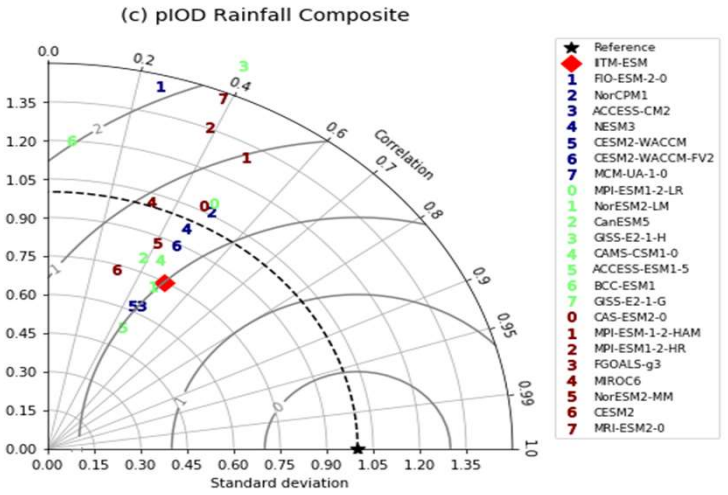


Anomaly composite of JJAS rainfall (mm/day) during positive IOD years from observation and IITM-ESM



Spatial pattern of leading modes of Indian Ocean SST variability for observation [left]. [a,c] 1st EOF and [b,d] 2nd EOF of monthly SST anomaly. EOFs are computed during 1950-2014 from HadiSST & historical run of IITM-ESM.





Taylor diagram showing the skill of IITM-ESM and other CMIP6 models in reproducing the rainfall anomaly over Indian land mass during pIOD years. Pattern correlation and stddev are computed from the pIOD composite anomalies of rainfall.

Prajeesh et al. 2021

Summary:

- **Heavy precipitation over Western India (WI)** – **Monsoon Rainstorms** *(Monsoon Lows and Depressions (LPS), Mid-Tropospheric Cyclones (MTC), Atmospheric Dynamics, …),* **Clouds & Convection** *(Large-scale organization of mesoscale convective systems (MCS), latent heating, …),* **Moisture Transport** (large-scale circulation, SST gradients in tropical Indo-Pacific, …) – **Impacts:** Flooding, landslides, hydrological / agricultural impacts
- **Duration of monsoon rainstorms over WI has risen since 1990s. Distinct enhancement during positive Indian Ocean Dipole (pIOD) events – e.g., 1994, 1997, 2006, 2007, 2019**
- **Impact of climate change on extreme precipitation**
  - Large-scale and regional circulation dynamics; Drivers of moisture transport into precipitating regions
  - Frequency of extreme positive IODs projected to increase under global warming
  - Increase of water vapor in a warming climate
- **Improving Prediction Potential of Heavy Precipitation & Flooding. Enhance Disaster Preparedness, Adaptation Capacity and Disaster Management**
  - **Enhancing Early Warning Systems** – **Observations** *(Satellite, Radar, Balloons, Lidar …),*
  - **Satellite retrieval of vertical profiles of water vapor and winds** – *Key for prediction of heavy precipitation*
  - **Data Assimilation** *(Winds {especially, vertical structure of divergent circulation}, Water Vapor, Convection)*
  - **High-resolution models with improved physical processes** *(including AI/ML, …)*
  - **Linking Research to Operations & Applications: Strengthen Basic Research, Education, Capacity Building, Coordinated Strategy** *(Water, Agriculture, Transport, Disaster Management, Defence, …).*

Thanks for your kind attention!

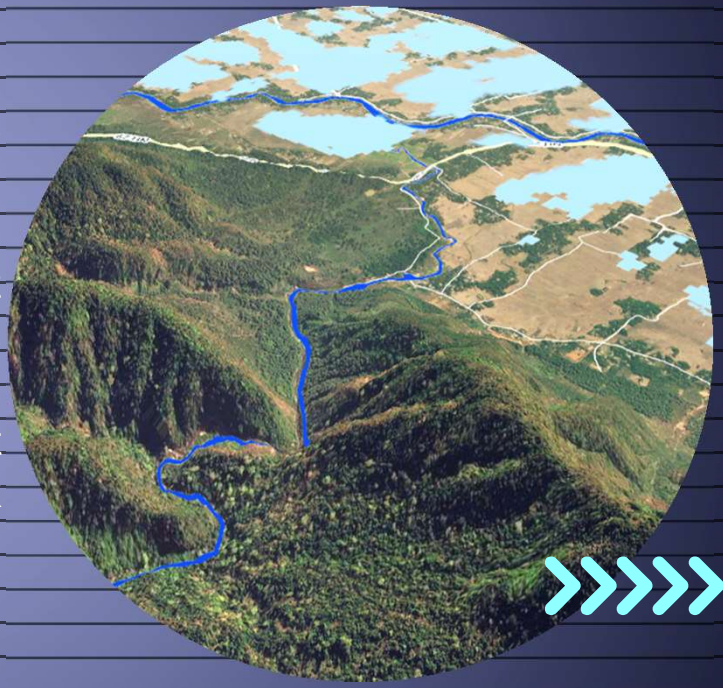
NATIONAL DATABASE FOR EMERGENCY MANAGEMENT

Geospatial Database for Disaster Management

TABLE OF CONTENTS

NDEM

National Database for Emergency Management (NDEM) is a unique Geo-portal to disseminate space based inputs along with services of forecasting organizations multi-scale geospatial database coupled with decision support system tools. At the behest of Ministry of Home Affairs (MHA), Government of India, National Remote Sensing Centre (NRSC), ISRO has established the state-of-art facility at NRSC, Hyderabad with structured framework with multi-institutional participation.



01

NDEM OVERVIEW

Concept of NDEM and Functionalities

NDEM OBJECTIVES

Multi-scale geospatial database for the country.

Development of Decision Support System tools for addressing disaster/ emergency management.

Establishment of Computer infrastructure

STAKE HOLDERS

Monitoring Dept.

MHA, NDMA, PMO,
NIDM, IDS

State Disaster Dept

All States/Uts DM Dept.
Officials

Forecasting Dept.

IMD, CWC, INCOIS, SASE

District Disaster Dept.

760+ Districts from all
States/UTs

Relief & Rescue Forces

NDRF, SDRF

NDEM MILESTONES

2013

NDEM v1
Geospatial Viewer
VPN Access
GIS Tools

2015

NDEM v2
Mobile Apps
MoU With NDRF
Regional Training Programs

2016

Customized NDEM-NDRF Portal

2017

NDEM v3
Disaster Dashboard
MoUs With States
3 SKOCH Awards

2018

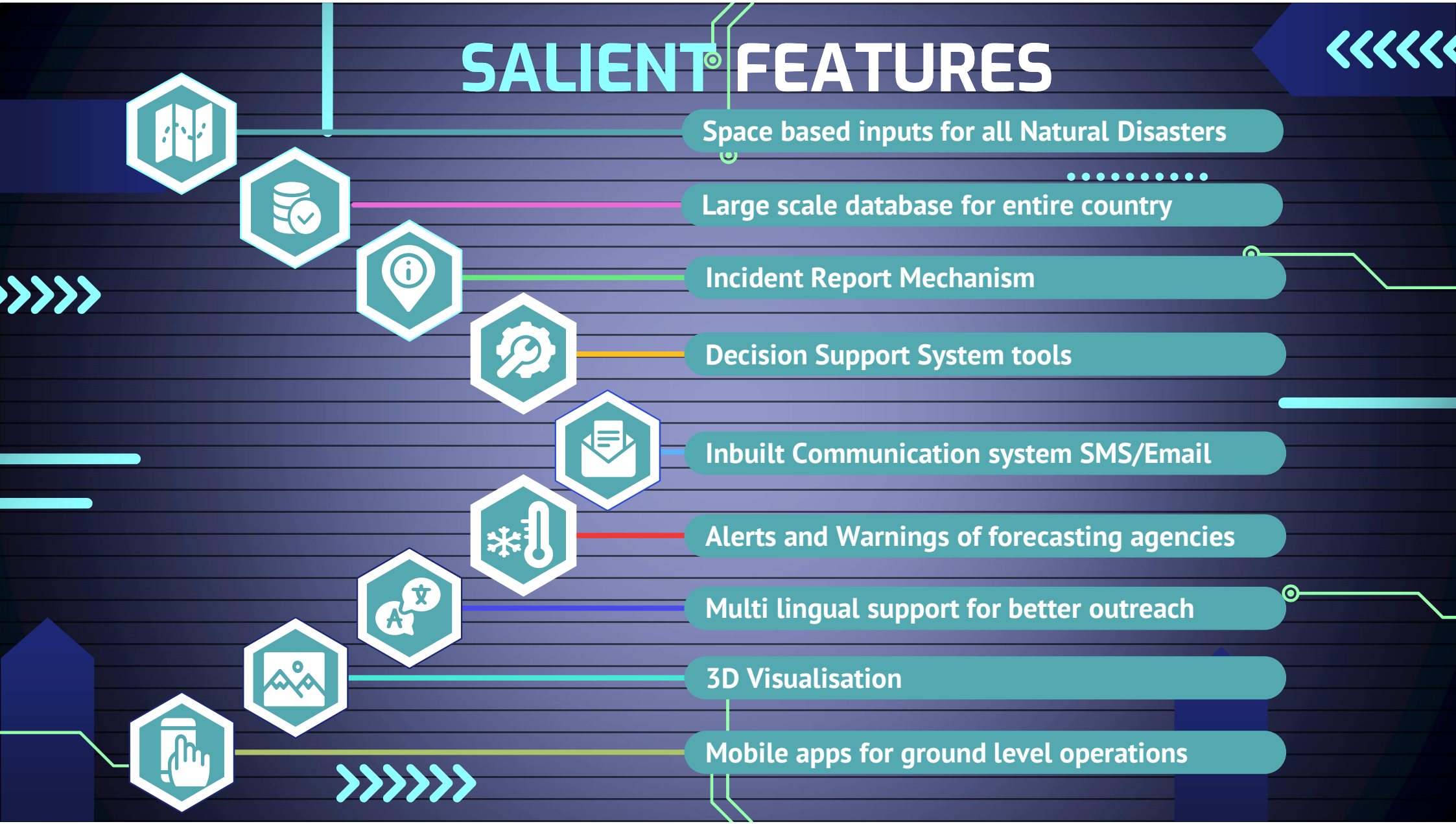
Customized Portals for States
Regional Training Programs

2021

NDEM v4
Regional Languages Support
More DSS Tools & PDNA Tools
Regional Training Programs
Public Access to Disaster Layers

2023

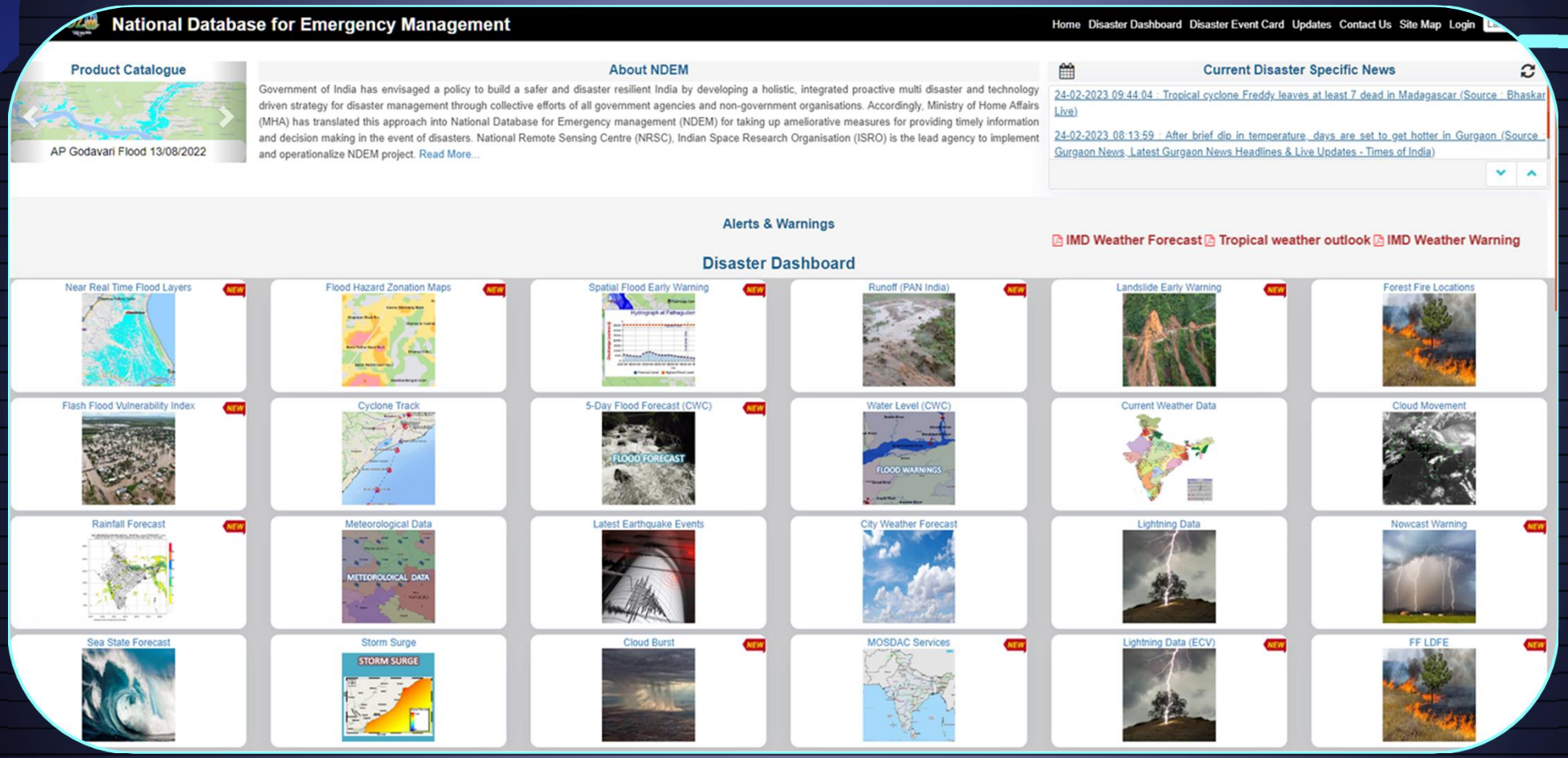
NDEM v4.1
Enhanced Disaster Dashboard
Forest Fire / Lightning Alerts
SMS alerts to stake holders
Terrain / 3D Visualization


SALIENT FEATURES
Space based inputs for all Natural Disasters
Large scale database for entire country
Incident Report Mechanism
Decision Support System tools
Inbuilt Communication system SMS/Email
Alerts and Warnings of forecasting agencies
Multi lingual support for better outreach
3D Visualisation
Mobile apps for ground level operations

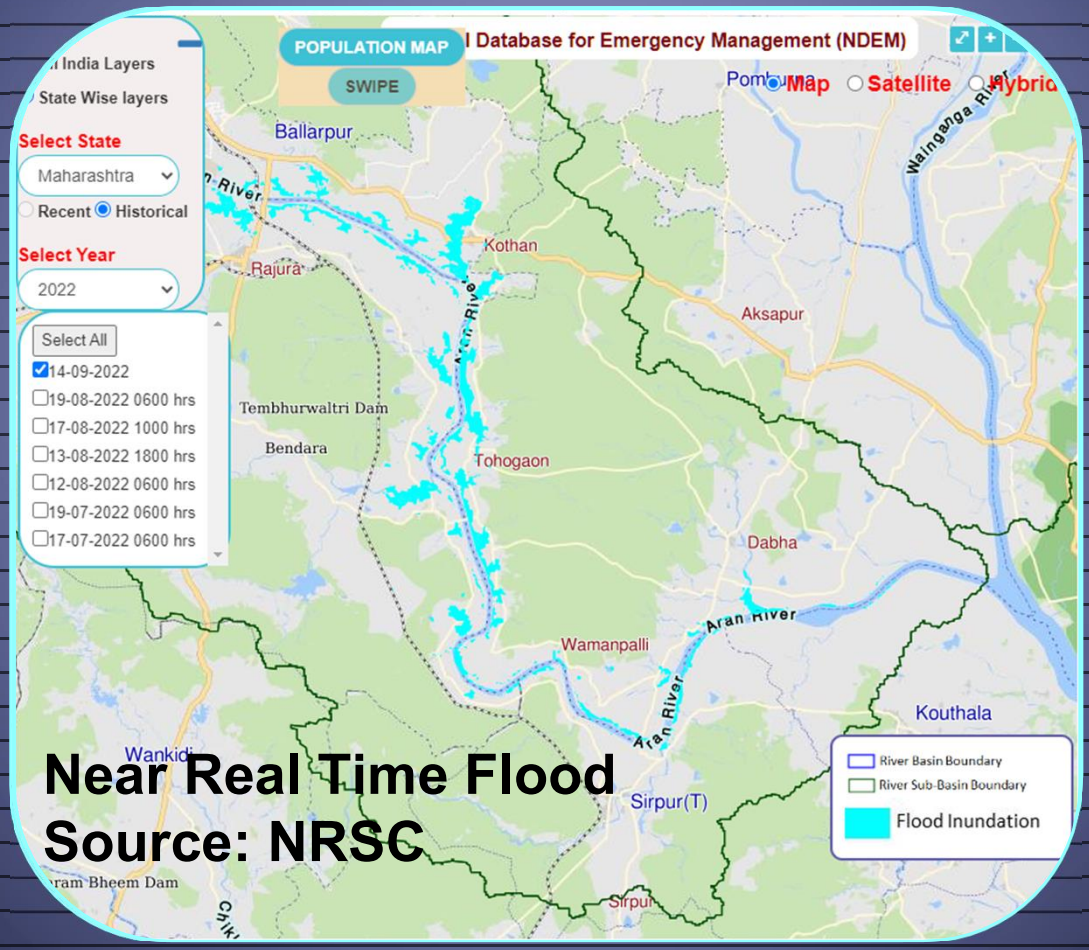
02 DISASTER DASHBOARD

Disaster related forecasts, warnings, alerts etc.,

DISASTER DASHBOARD

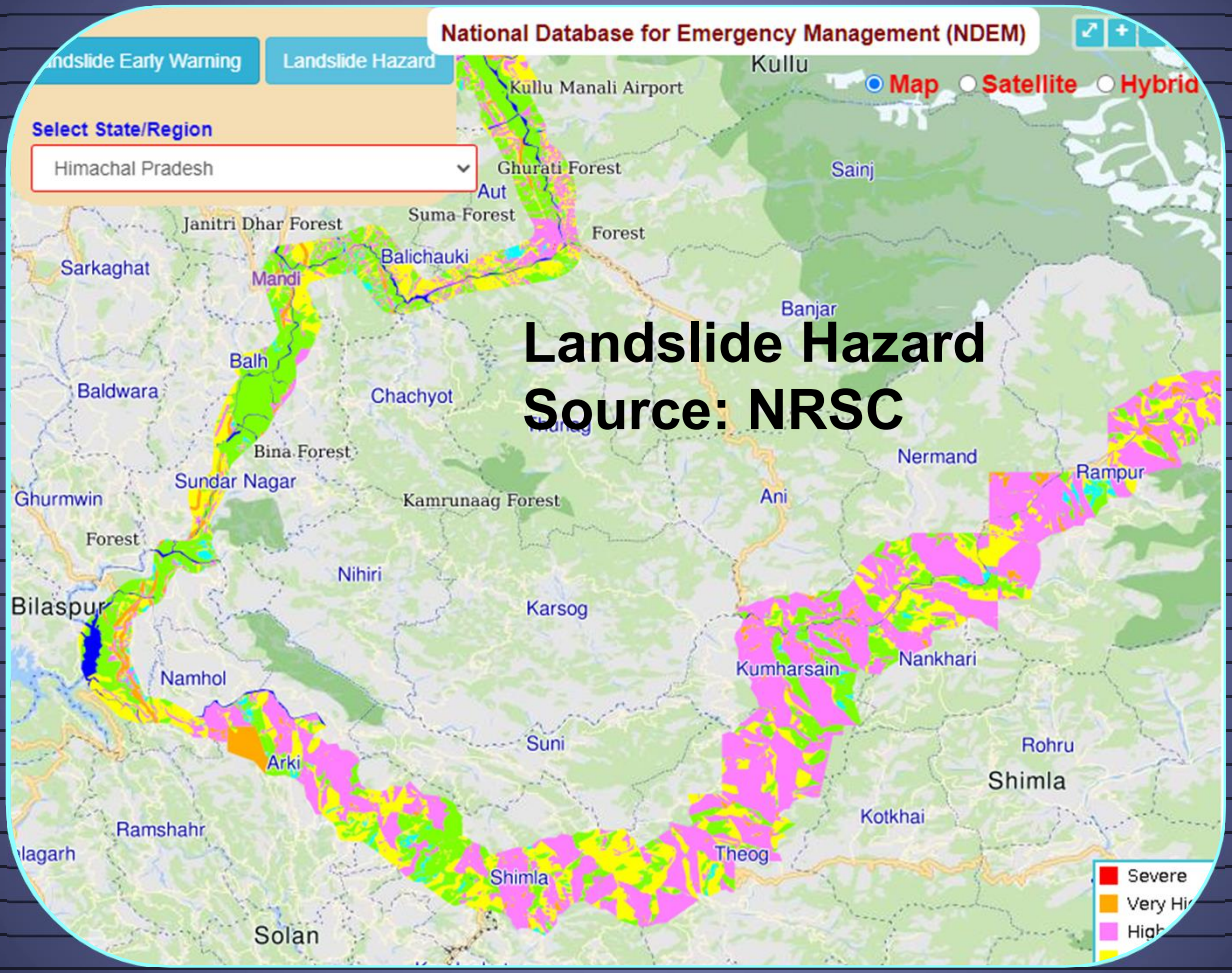


HYDROLOGICAL DISASTERS

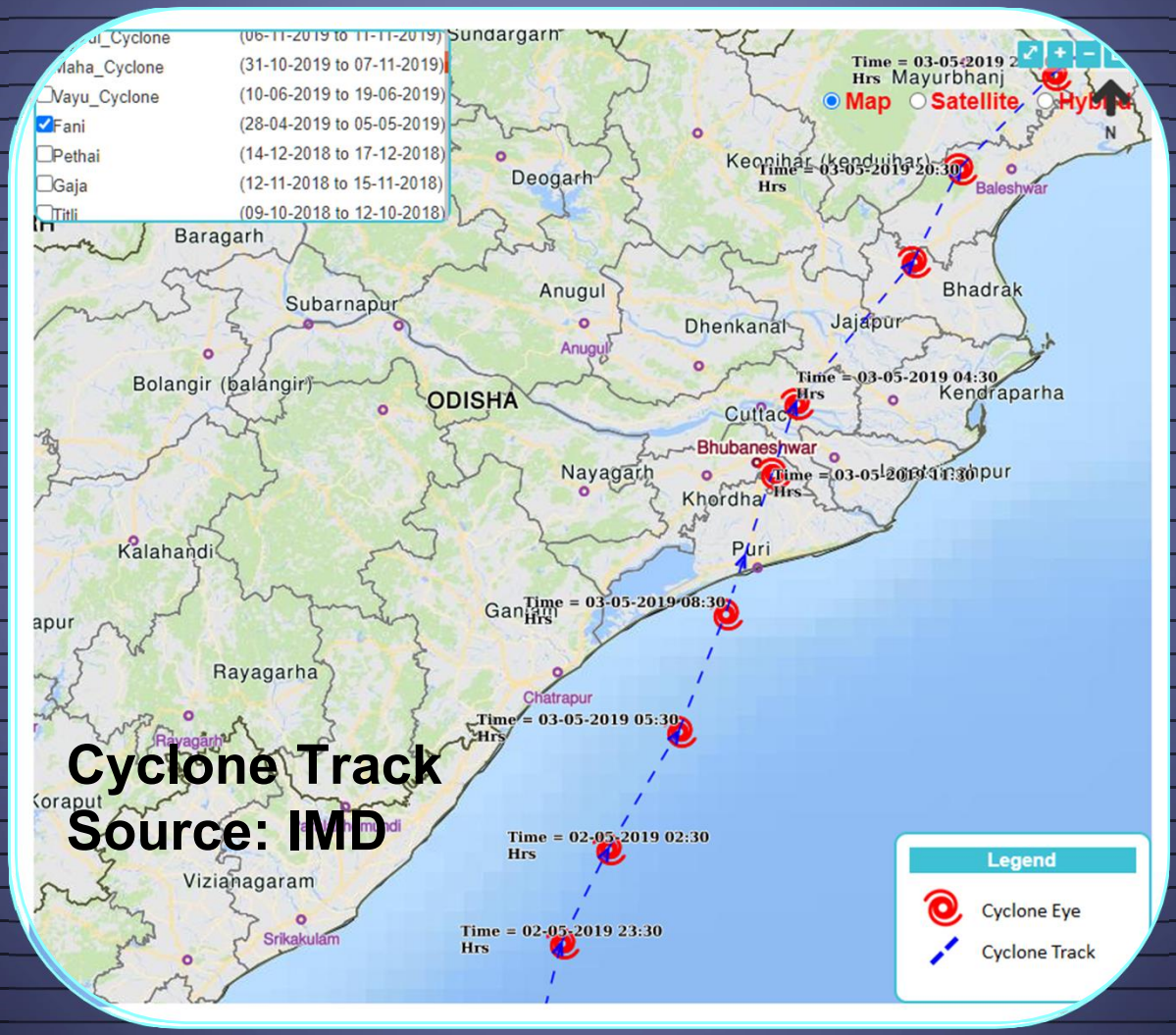


Near Real Time Flood
Source: NRSC

GEOLOGICAL DISASTERS

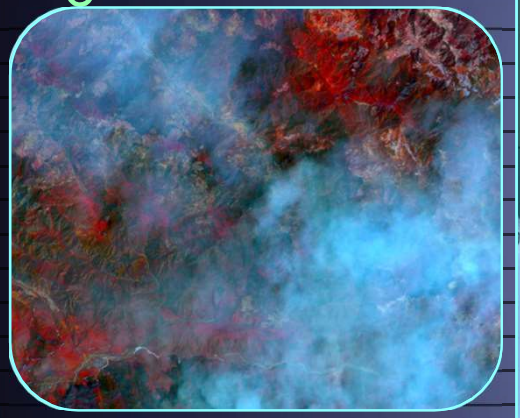


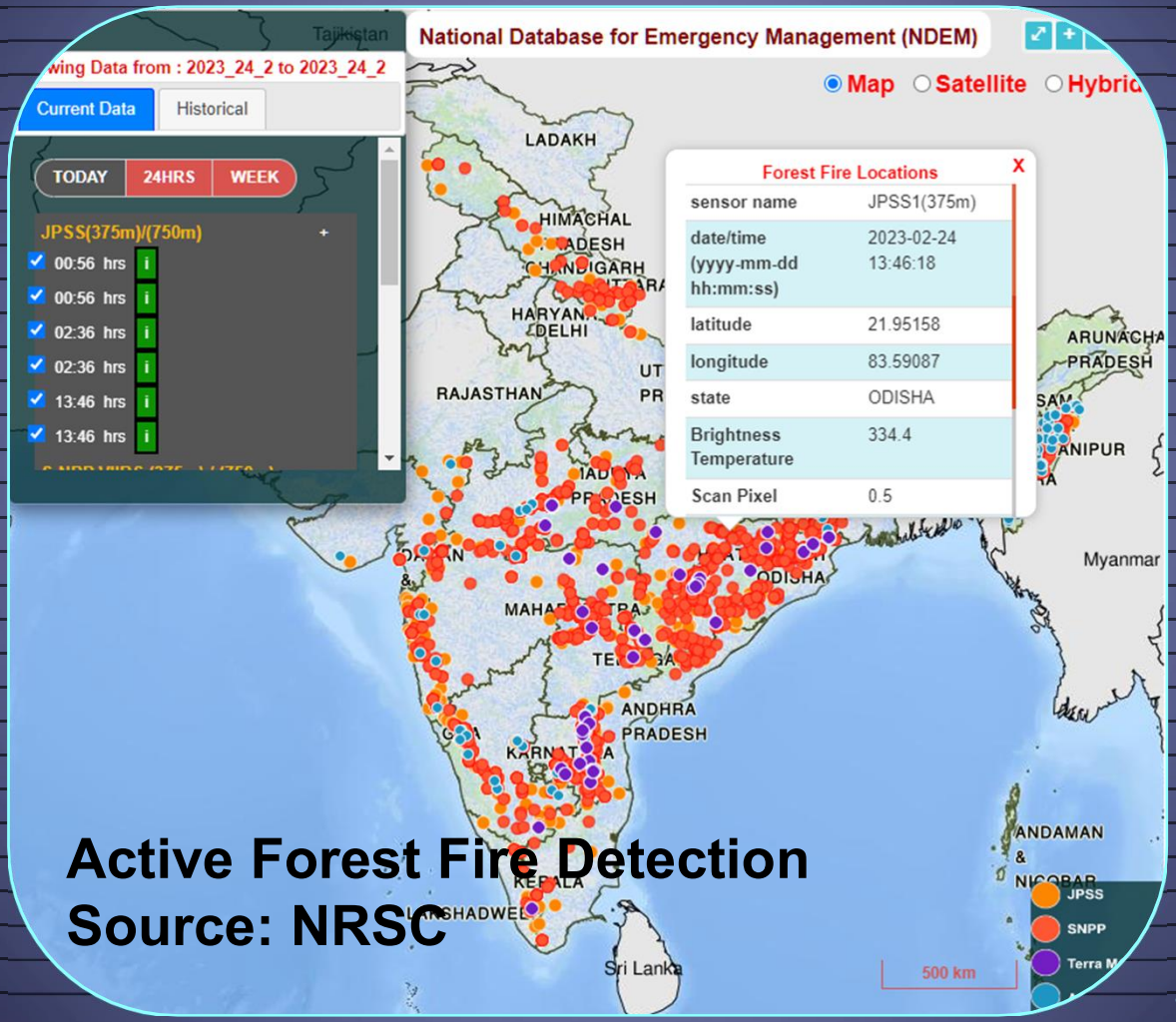
METEOROLOGICAL DISASTERS



Cyclone Track
Source: IMD

FOREST FIRE

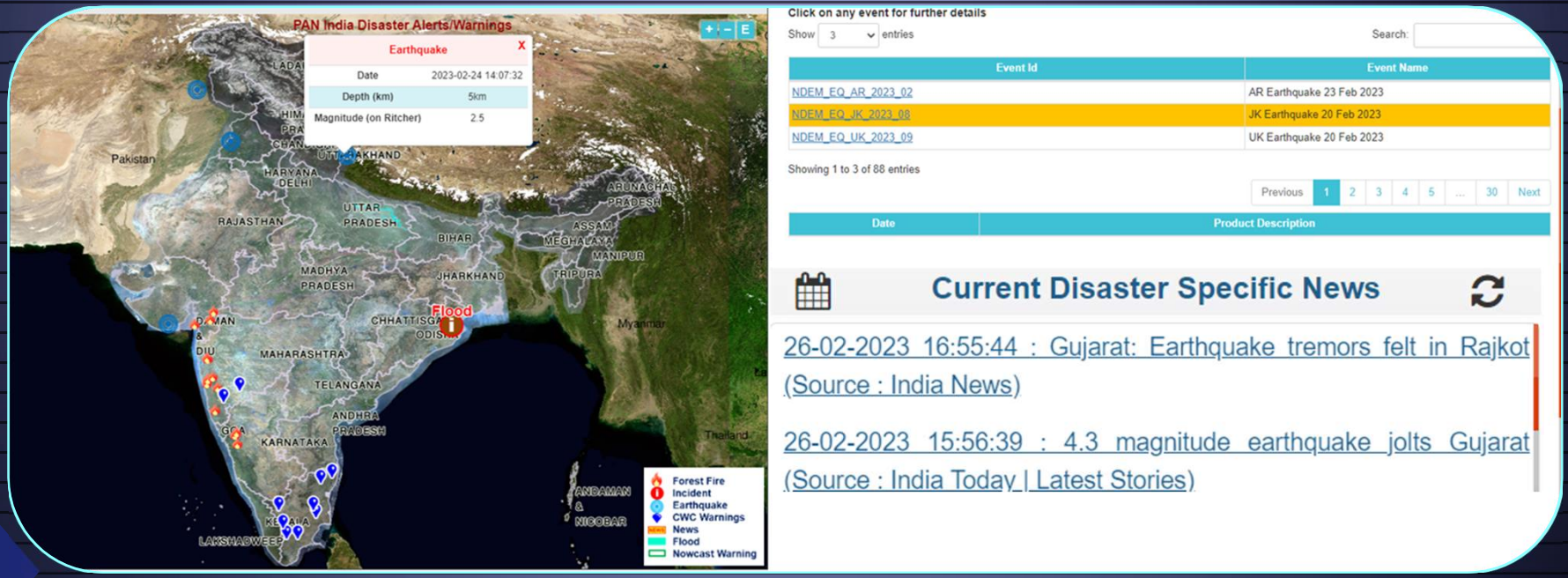




Active Forest Fire Detection
Source: NRSC

DISASTER EVENT CARD

- All India Disaster Scenario in One Map
- Disaster Related News and Disaster Watch Report



03

GEOSPATIAL DATA

Spatial data elements to tackle disasters

DATA SERVICES

Base Data

Admin boundaries,
Hydrological data etc.,

Point of Interest

Location information of facilities

Thematic Data

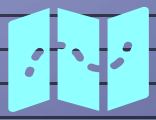
Data products derived from satellite imagery

Satellite Imagery

5.8 Meter to Sub-Meter resolution Satellite Imagery

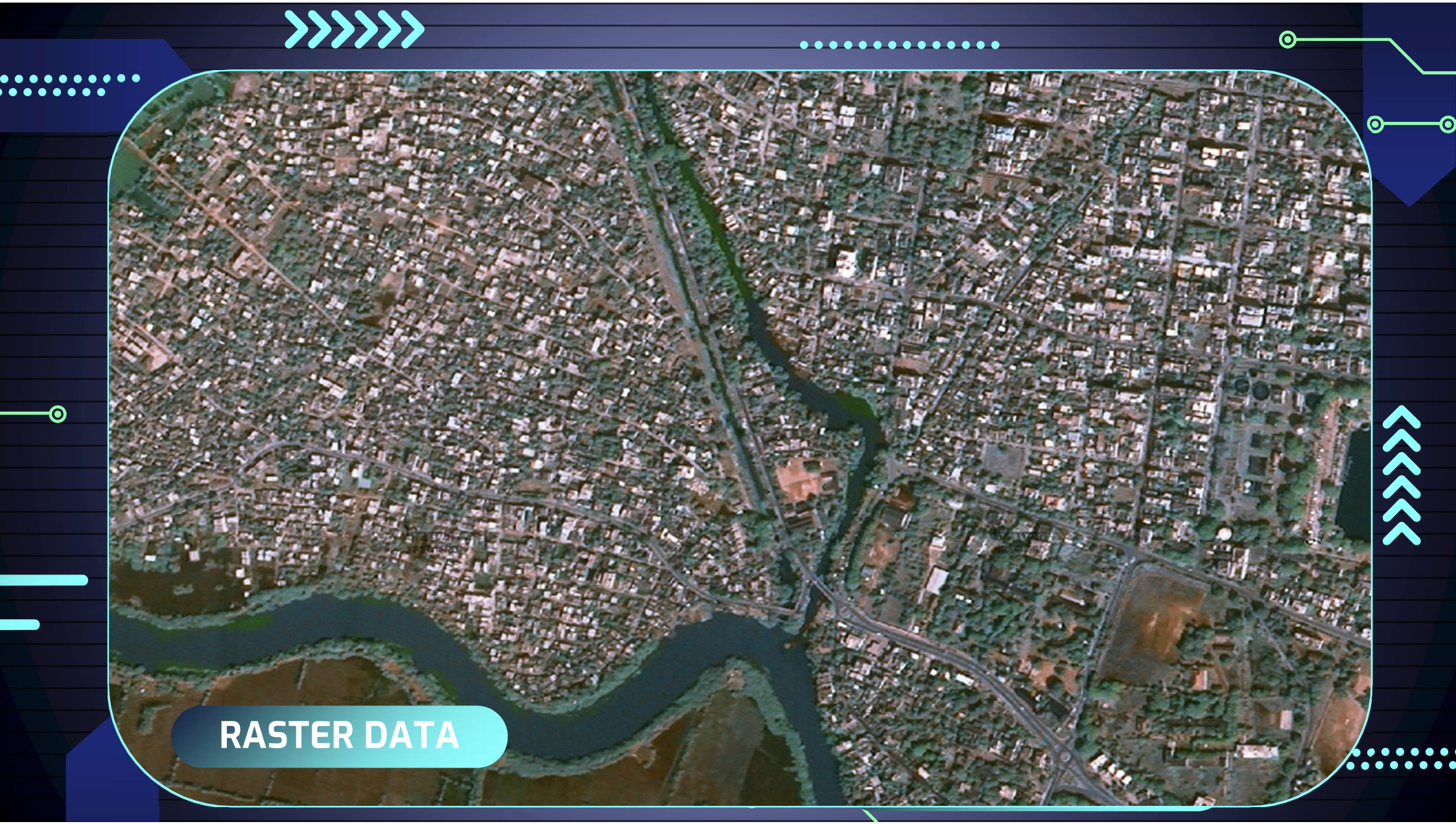
Infrastructure Dta

Road/Rail network etc.,



Non-Spatial Data

Socio economic, Census, Health database


RASTER DATA

04

GEOSPATIAL TOOLS

Tools for planning, analysis & Mitigation

DECISION SUPPORT SYSTEM TOOLS

Proximity Analysis

Proximity tool for identifying emergency facilities.

Evacuation Plan

Aids the disaster managers to identify the extent of area along with list of villages and suitable shelters for evacuating people

Route Analysis

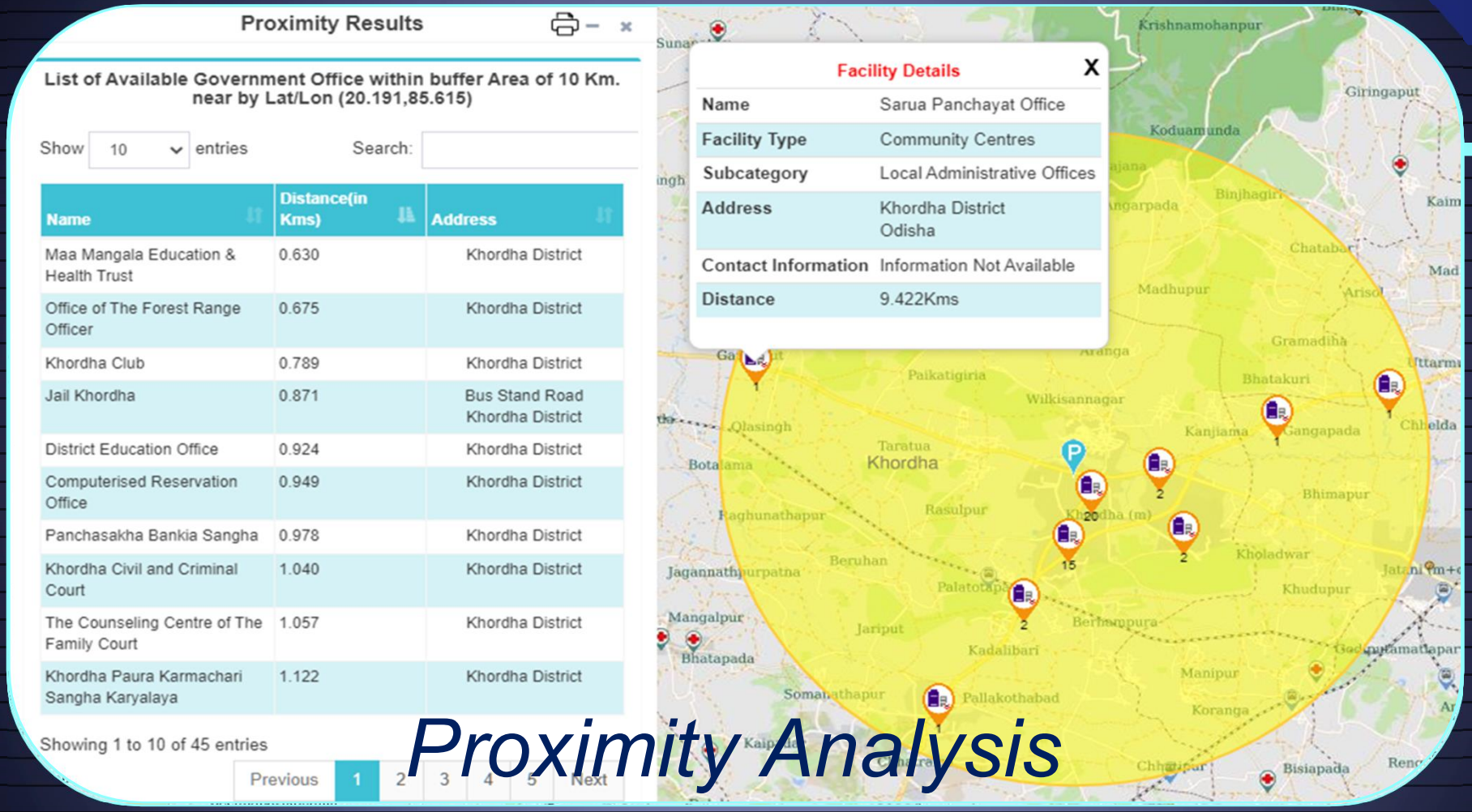
Route analysis facilitates the user to find out the shortest route between emergency facility and user interested location/disaster site with details of the route.

Spatial Query

It is used to query/filter the existing spatial layers and display particular layer on the map.

Multi-Layer Analysis

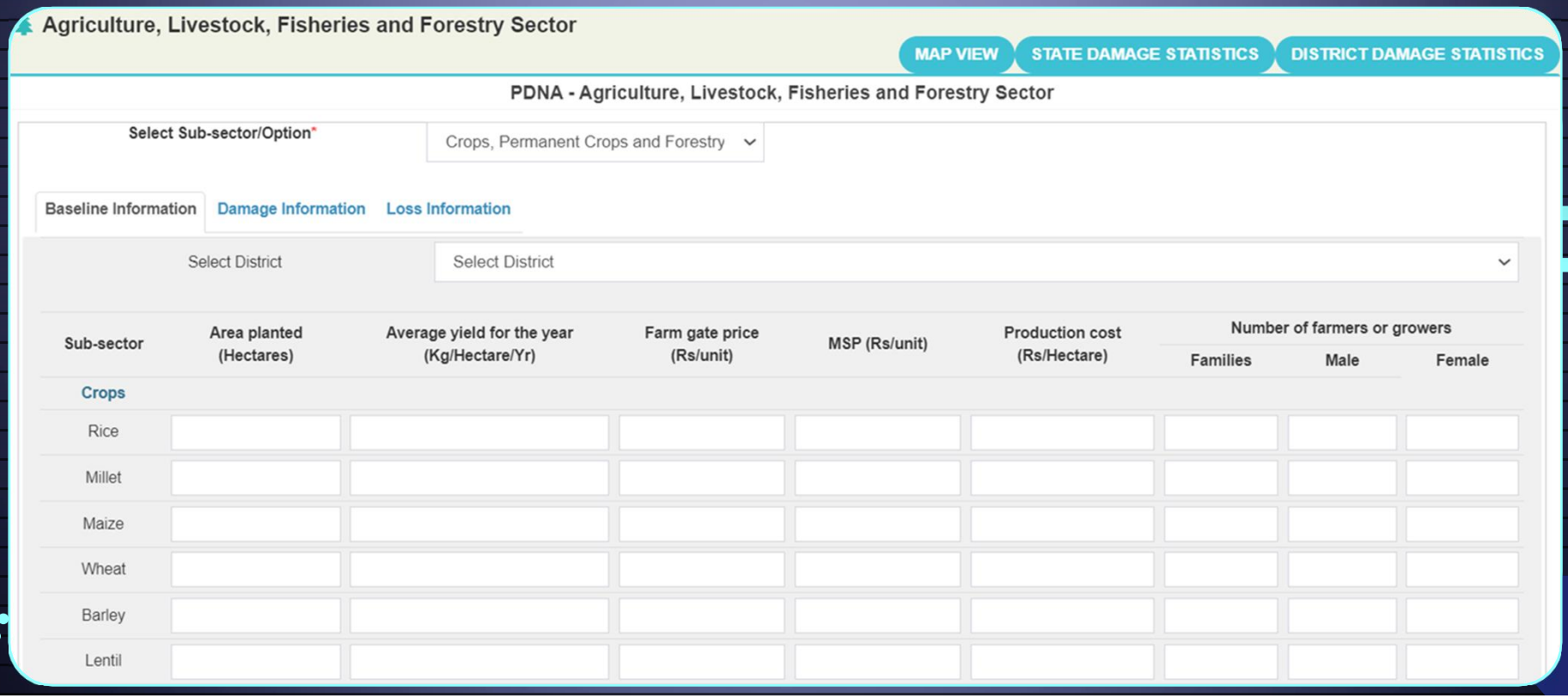
Spatial analysis tool enables the user to add multiple layers on NDEM Map Viewer for analyzing the features for effective decision making.



Proximity Analysis

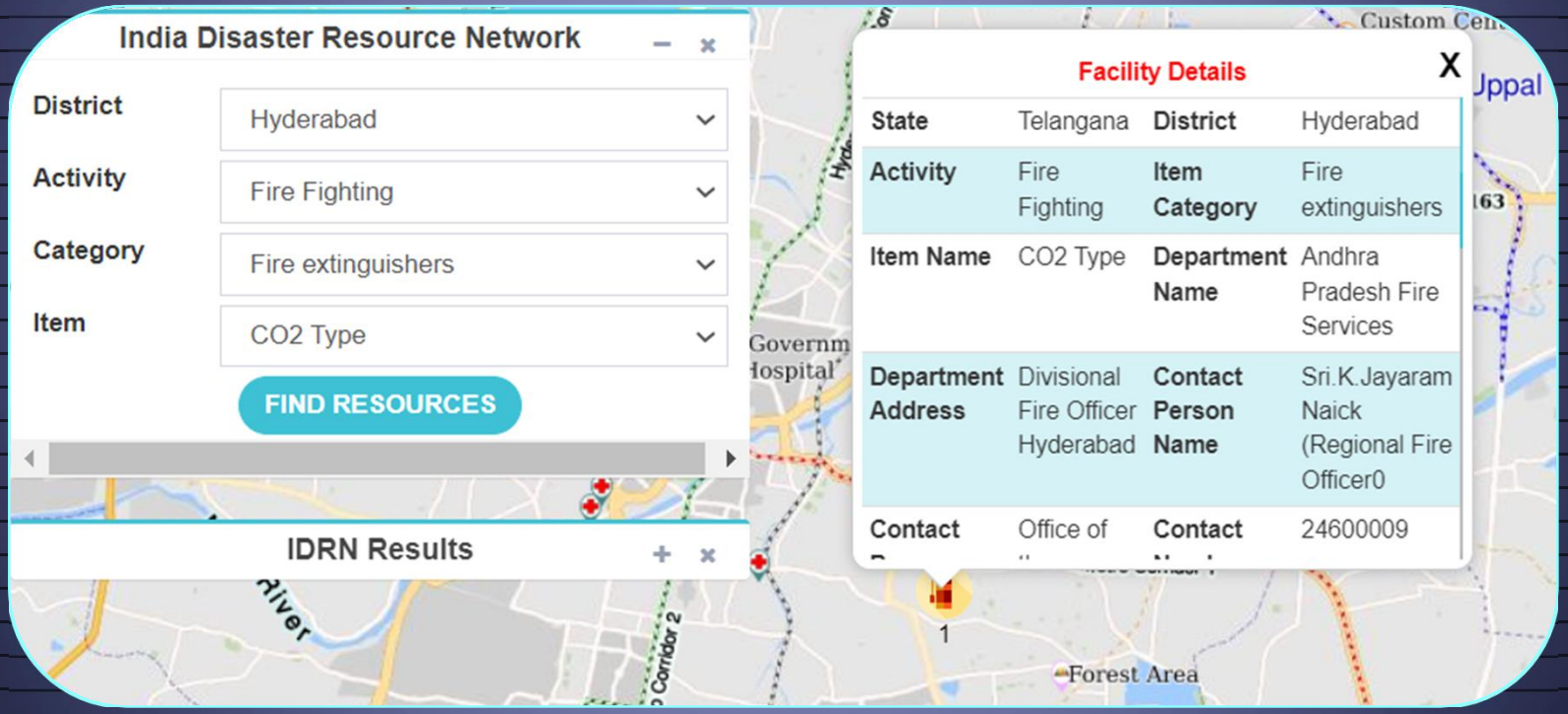
PDNA TOOLS

Post Disaster Needs Assessment (PDNA) - National Institute of Disaster Management, Ministry of Home Affairs, Government of India has designed the Post Disaster Needs Assessment (PDNA) Tools for India. This tool will enable the comprehensive and scientific assessment of recovery and reconstruction needs on the basis of a thorough analysis of disaster effects and impacts.



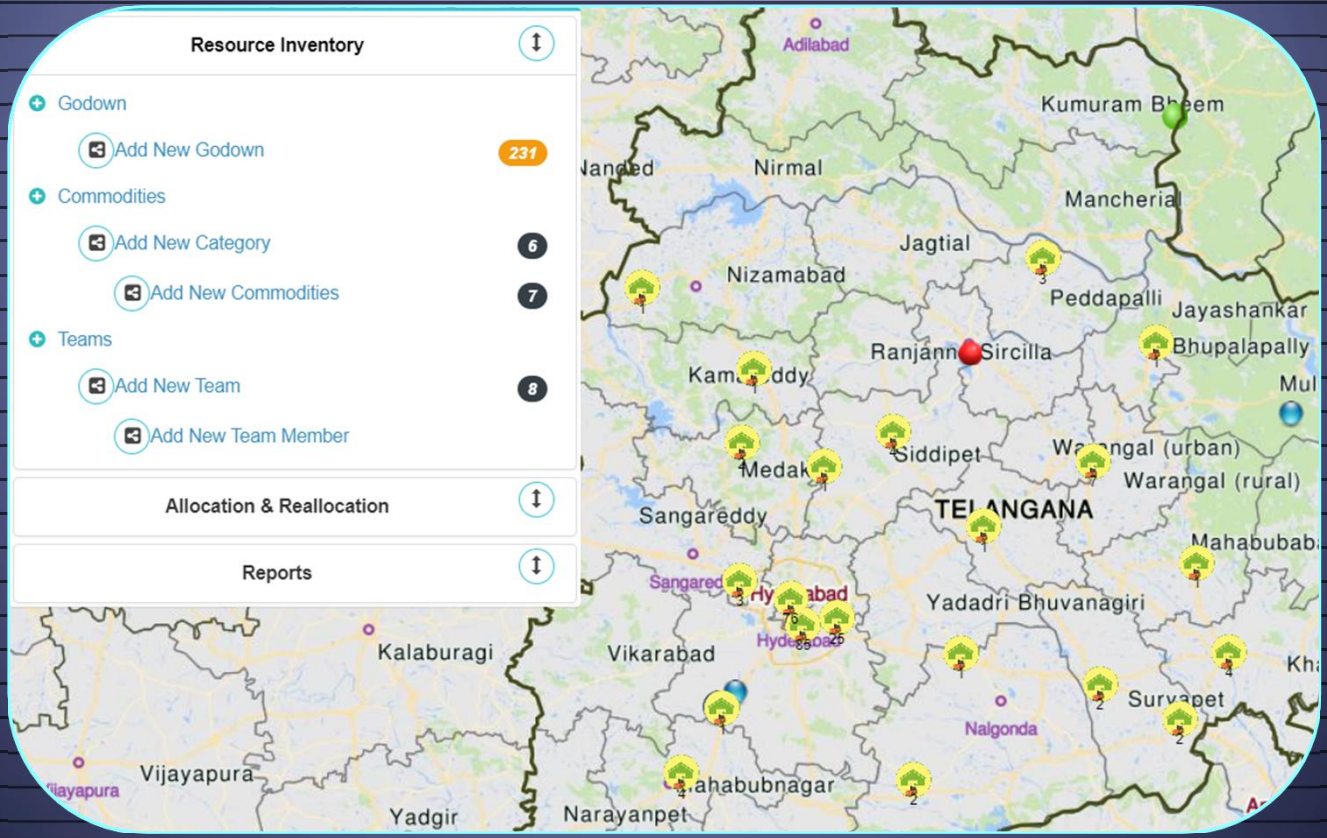
IDRN TOOLS

India Disaster Resource Network (IDRN) - database is integrated in NDEM along with its Geo-location of resources. This module helps to locate rescue equipment along with geospatial visualization

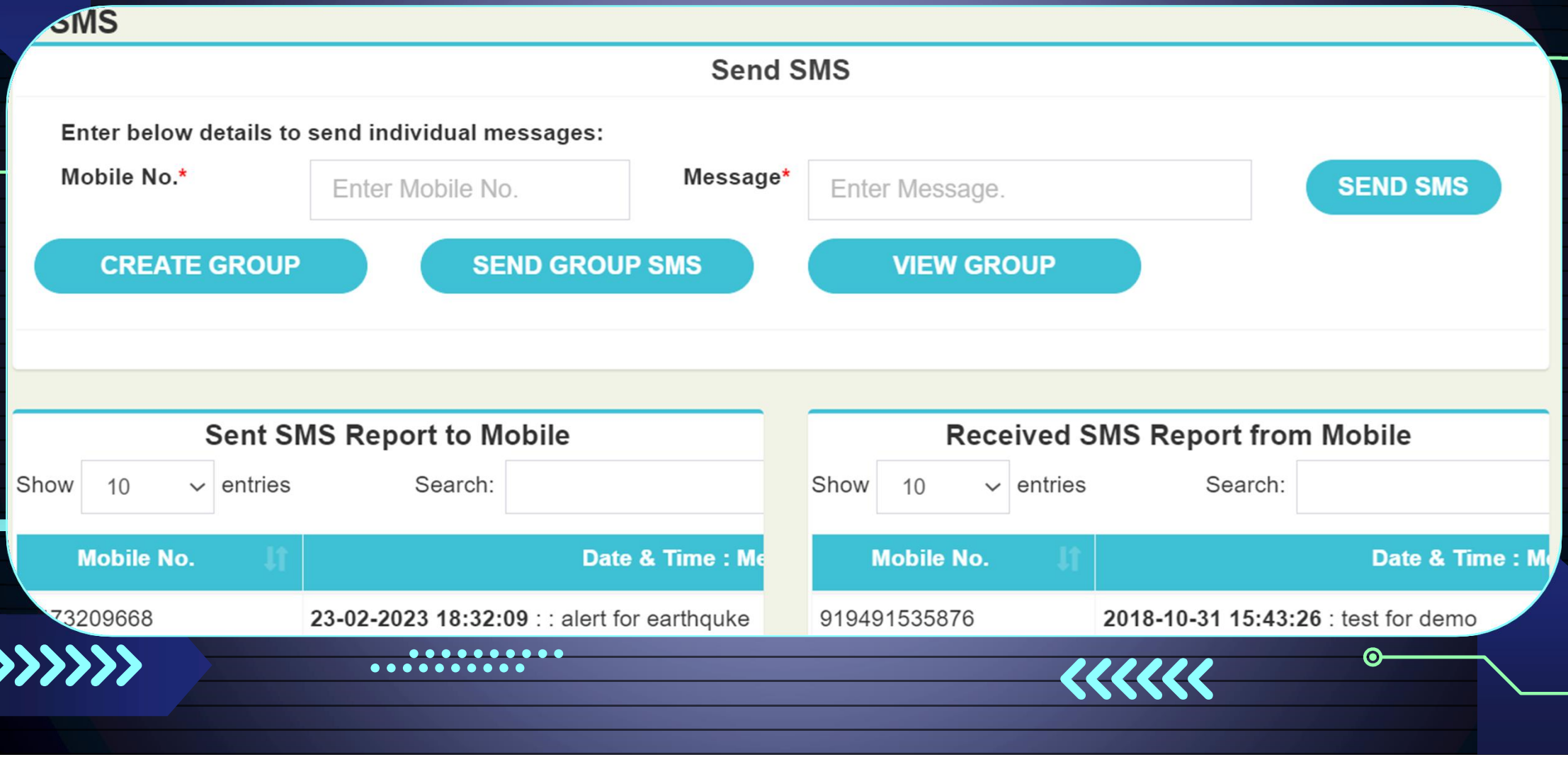


RESOURCE MANAGEMENT TOOLS

A well planned resource management module is developed to cover inventory, Resource allocation, organisation and tracking of essential commodities/ resources during disaster time.



INTERACTION TOOLS

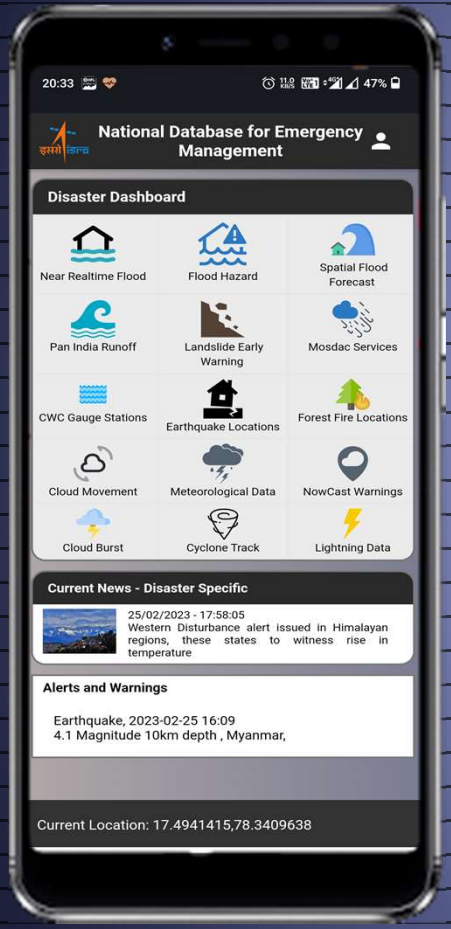


05

MOBILE APPS

Mobile Apps for field level

MOBILE APPS



NDEM Lite

NDEM Relief Management App consists four modules;

1. Relief Management
2. Incident Reporting
3. Geospatial Data Collection
4. Geo-tagging

NDEM Lite App is designed with essential disaster dashboard services, base data, DSS tools etc.,

Relief Management

06

ICR - ER

Integrated Control Room for Emergency Response

ICR - ER

Integrated Control Room for Emergency Response (ICR-ER) is being established by MHA at NDCC-II, New Delhi for both Disaster Management and Internal Security of the country. In the event of ICR-ER

Responsibilities of NDEM;

- To function as Disaster Recovery site for Redirection of services.
- To provide near real time disaster specific data and satellite data during any disasters or emergency.

07

CAPACITY BUILDING

Training Programmes/Workshops/Mock Drills

CAPACITY BUILDING

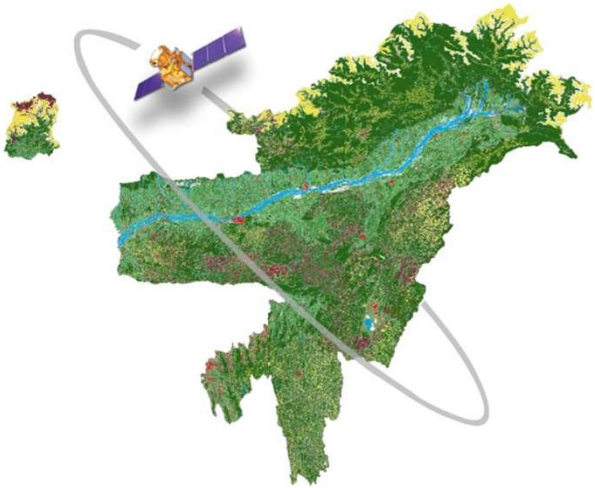
In order to increase the awareness amongst users and for better utilization of NDEM services, training programmes, workshops and mock drills are conducted to Central, State, District disaster management officials and NDRF, SDRF personnel. Capacity building programmes are also conducted in co-ordination\with GIDM and NIDM. Regional training programmes are conducted across the country on NDEM version 4.0; So far, more than 2000 officials are trained on NDEM version 4.0

NDRF Workshop

Visit of IG, NDRF

Mock Drill

Thanks!

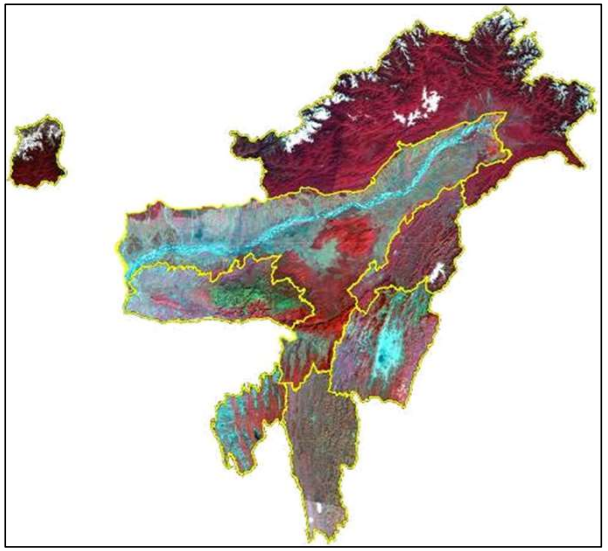


Impact of Climate Change on Disasters: North East Perspective

By
Dr SP Aggarwal,
Director
North Eastern Space Applications Centre

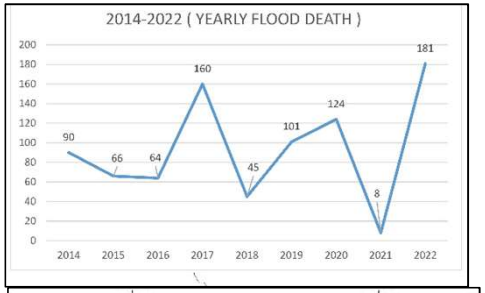
North-Eastern Region of India

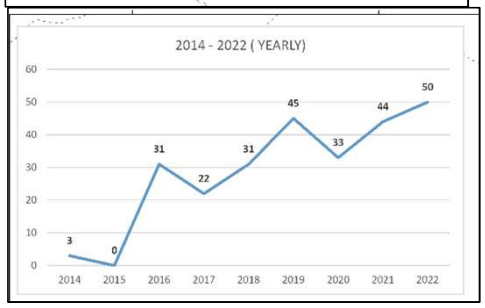
- 8 States
- Land Area: 8% of the country
- Water Resources: 30%
- Hydropower potential: 44%
- Forest : 24%
- 2nd Biggest biodiversity hotspot in the world

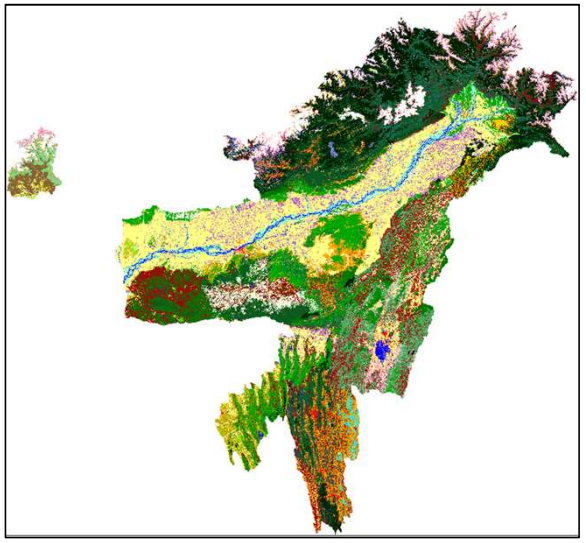


Challenges

- Floods
- Landslides
- Lightening
- Erosion
- Earthquake
- Forest Fire
- Terrain
- Health







Glimpse of recent disasters in NE India

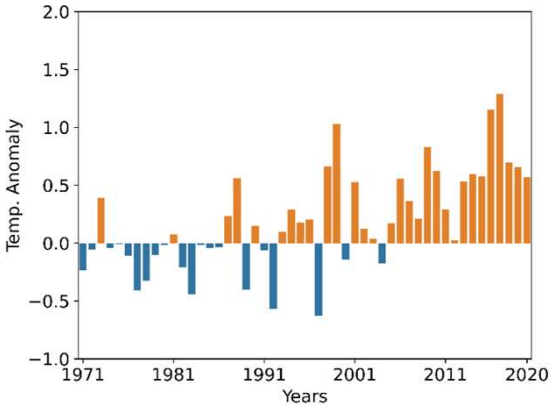
Guwahati, Assam, 14 June, 2022, Hindustan Times

Heavy Rainfall and Land-slides at New Haflong railway station, Assam, 16 May, 2022, The Hindu

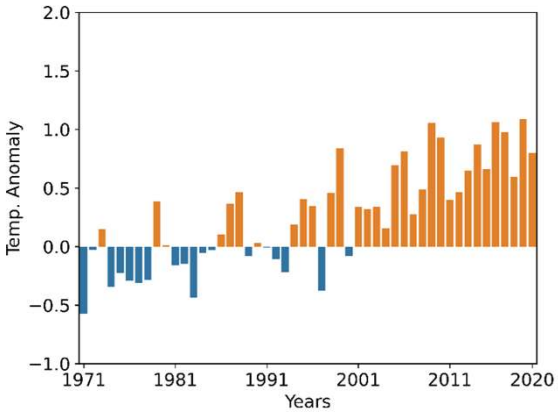
17 June, 2022, Quint

Rise in Temperature over North East India

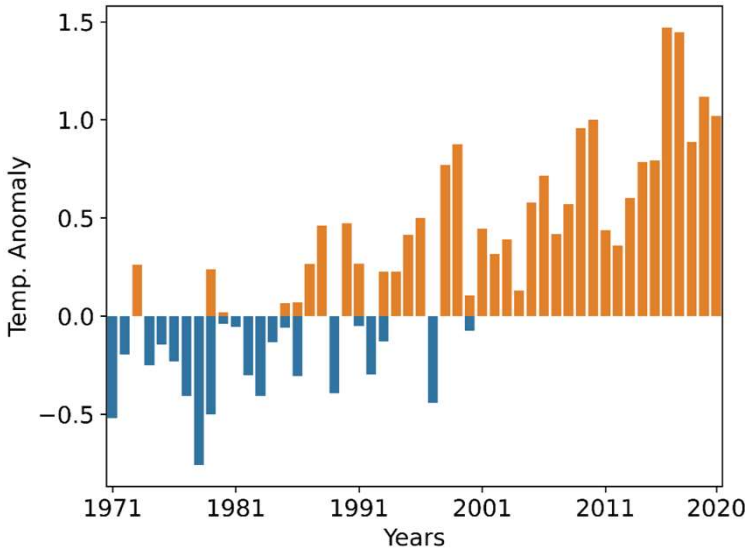
Annual Mean Temperature Anomaly
(Arunachal Pradesh)



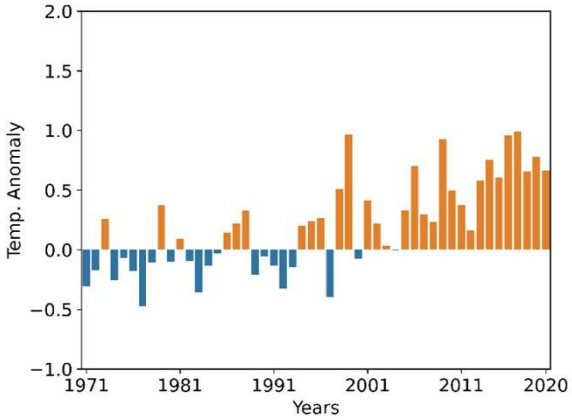
Annual Mean Temperature Anomaly
(Mizoram, Manipur, Nagaland, Tripura)



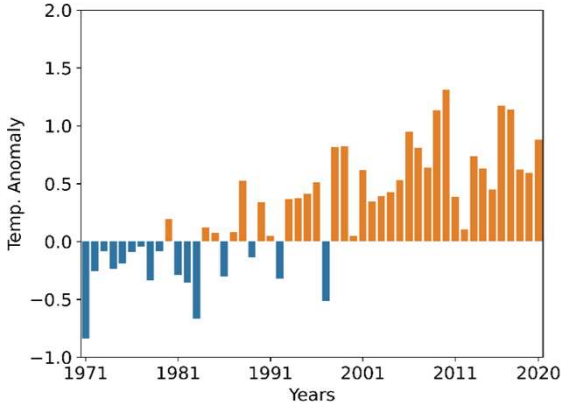
Annual Mean Temperature Anomaly
(North East India)



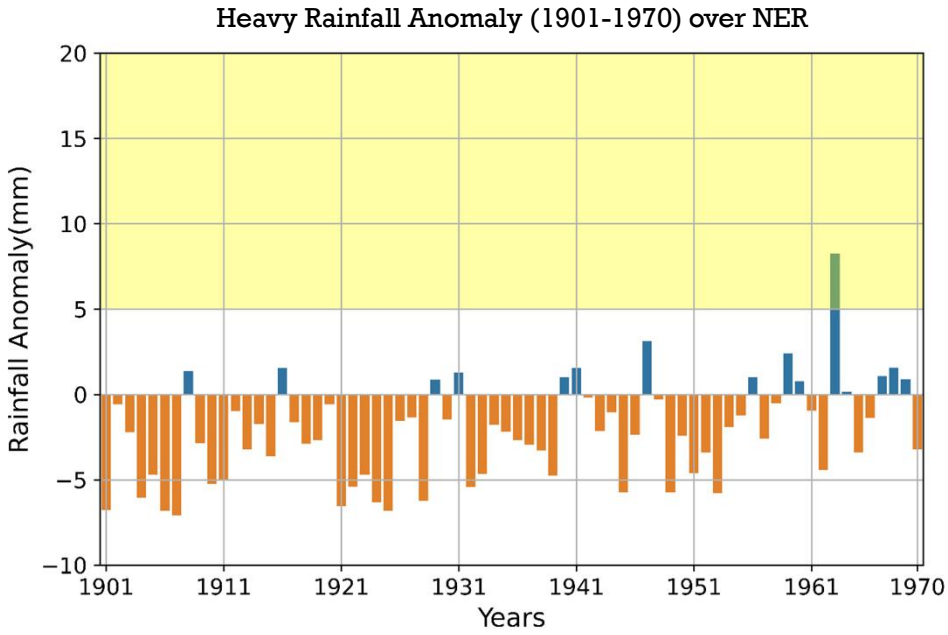
Annual Mean Temperature Anomaly
(Assam + Meghalaya)

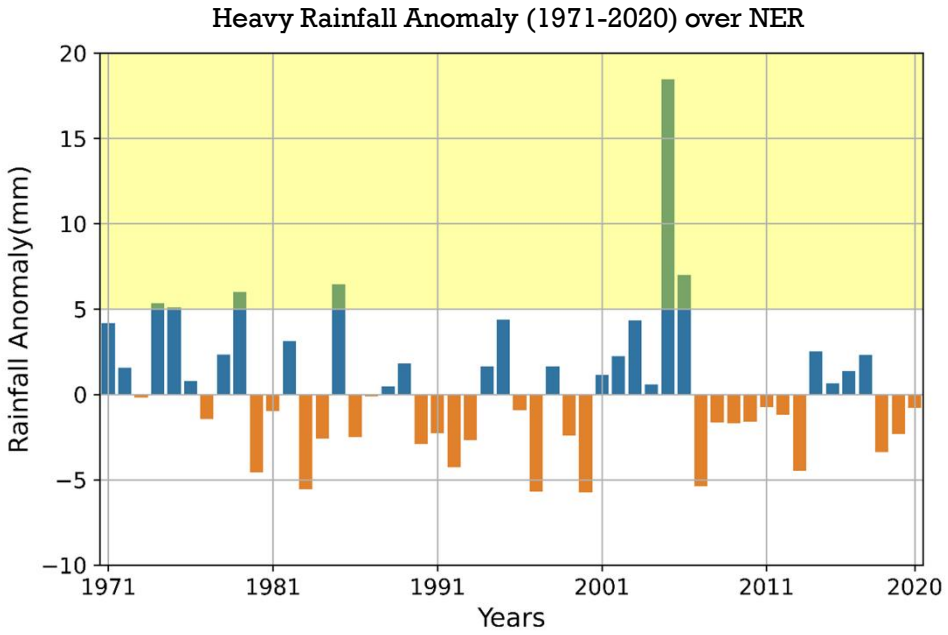


Annual Mean Temperature Anomaly
(Sikkim + Sub-Himalayan West Bengal)



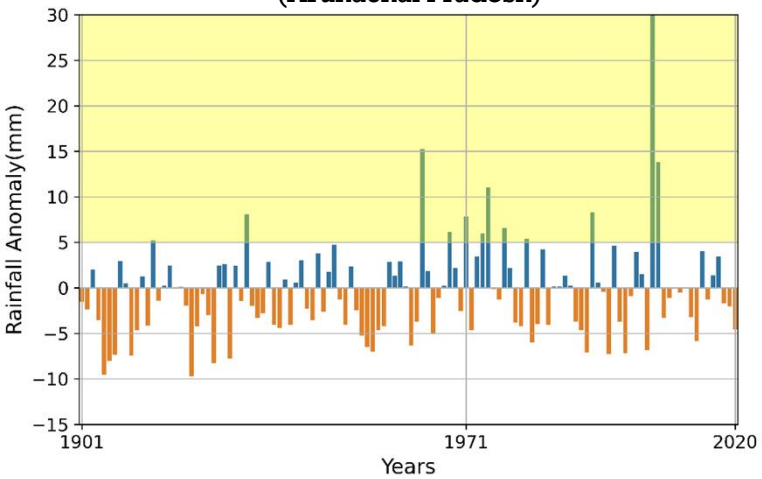
Rainfall Anomaly over North East India



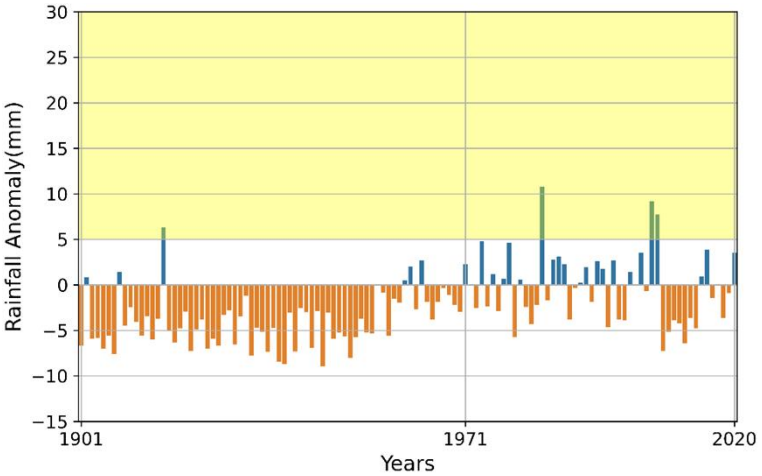


Rainfall Anomaly over North East India

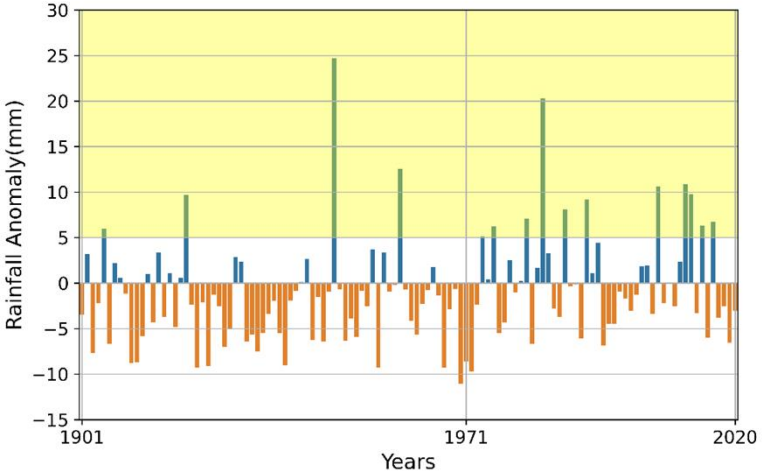
Heavy Rainfall Anomaly (1901-1970) over (Arunachal Pradesh)



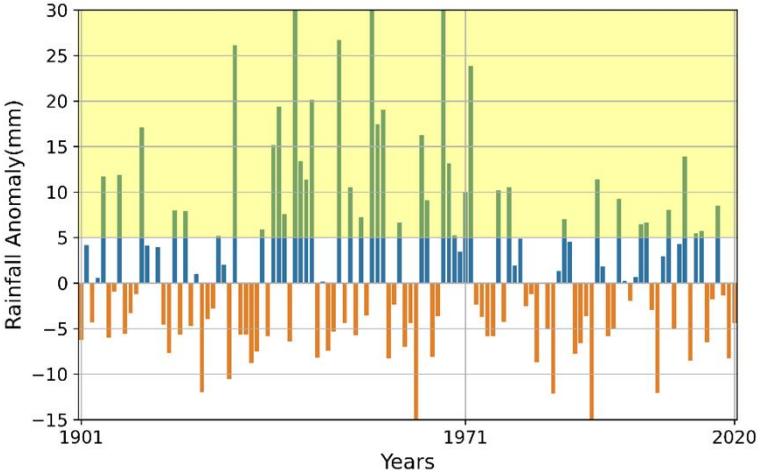
Heavy Rainfall Anomaly (1901-1970) over (Assam + Meghalaya)



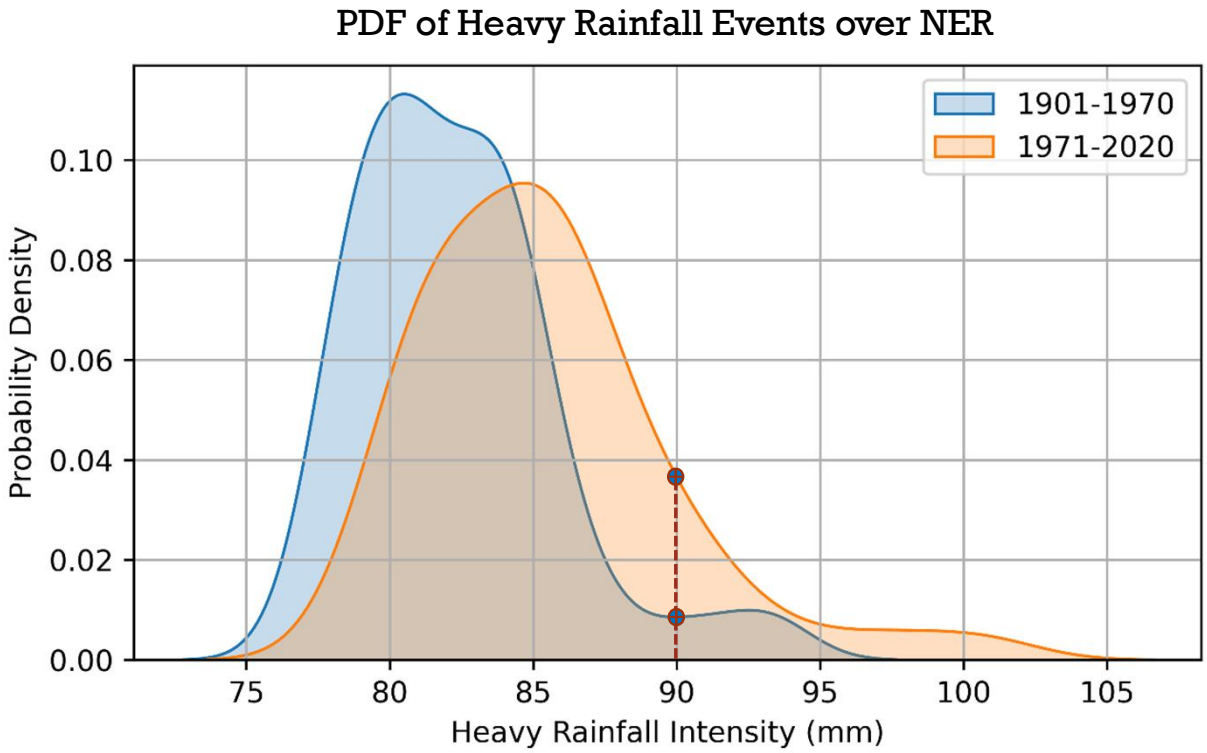
Heavy Rainfall Anomaly (1901-1970) over (Mizoram + Manipur + Nagaland + Tripura)



Heavy Rainfall Anomaly (1901-1970) over (Sikkim + Sub-Himalayan West Bengal)

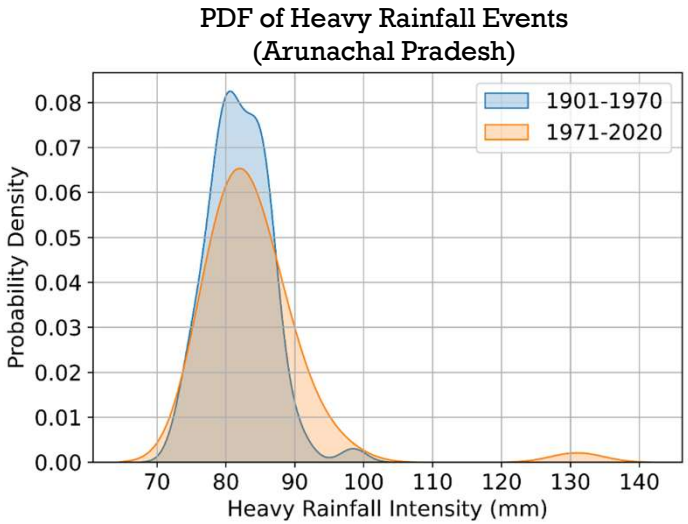


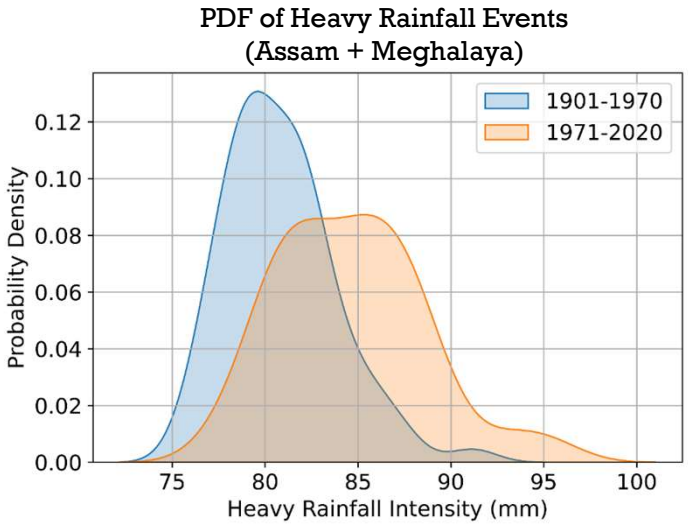
Changing Probability of heavy Rainfall Anomaly over North East India

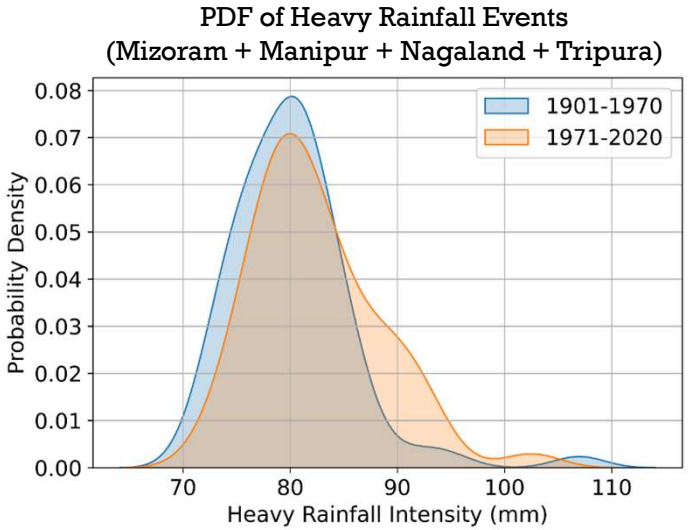


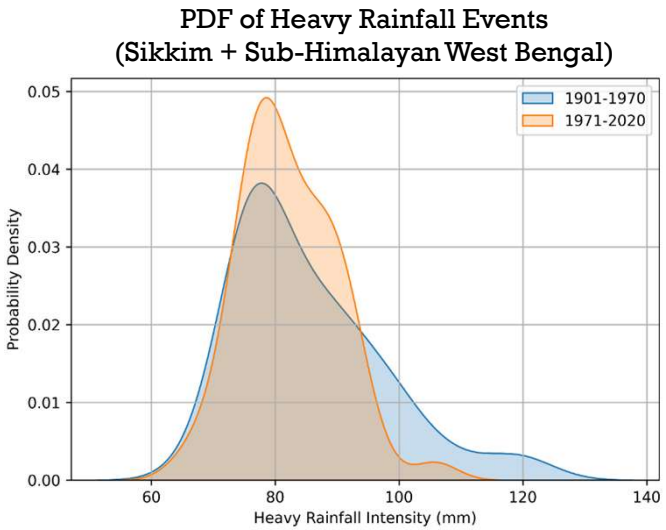
- The Probability Distribution Function of occurrence of Heavy Rainfall event shows its changing probability from Pre-1970 to Post-1970.
- The figure shows that for the larger extremes of rainfall intensities the probability that a rainfall event of a specific intensity or more shows a significant increase.

Changing Probability of heavy Rainfall Anomaly over North East India



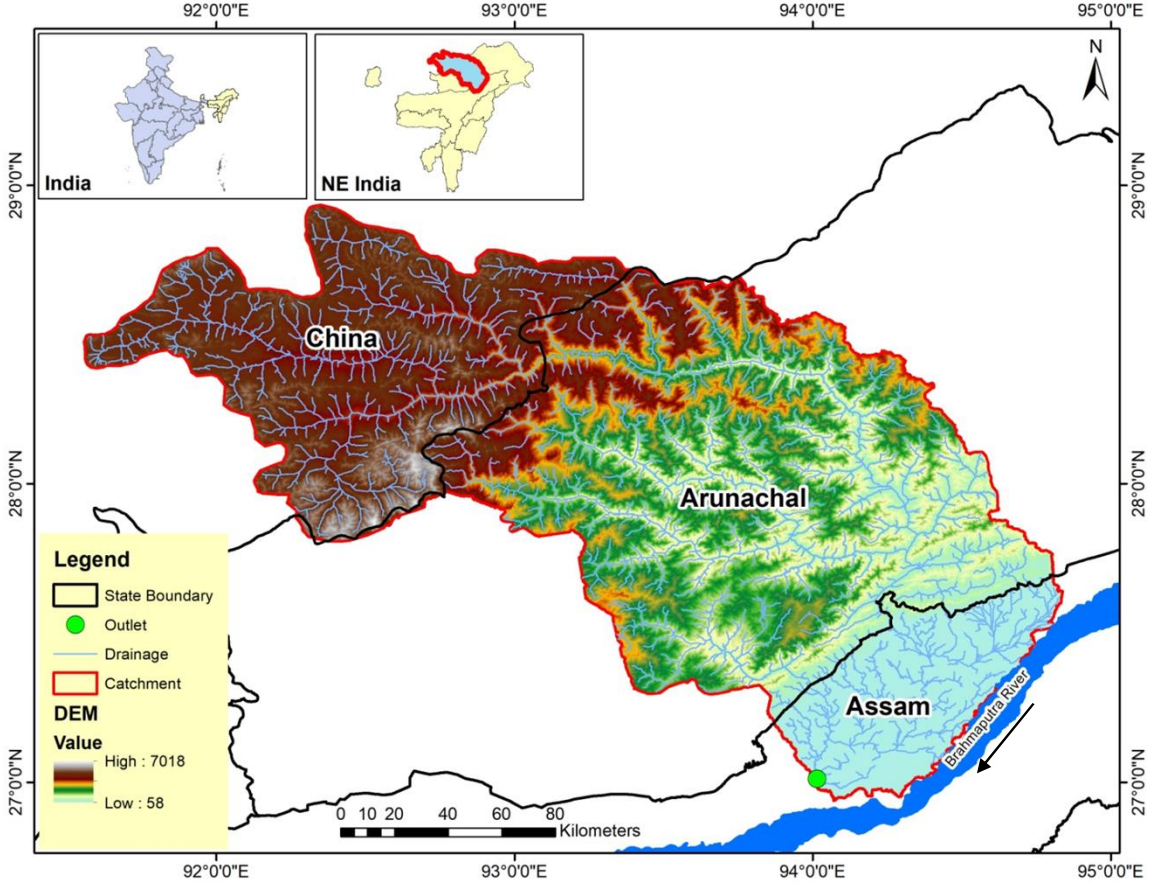






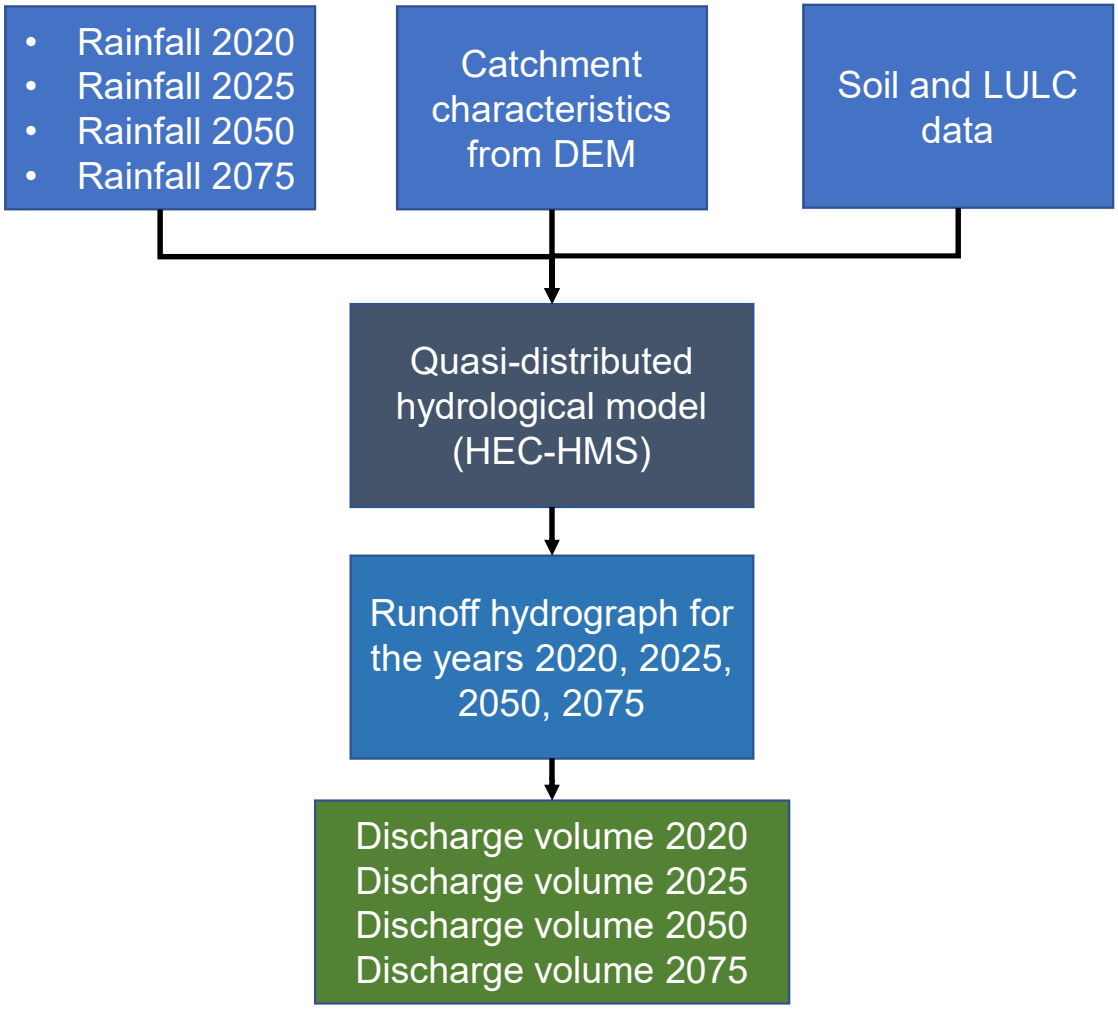
Climate Change impact on Subansiri river basin

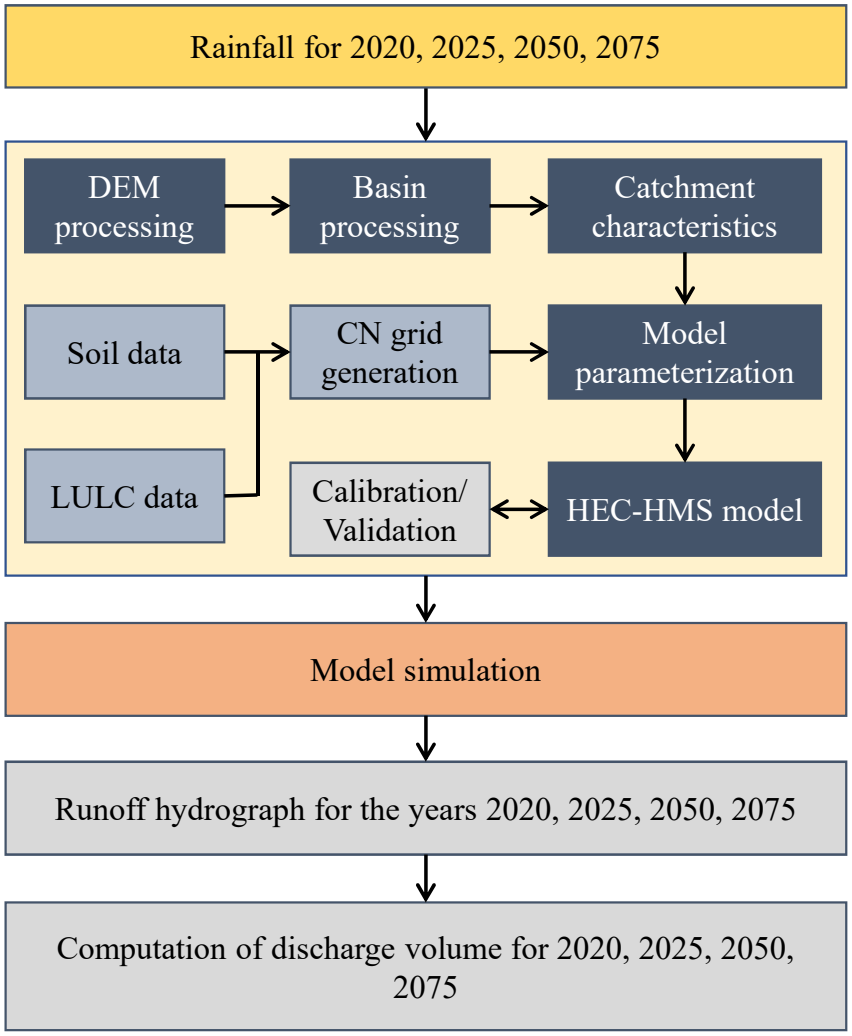
- Subansiri river is the North Bank tributary of Brahmaputra river (442 Km long)
- Originates in Tibet, flow through Arunachal, Assam and joins Brahmaputra
- Area of Subansiri is 35,771 sq.km (10,345 sq.km in Tibet)
- Observed max. discharge is 12,799 cumecs and min. discharge is 131 cumecs
- It contributes 7.92% of the Brahmaputra's total flow



Subansiri Catchment

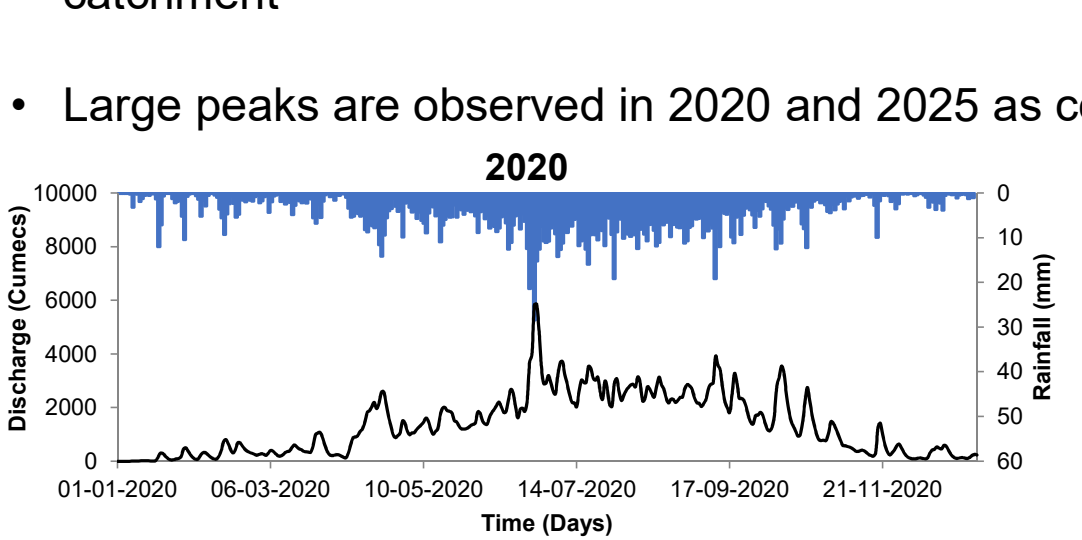
Methodology

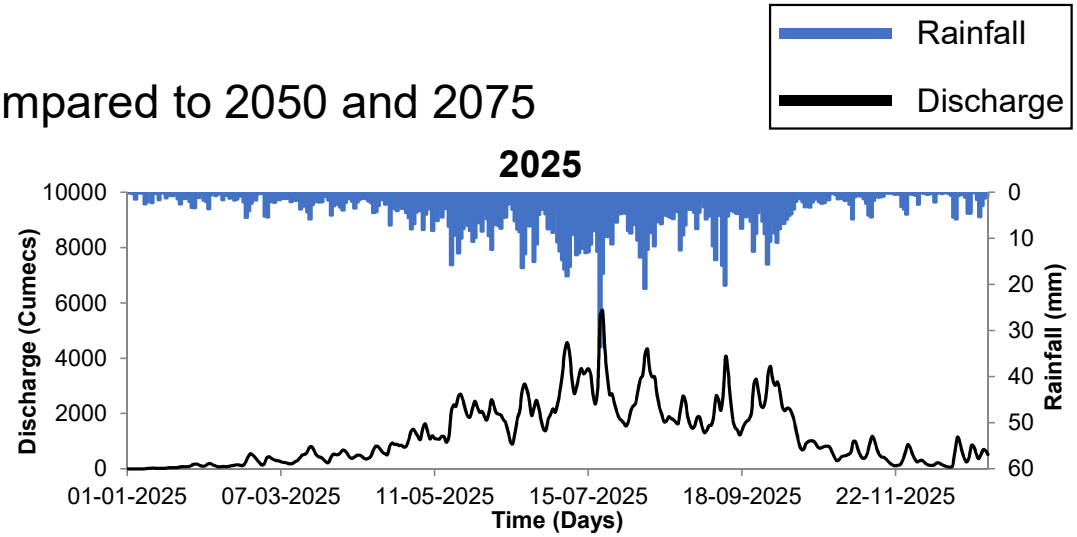


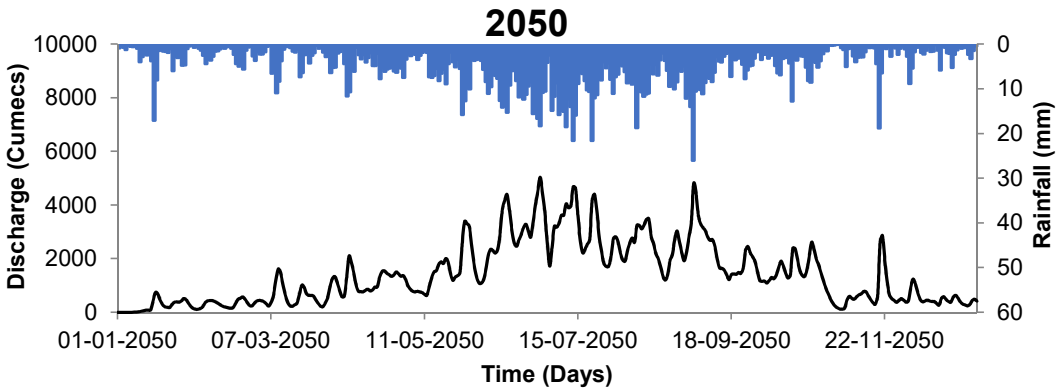


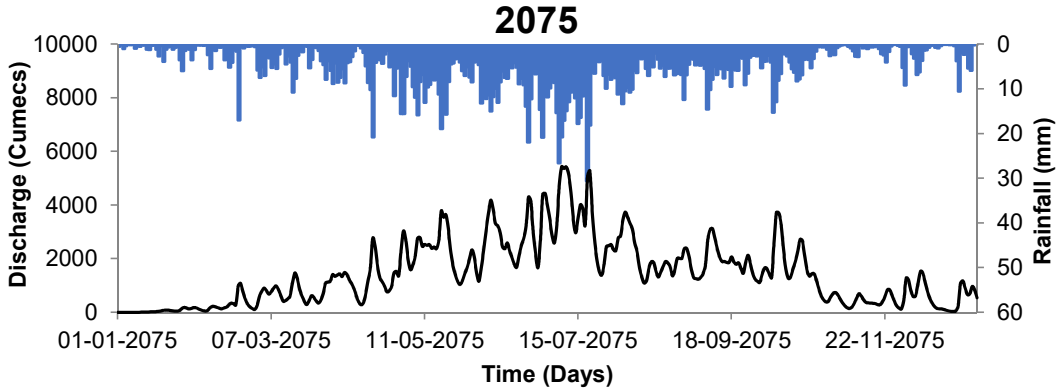
Climate Change impact on Subansiri river

- Time series plots b/w rainfall and discharge for the years, 2020, 2025, 2050 and 2075 for Subansiri catchment
- Large peaks are observed in 2020 and 2025 as compared to 2050 and 2075





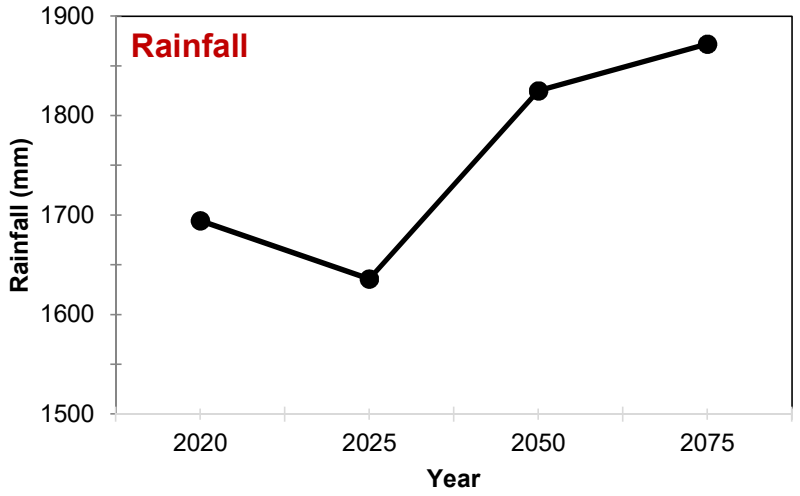


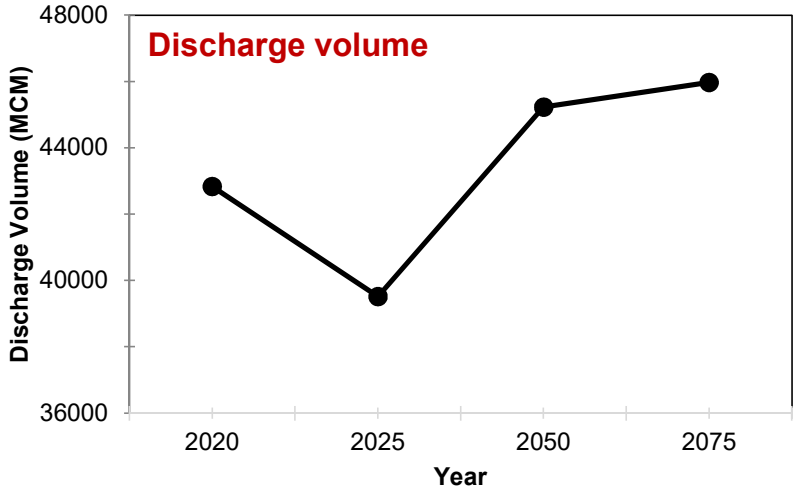


Simulation has been carried out using the forecasted rainfall dataset from CORDEX

Climate Change impact on Subansiri river

- Rainfall in the Subansiri catchment is showing the rising trend in 2050 and 2075
- Similar trend is observed in the volume of discharge from the catchment during 2050 and 2075
- Significant rise in the discharge volume is observed between 2025 to 2050





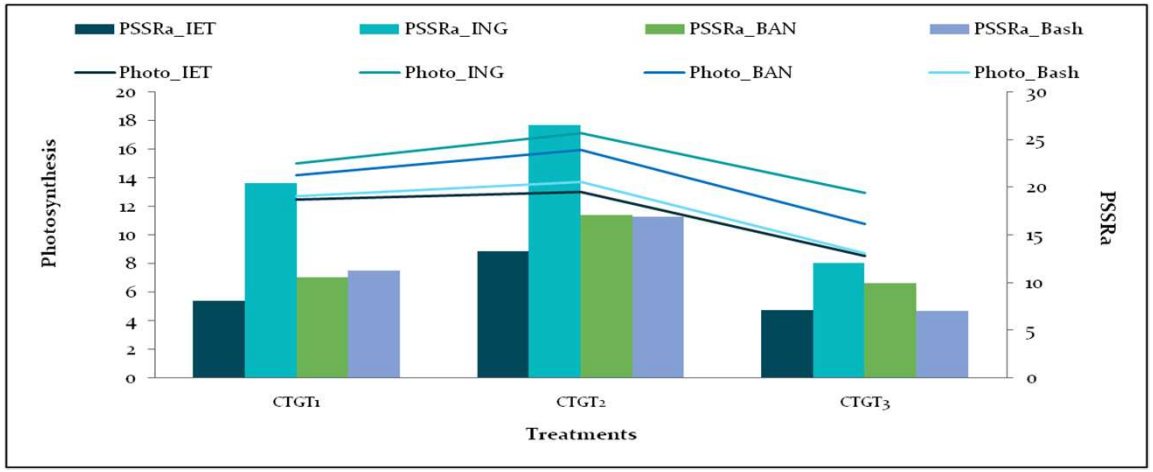
Simulation has been carried out using the forecasted rainfall dataset from CORDEX

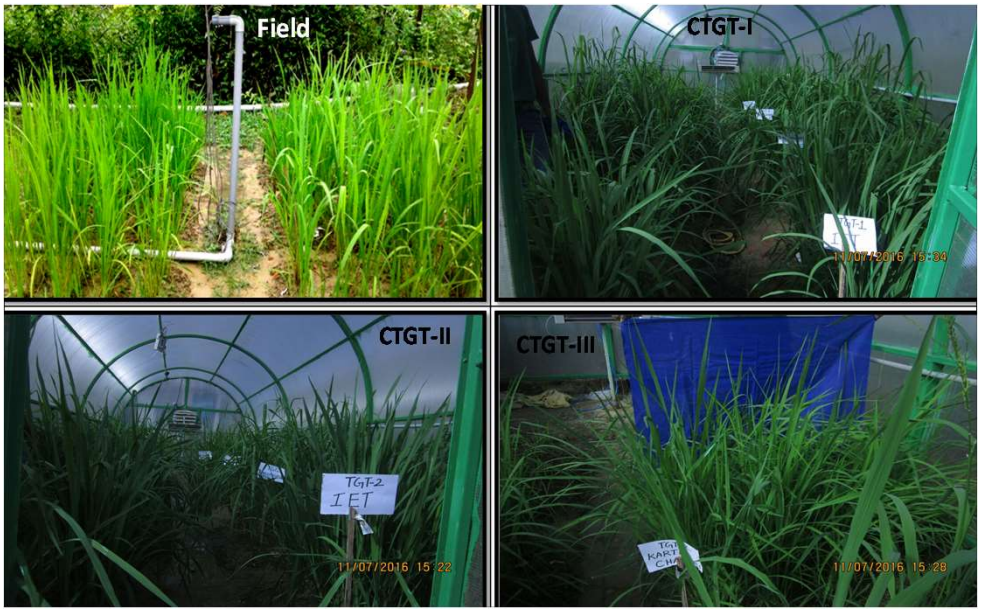
Rice varietal performance at elevated CO_2 and temperature

CTGT (I) : CO_2 level of 400 ppm and a temperature of 2ºC greater than ambient was maintained.

CTGT (II) : CO_2 level of 550 ppm and a temperature of 4ºC greater than ambient was maintained.

CTGT (III): CO_2 level of 750 ppm and a temperature of 6ºC greater than ambient was maintained.



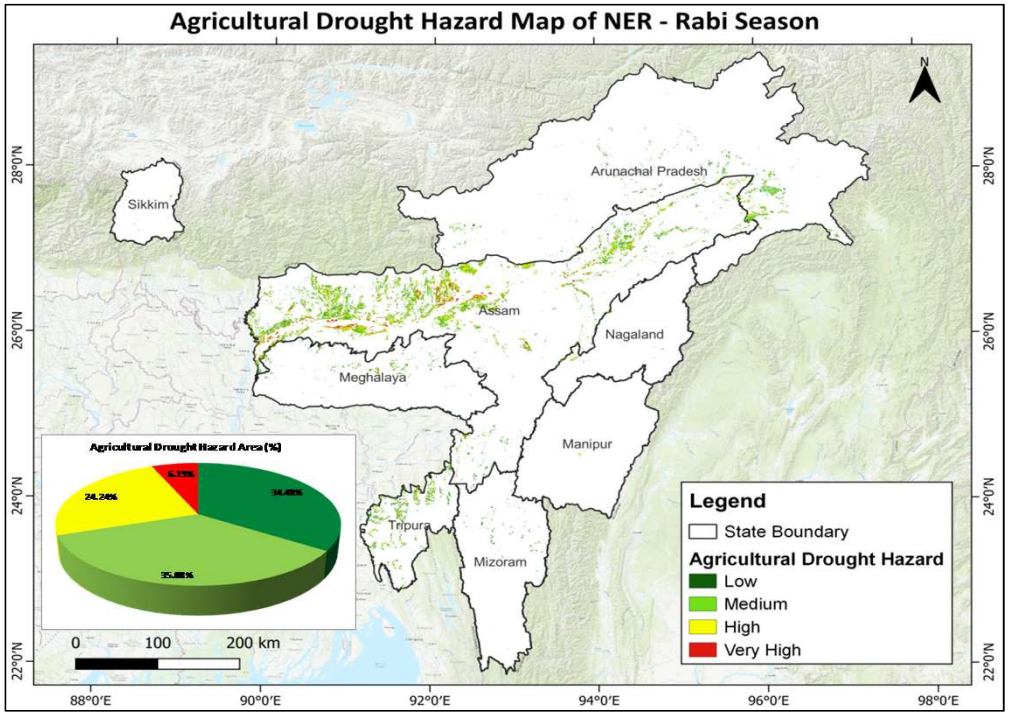


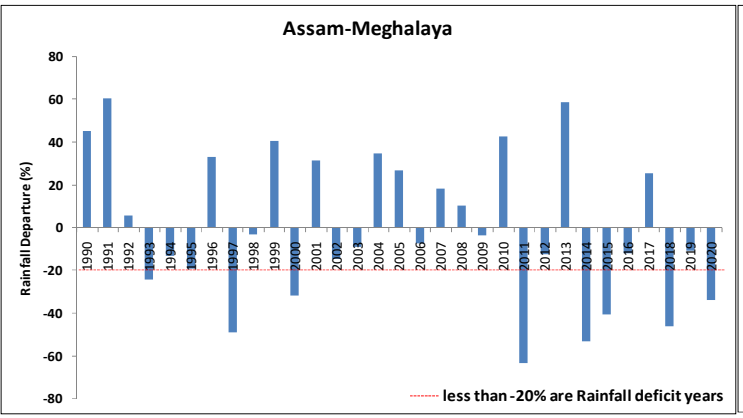
Rice growth inside CTGT (CO_2 and Temp Gradient Tunnel)

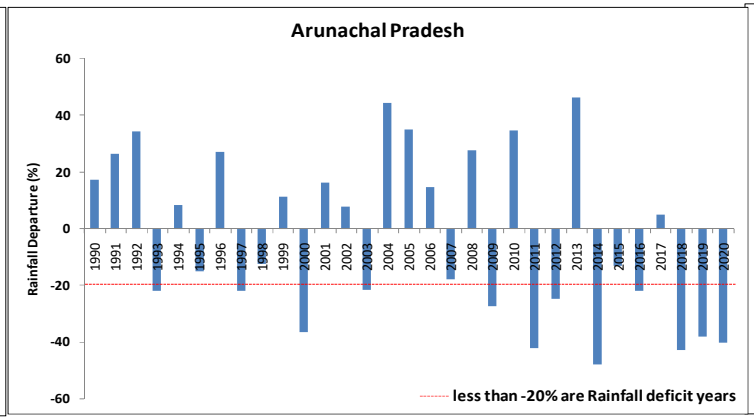
Estimation of Photosynthesis using spectral derived PSSRa indices (+ve correlation), **Highest in CTGT II** in Inglonkiri (Tolerant genotype) followed by Banglami (Susceptible genotype). **In CTGT III, morphology, physiology, and yield are adversely affected.**

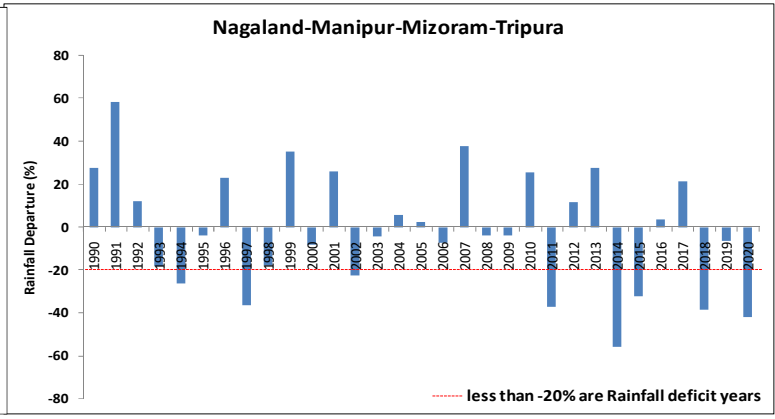
Agricultural Drought like scenario in NER during Rabi season

- Frequency of **rainfall deficit years** and their spatial extent have been increasing over the North Eastern Region (NER) of India in the last decades
- Increase in rainfall deficiency has lead to drought like scenario affecting the crops in Assam and other states
- In view of that Cropping season (Rabi) wise Agricultural drought hazard mapping is done and about 6.19 % of NER's Rabi crop area is falling under very high drought hazard









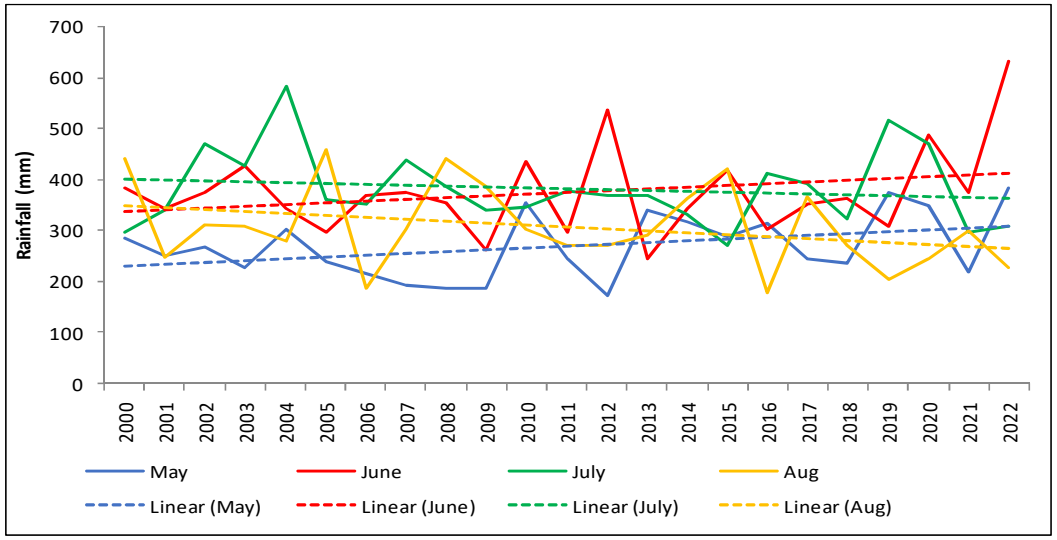
Meteorological Subdivision-wise rainfall departure (Rabi Season - 1990-91 to 2020-21), where years with less than -20 % are deficit years

Revision of existing Sowing Window of Kharif crops due to abnormal trend of monsoon

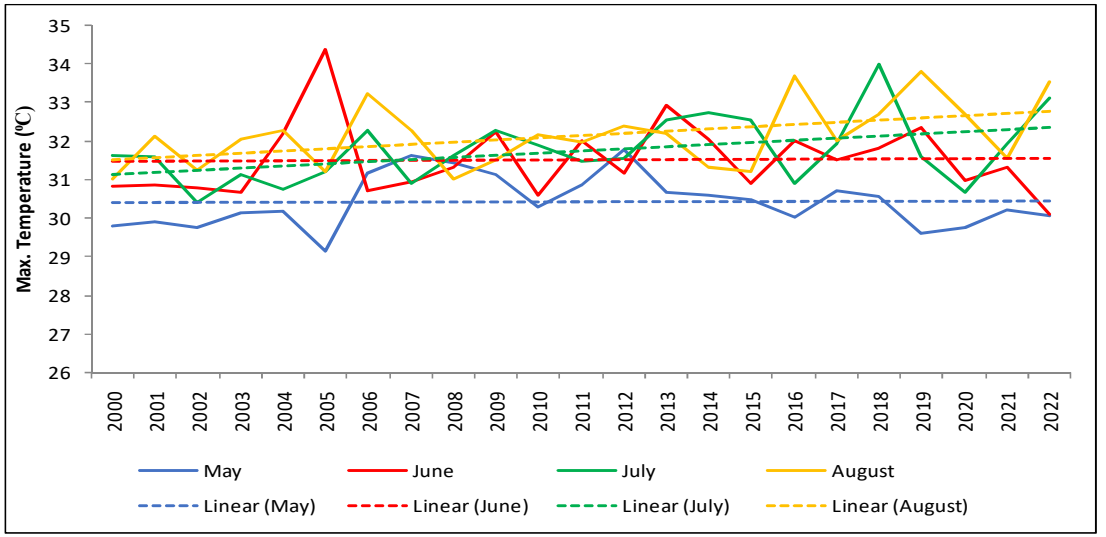
- Based on the 23 years data (2000 to 2022), Rainfall has increasing trend in May – June and decreasing trend in July – August

- Whereas, Max. Temperature has decreasing in May – June and increasing in July - August

Monthly Rainfall) of Assam from 2000 to 2022

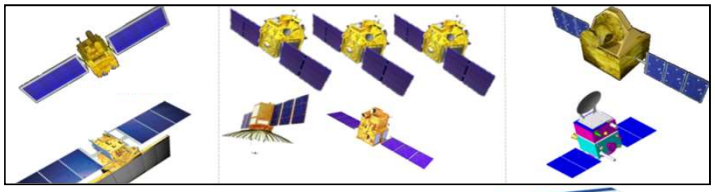


Monthly Maximum Temperature from 2000 to 2022



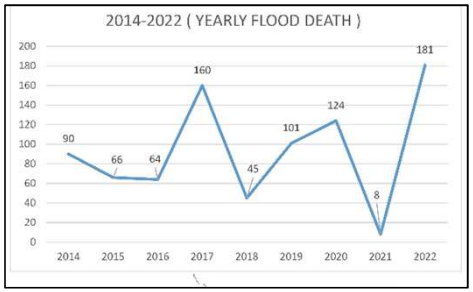
Next step: Being better prepared

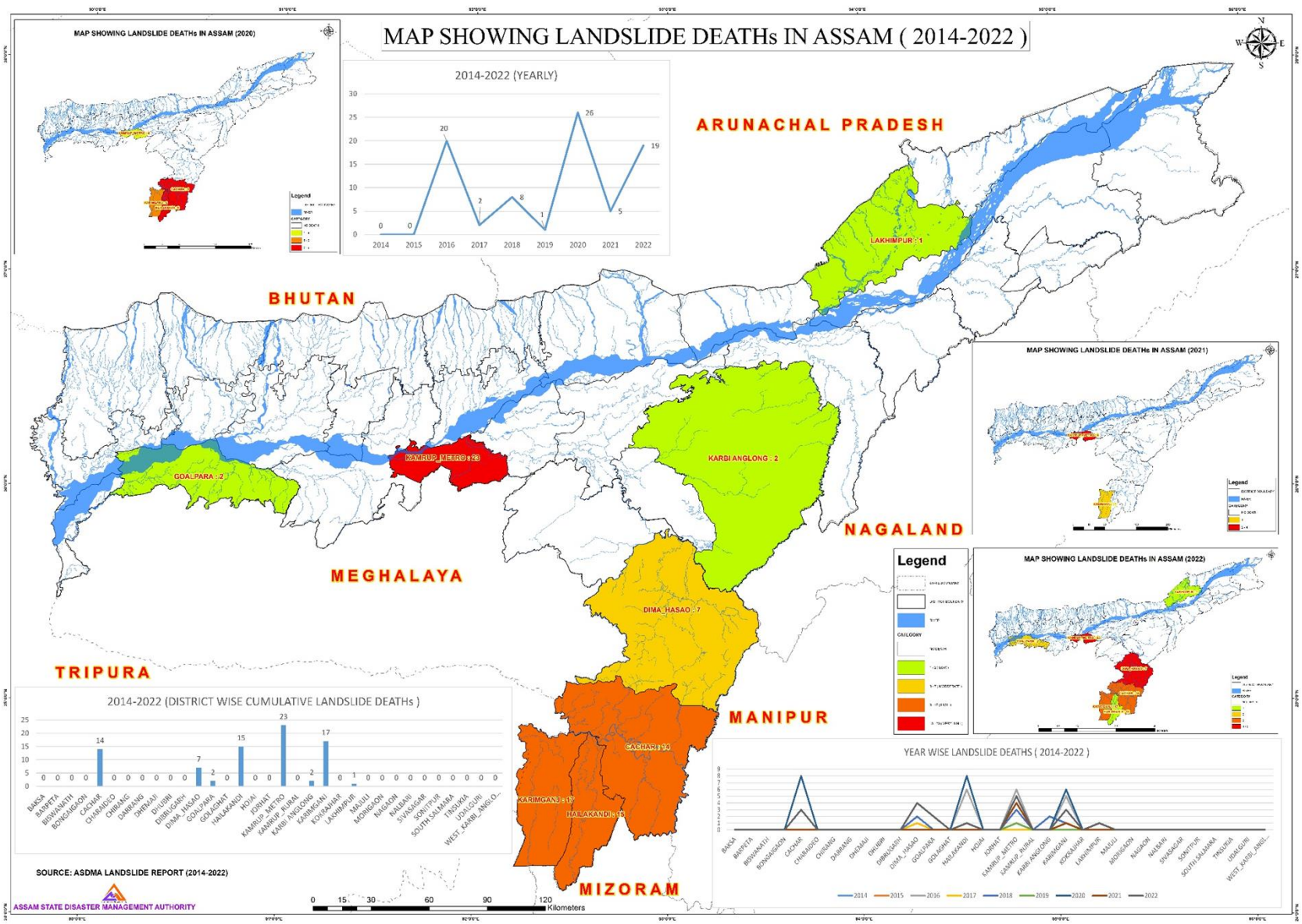
- Constellation of Satellites:
  - Microwave, optical, Thermal
  - Resolution, revisit
  - Communication/ Weather
- UAV
  - Future requirements
    - Mapping, monitoring, relief and rescue
- IOT and Automation

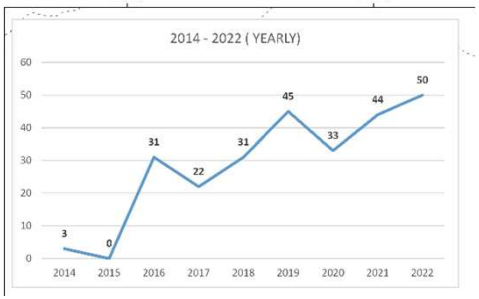


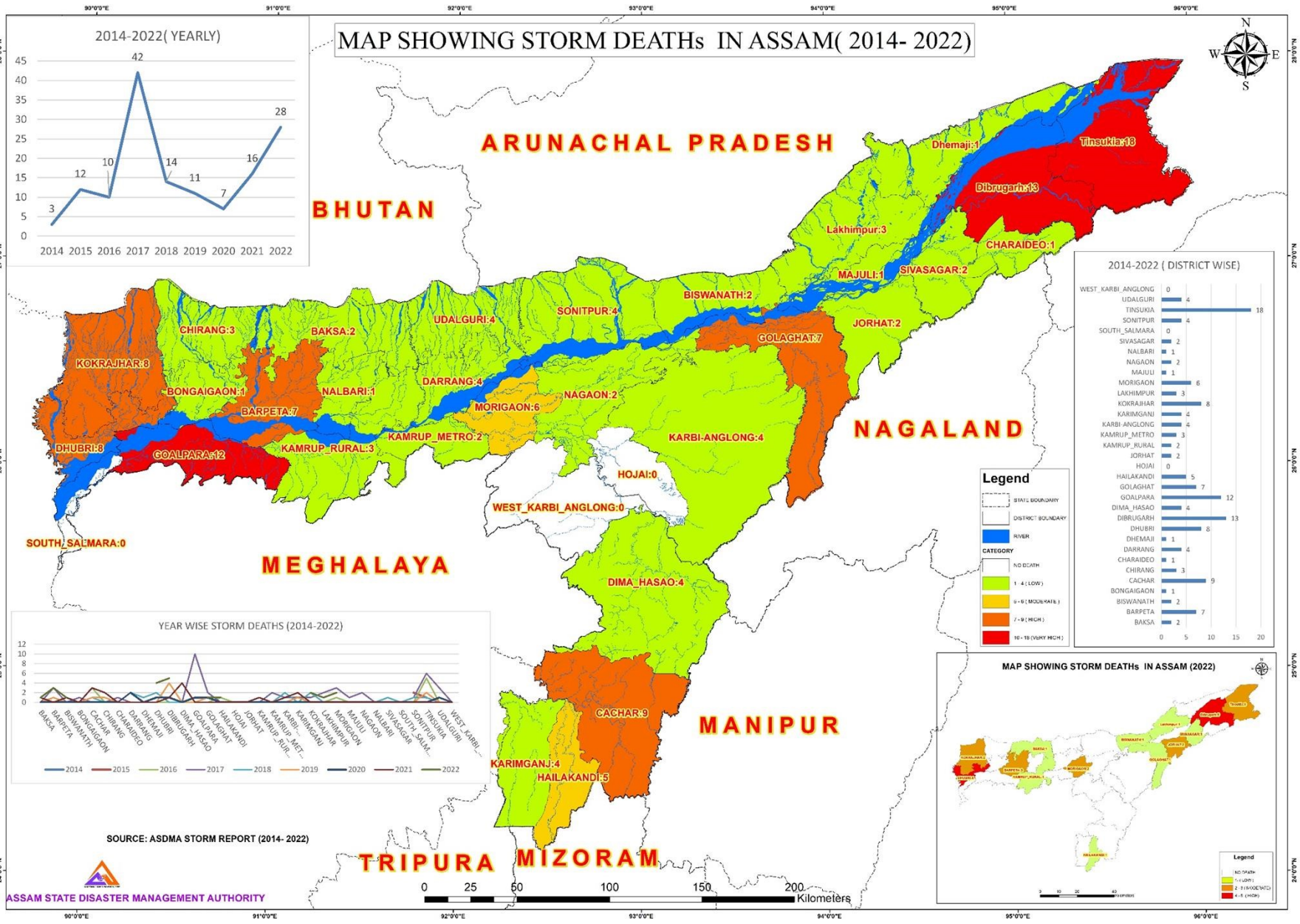
- Strong Linkages between Different agencies:
  - ISRO, IMD, CWC,SDMA, NDRF
- Never forget Community


NESAC
GOVT. OF INDIA
JCBL
GOVT. OF INDIA
Thank You

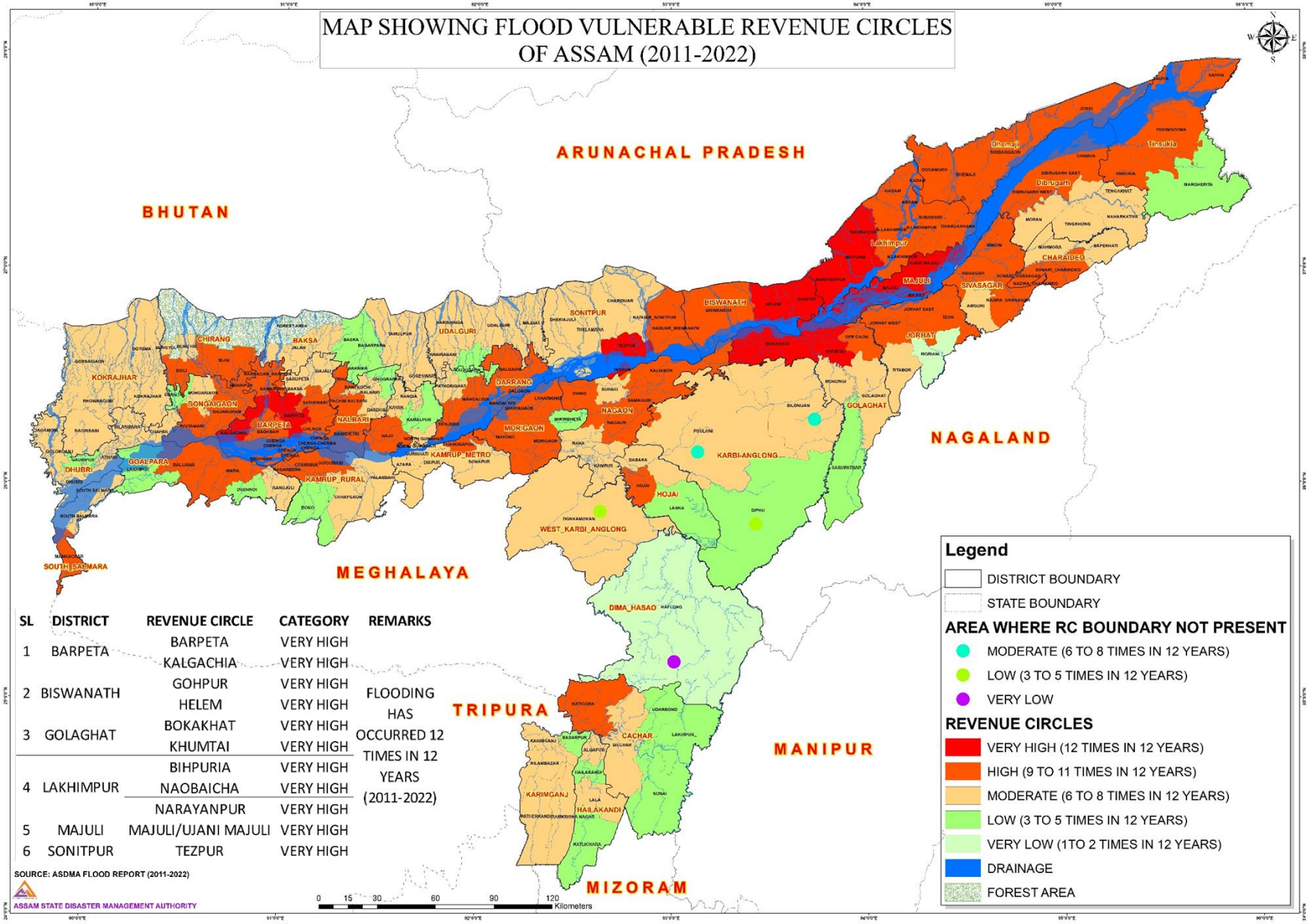

2014-2022 (YEARLY FLOOD DEATH)
200
180
160
140
120
100
80
60
40
20
0
90
66
64
160
45
101
124
8
181
2014
2015
2016
2017
2018
2019
2020
2021
2022


MAP SHOWING LANDSLIDE DEATHs IN ASSAM (2014-2022)
MAP SHOWING LANDSLIDE DEATHs IN ASSAM (2020)
2014-2022 (YEARLY)
2014 2015 2016 2017 2018 2019 2020 2021 2022
0 0 20 2 8 1 26 5 19
ARUNACHAL PRADESH
LAKHIMPUR : 1
BHUTAN
KAMRUP_METRO : 23
GOALPARA : 2
KARBI ANGLONG : 2
NAGALAND
MEGHALAYA
DIMA_HASAO : 7
MAP SHOWING LANDSLIDE DEATHs IN ASSAM (2021)
Legend
MAP SHOWING LANDSLIDE DEATHs IN ASSAM (2022)
TRIPURA
MANIPUR
CACHAR : 14
KARIMGANJ : 17
HAILAKANDI : 15
2014-2022 (DISTRICT WISE CUMULATIVE LANDSLIDE DEATHs)
BAKSA BARPETA BISWANATH BONGAIGAON CACHAR CHARAIDEO CHIRANG DARRANG DHEMAJI DHUBRI DIBRUGARH DIMA_HASAO GOALPARA GOLAGHAT HAILAKANDI HOJAI JORHAT KAMRUP_METRO KAMRUP_RURAL KARBI ANGLONG KARIMGANJ KOKRAJHAR LAKHIMPUR MAJULI MORIGAON NAGAON NALBARI SIVASAGAR SONITPUR SOUTH SALMARA TINSUKIA UDALGURI WEST_KARBI_ANGLO...
YEAR WISE LANDSLIDE DEATHS (2014-2022)
2014 2015 2016 2017 2018 2019 2020 2021 2022
SOURCE: ASDMA LANDSLIDE REPORT (2014-2022)
ASSAM STATE DISASTER MANAGEMENT AUTHORITY
0 15 30 60 90 120 Kilometers


2014 - 2022 (YEARLY)
60
50
40
30
20
10
0
3
0
31
22
31
45
33
44
50
2014
2015
2016
2017
2018
2019
2020
2021
2022


MAP SHOWING STORM DEATHs IN ASSAM(2014- 2022)
2014-2022(YEARLY)
45
40
35
30
25
20
15
10
5
0
3
12
10
42
14
11
7
16
28
2014 2015 2016 2017 2018 2019 2020 2021 2022
ARUNACHAL PRADESH
BHUTAN
NAGALAND
MEGHALAYA
MANIPUR
TRIPURA
MIZORAM
Dhemaji:1
Tinsukia:18
Dibrugarh:13
Lakhimpur:3
CHARAIDEO:1
MAJULI:1
SIVASAGAR:2
BISWANATH:2
SONITPUR:4
JORHAT:2
GOLAGHAT:7
UDALGURI:4
CHIRANG:3
BAKSA:2
KOKRAJHAR:8
BONGAIGAON:1
NALBARI:1
DARRANG:4
BARPETA:7
MORIGAON:6
NAGAON:2
KAMRUP_METRO:2
KAMRUP_RURAL:3
KARBI-ANGLONG:4
DHUBRI:8
GOALPARA:12
HOJAI:0
WEST_KARBI_ANGLONG:0
SOUTH_SALMARA:0
DIMA_HASAO:4
CACHAR:9
KARIMGANJ:4
HAILAKANDI:5
2014-2022 (DISTRICT WISE)
WEST_KARBI_ANGLONG 0
UDALGURI 4
TINSUKIA 18
SONITPUR 4
SOUTH_SALMARA 0
SIVASAGAR 2
NALBARI 1
NAGAON 2
MAJULI 1
MORIGAON 6
LAKHIMPUR 3
KOKRAJHAR 8
KARIMGANJ 4
KARBI-ANGLONG 4
KAMRUP_METRO 3
KAMRUP_RURAL 2
JORHAT 2
HOJAI 0
HAILAKANDI 5
GOLAGHAT 7
GOALPARA 12
DIMA_HASAO 4
DIBRUGARH 13
DHUBRI 8
DHEMAJI 1
DARRANG 4
CHARAIDEO 1
CHIRANG 3
CACHAR 9
BONGAIGAON 1
BISWANATH 2
BARPETA 7
BAKSA 2
0 5 10 15 20
Legend
STATE BOUNDARY
DISTRICT BOUNDARY
RIVER
CATEGORY
NO DEATH
1 - 4 (LOW)
5 - 6 (MODERATE)
7 - 9 (HIGH)
10 - 18 (VERY HIGH)
YEAR WISE STORM DEATHS (2014-2022)
12
10
8
6
4
2
0
2014 2015 2016 2017 2018 2019 2020 2021 2022
MAP SHOWING STORM DEATHs IN ASSAM (2022)
Legend
0 25 50 100 150 200 Kilometers
SOURCE: ASDMA STORM REPORT (2014- 2022)
ASSAM STATE DISASTER MANAGEMENT AUTHORITY
N
S
E
W

MAP SHOWING FLOOD VULNERABLE REVENUE CIRCLES OF ASSAM (2011-2022)



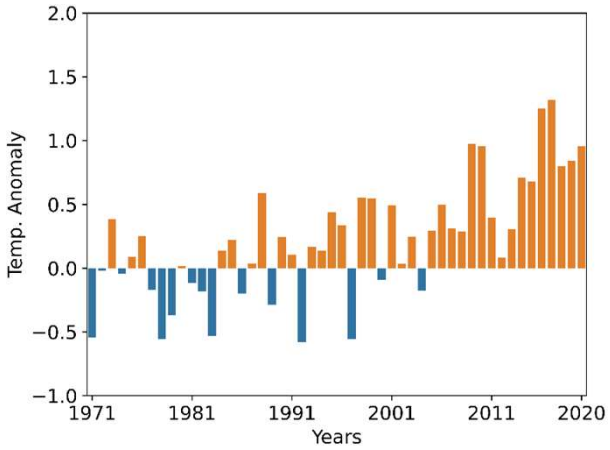
SL	DISTRICT	REVENUE CIRCLE	CATEGORY	REMARKS
1	BARPETA	BARPETA	VERY HIGH	FLOODING HAS OCCURRED 12 TIMES IN 12 YEARS (2011-2022)
		KALGACHIA	VERY HIGH	
2	BISWANATH	GOHPUR	VERY HIGH	
		HELEM	VERY HIGH	
3	GOLAGHAT	BOKAKHAT	VERY HIGH	
		KHUMTAI	VERY HIGH	
4	LAKHIMPUR	BIHPURIA	VERY HIGH	
		NAOBAICHA	VERY HIGH	
5	MAJULI	NARAYANPUR	VERY HIGH	
		MAJULI/UJANI MAJULI	VERY HIGH	
6	SONITPUR	TEZPUR	VERY HIGH	

SOURCE: ASDMA FLOOD REPORT (2011-2022)

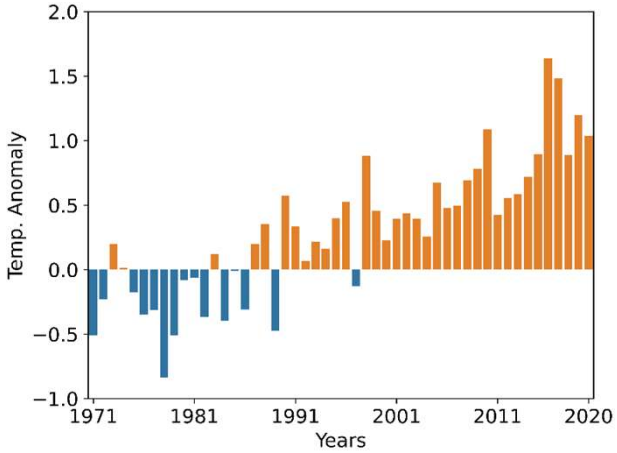
ASSAM STATE DISASTER MANAGEMENT AUTHORITY

Rise in Absolute Humidity Over North East India

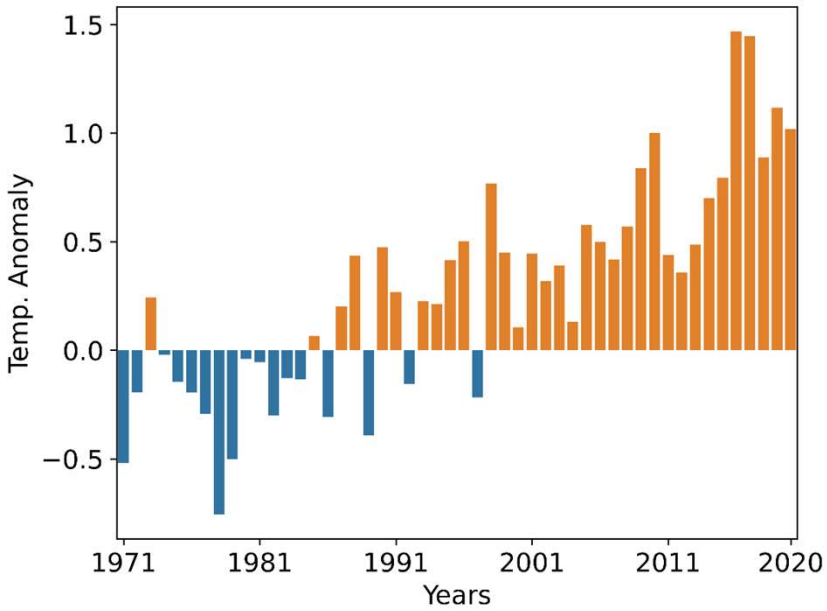
Annual Mean Dew-Point Temperature Anomaly (Arunachal Pradesh)



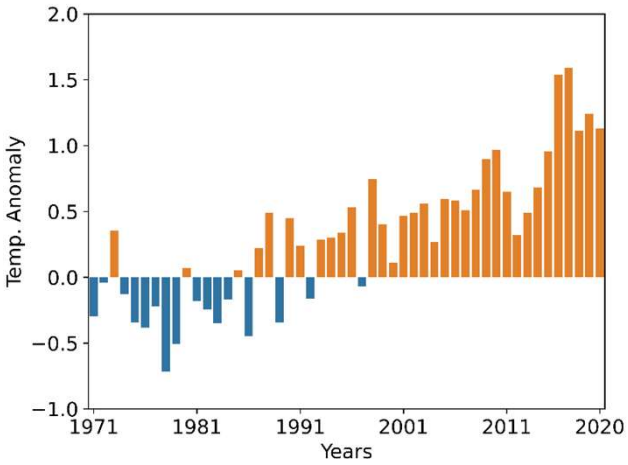
Annual Mean Temperature Anomaly (Mizoram + Manipur + Nagaland + Tripura)



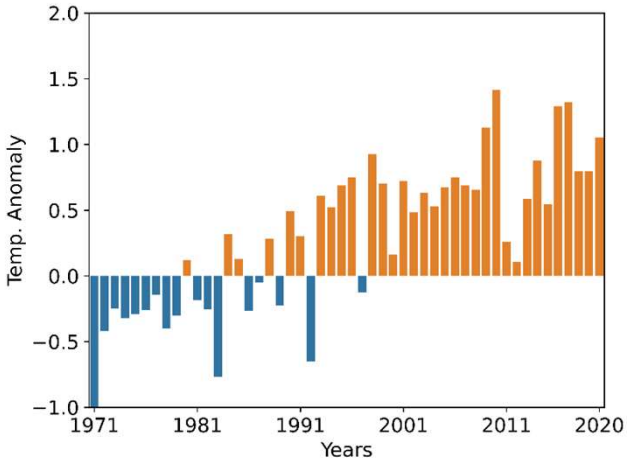
Annual Mean Dew-Point Temperature Anomaly (North East India)



Annual Mean Temperature Anomaly (Assam + Meghalaya)



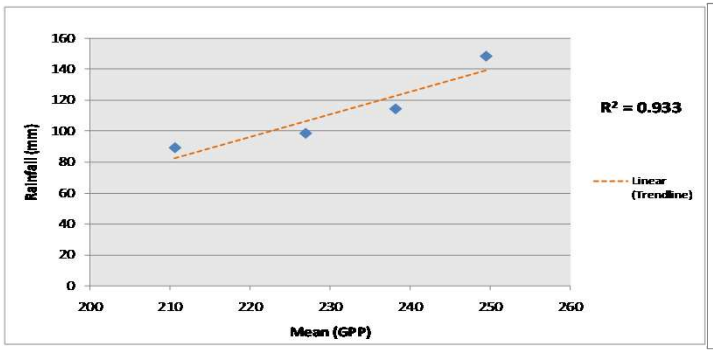
Annual Mean Temperature Anomaly (Sikkim + Sub-Himalayan West Bengal)

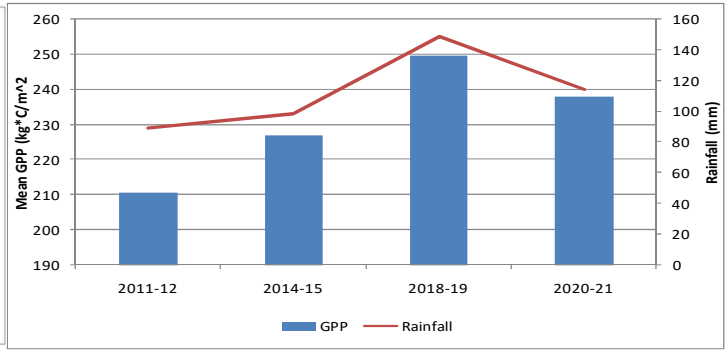


Rabi crop season's Gross Primary Productivity (GPP) and Rainfall variation

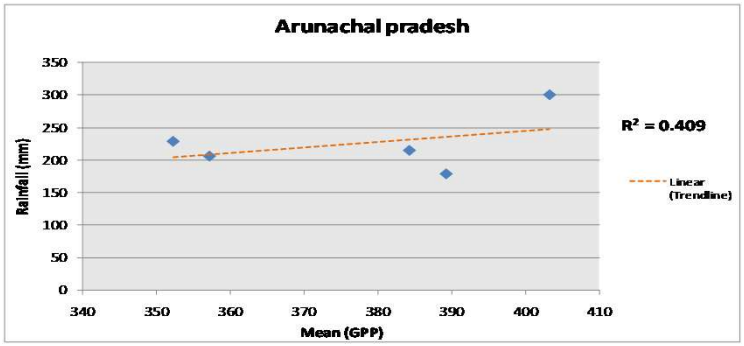
- Gross Primary Productivity (GPP) acquired from MODIS data for the Rabi season is plotted against the rainfall data of deficit years
- GPP and rainfall data of the deficit years (2011-12, 2014-15, 2018-19 and 2020-21) are positively correlated

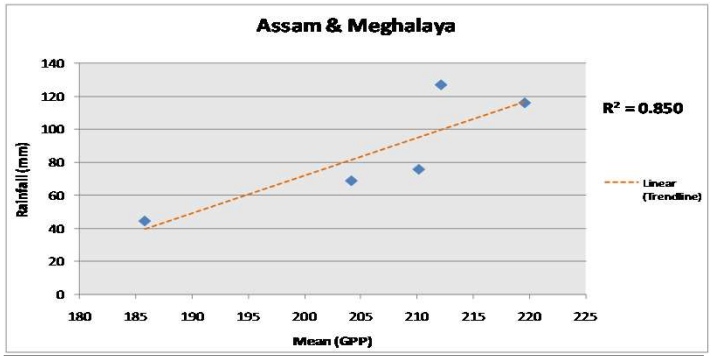
GPP vs Rainfall data of Deficit years (2011-12, 14-15, 18-19 and 20-21) for NER region

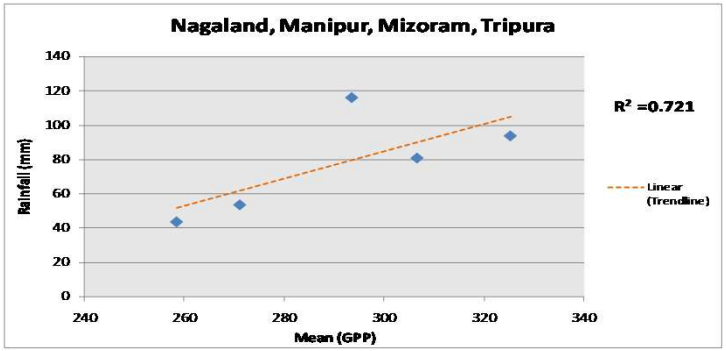


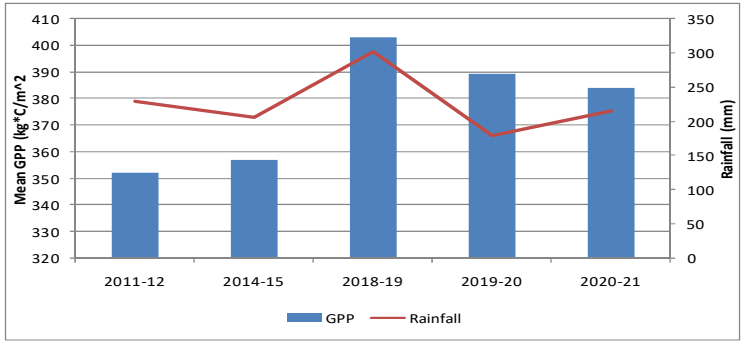


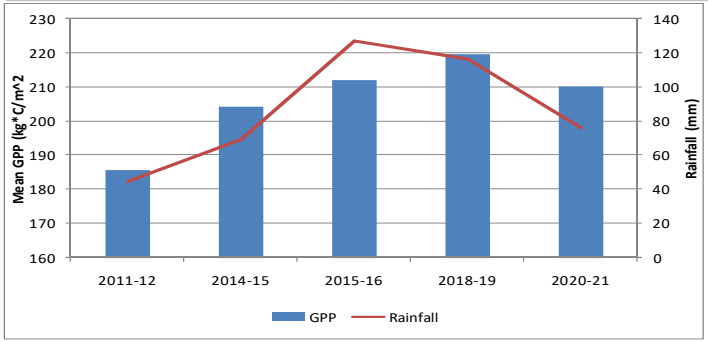
GPP vs Rainfall data of Deficit years – Meteorological Subdivision wise

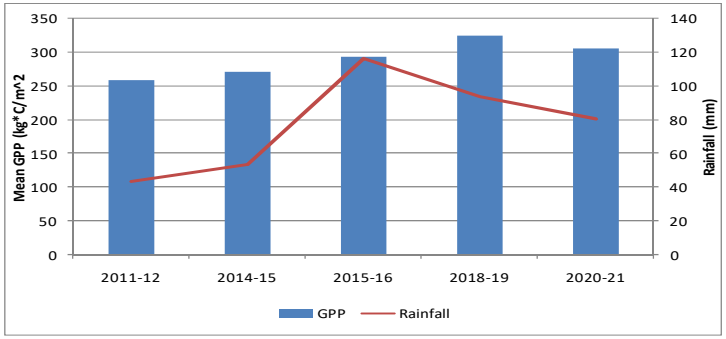


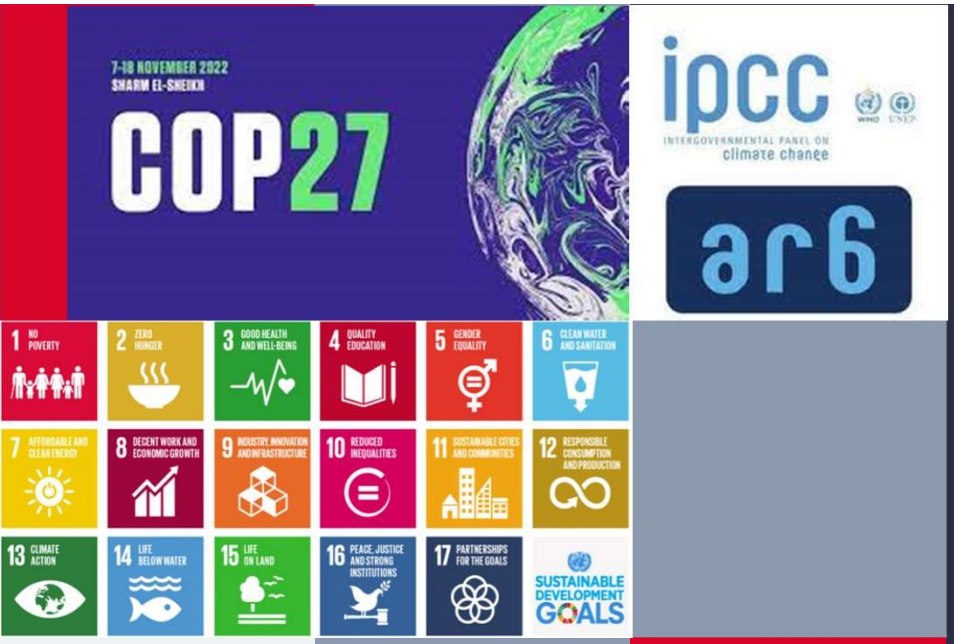












ipcc
INTERGOVERNMENTAL PANEL ON climate change

ar6

SENDAI FRAMEWORK
FOR DISASTER RISK REDUCTION 2015-2030

nidm
Resilient India - Disaster Free India

CAPACITY DEVELOPMENT: DISASTER RISK REDUCTION

28TH FEBRUARY 2023

CAPACITY ???

Capacity

- Ability to do, perform and accomplish task.
- Capacity-building is defined as the process of developing and strengthening the skills instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive in a fast-changing world-UN

CAPACITY .....

•is much more than training and includes human resource development,

• the process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively.

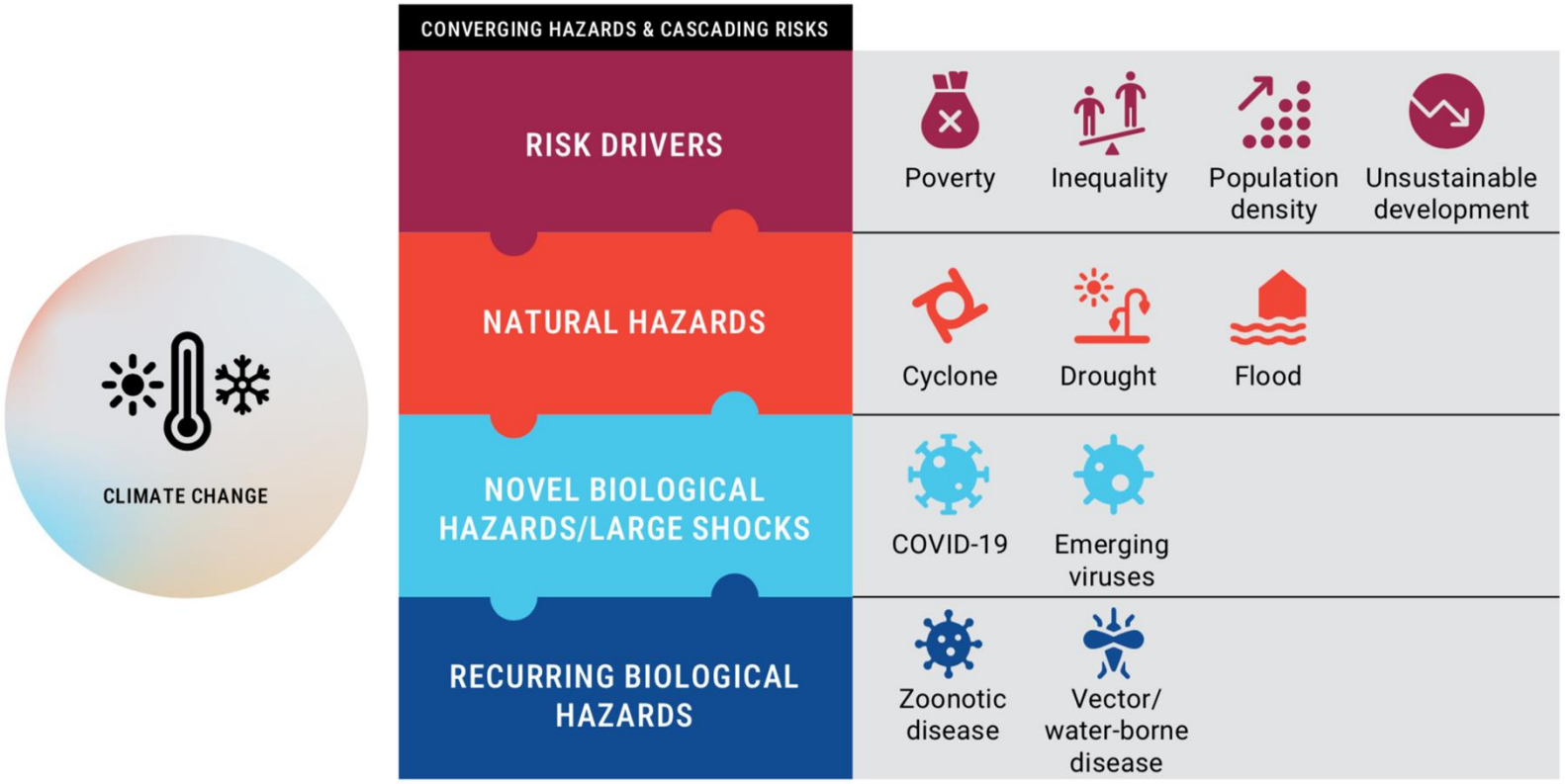
•Organizational development, the elaboration of management structures, processes and procedures, also the management of relationships between the different organizations and sectors (public, private and community).

•Institutional and legal framework development, making

RISK IS ALL OVER: PEOPLE & INFRA

Why do we need to bother so much about disasters?

FIGURE 1-18 **Climate change exacerbates disaster risk**



Disaster Management Plan must be dynamic to include India's changing disaster riskcape

Mapping India's Climate Vulnerability at district level: CEEW (2021)

01

Risk Geography

- Above 80% Of Indians Live In Climate Risk Districts,
- 75 per cent of districts are in climate risk hotspots,
- Over 40% have experienced climatic disruptions such as a shift from being flood-prone to being drought-prone, or vice-versa.

Climate Hazards and Vulnerability Atlas of India, IMD (2022)

02

Risk Atlas

Online risk atlas provides a range of vulnerability with risks ranging from nil, low, moderate, high and very high categories for every Indian district.

Climate Vulnerability Assessment for Adaptation Planning in India, Department of S&T, India (2021)

03

Climate vulnerability

District level vulnerability maps with a common IPCC framework to support the states to update their revised State Action Plan on Climate Change, DRR

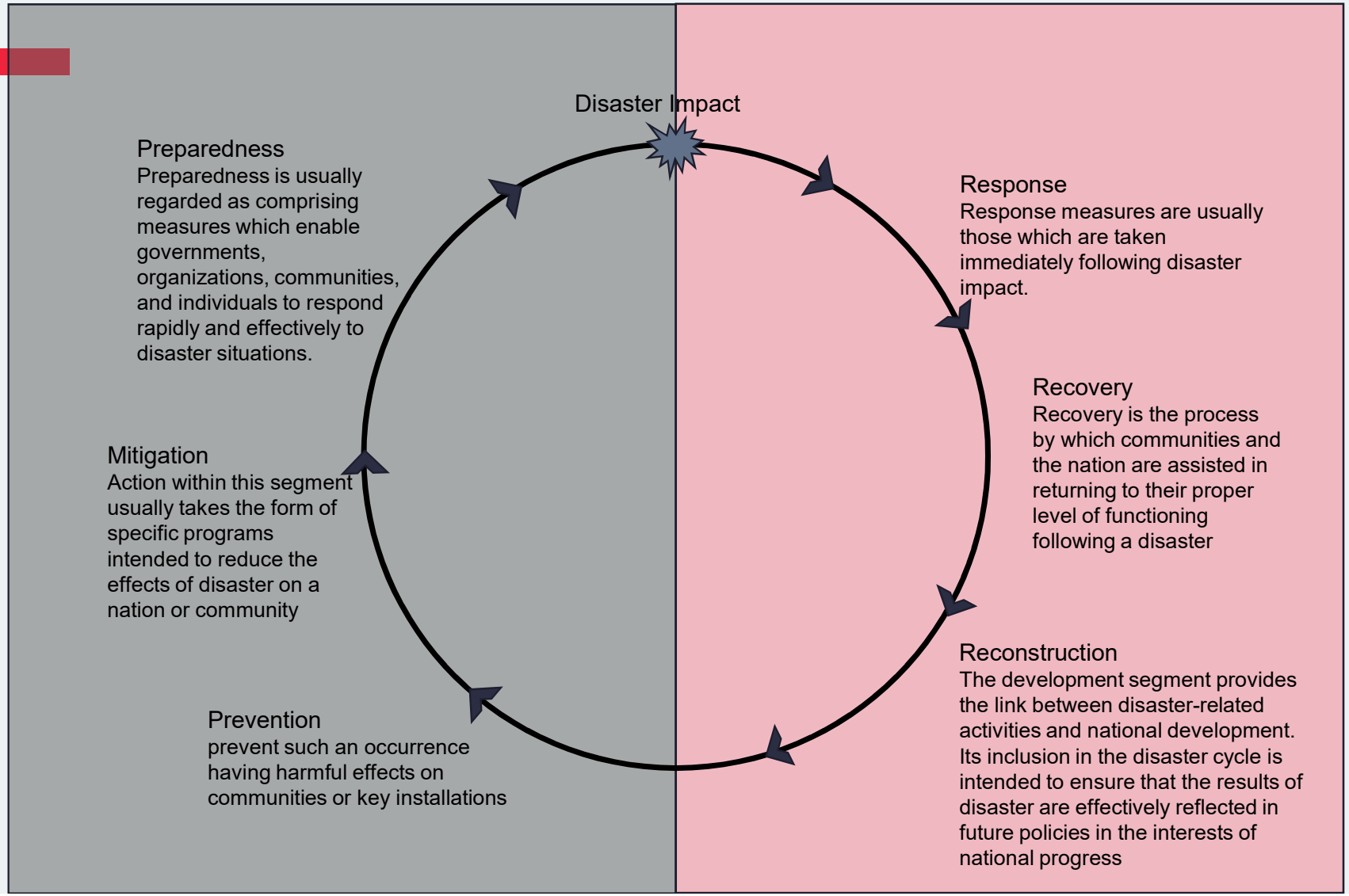
Vulnerability Atlas of India, Digital Version BMTC/Min of Housing and Urban Affairs

04

Vulnerability Atlas

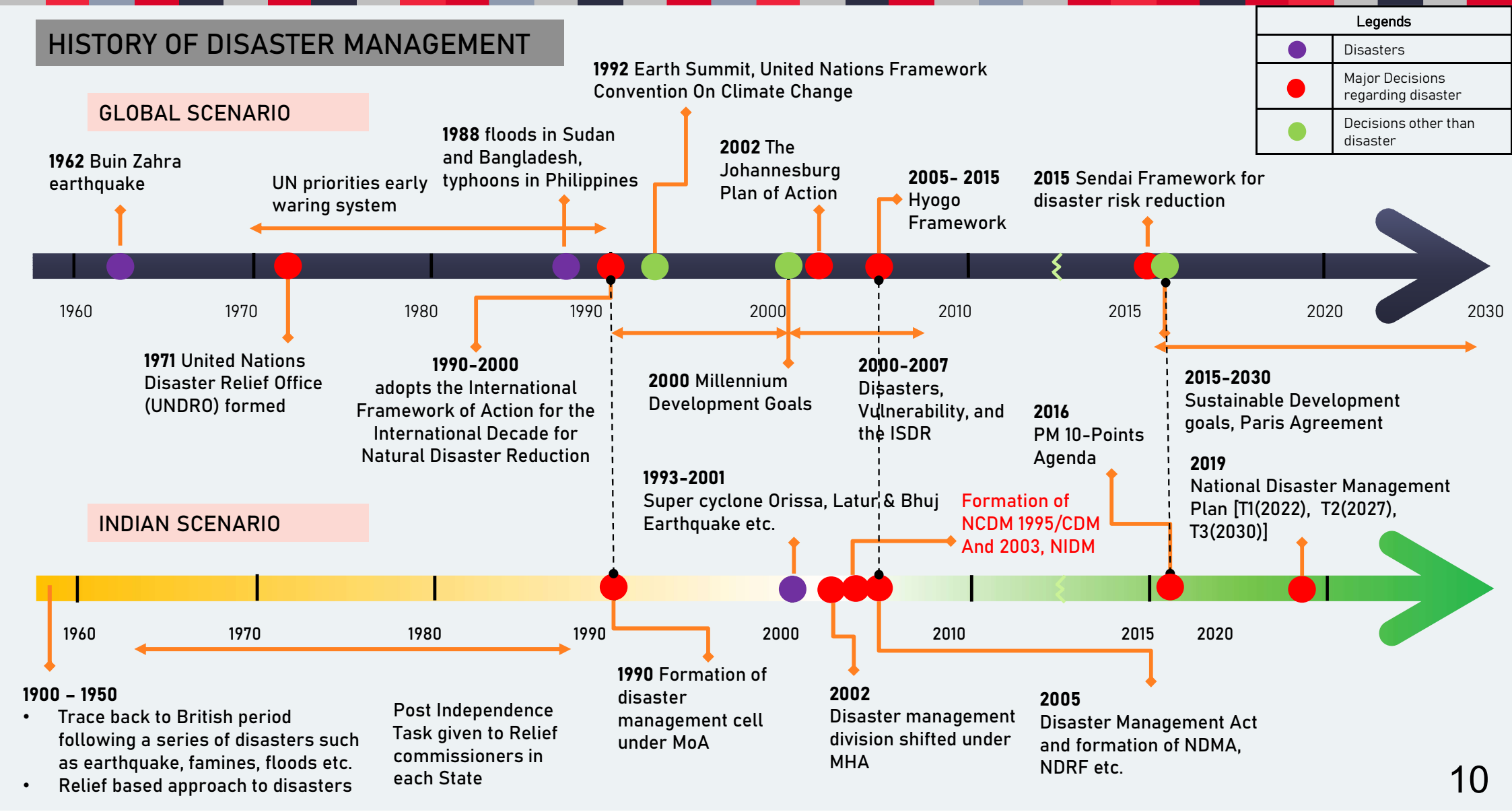
District wise vulnerable areas – structural vulnerability – earthquake and seismic

CAPACITY NEED AND GAP IN DM



Trace back the history of disaster management CAPACITY BUILDING

HISTORY OF DISASTER MANAGEMENT

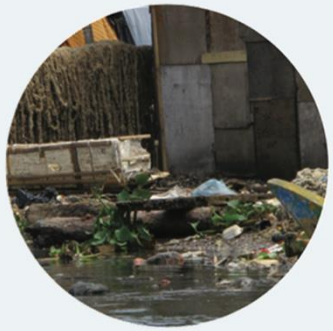


Impacts from disasters

Why we need to understand CAPACITY GAP?

$50 billion to
$200 billion
increase in average annual weather-related losses & damages alone since the 1980s.

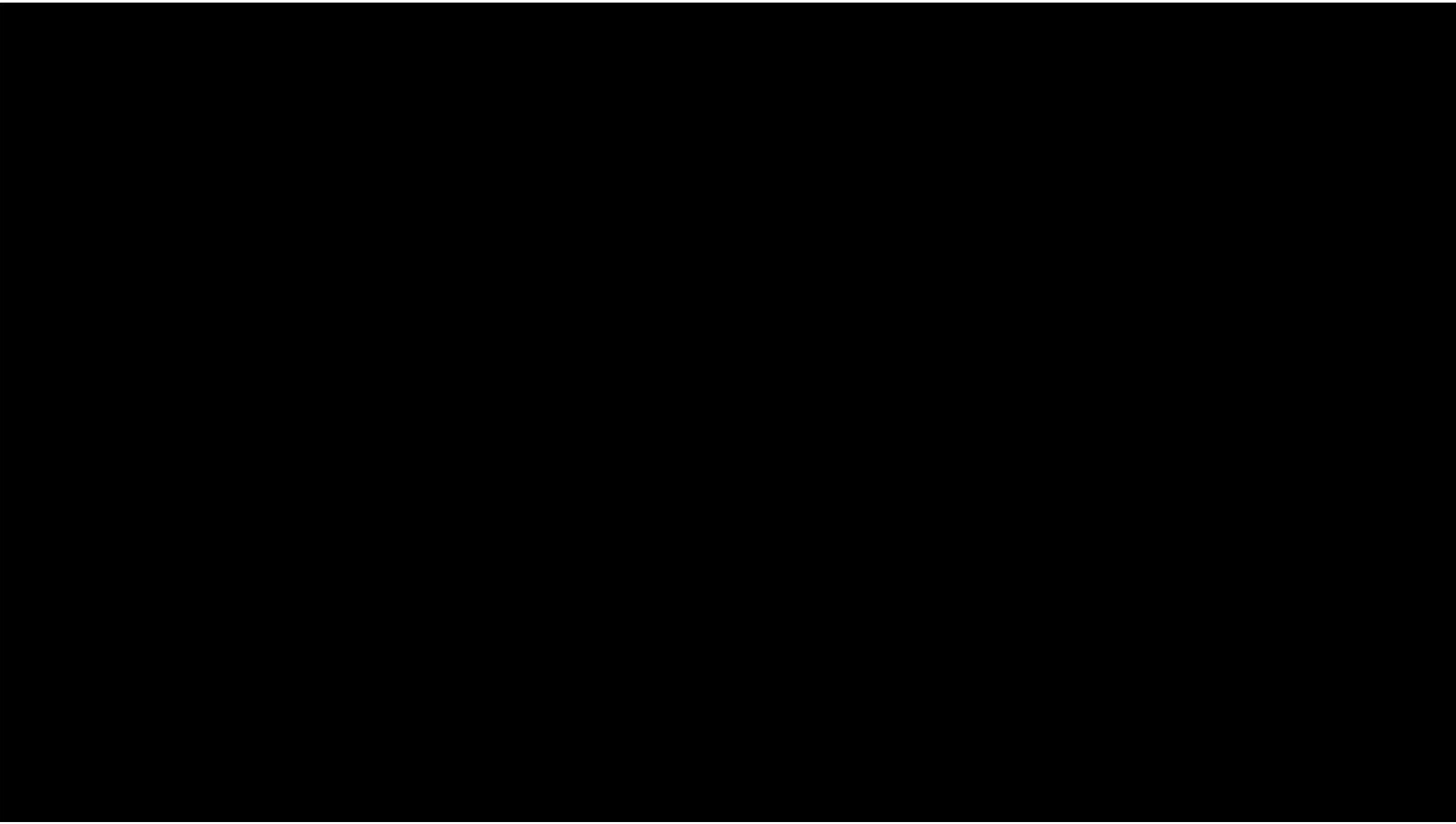
By 2050, the average annual economic losses from Asian flood disasters could surge to
$500 billion.

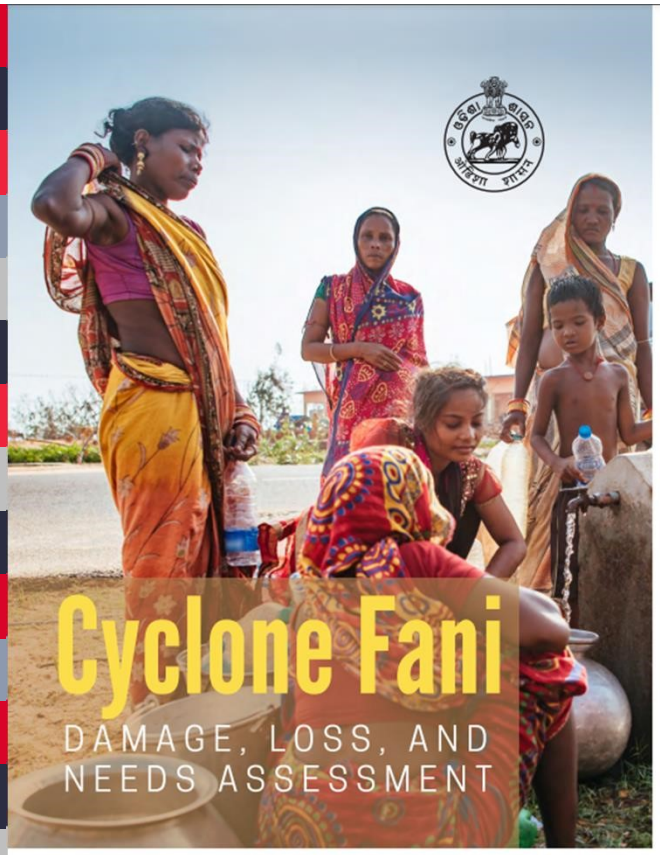


100 million people
could be pushed into poverty by climate change over the next 15 years.

Source :Global Assessment Report, 2019

Lets understand this with an example





Cyclone Fani

DAMAGE, LOSS, AND NEEDS ASSESSMENT

Odisha

MAY 2019

ADB

EDUCATION AND CHILD PROTECTION

- Elementary and secondary schools damaged 5,735
- Universities (5), government colleges (6), and government-aided colleges (96) suffered extensive damage
- Teacher Education Institutions damaged 18

CULTURAL HERITAGE AND TOURISM

- Monuments and sites damaged 113+
- Performing arts affected include 12 folk art forms like Pala, Sankirtan, Daskathia, Gotipua, Paika Akhada, Danda Nach, Ghodha Nach
- Performing artists affected 21,101
- Handicrafts and handlooms affected include—palm leaf paintings, patachitra, applique, stone carving, wood carving, handloom weaving
- Handicraft artisans affected 71,060
- Handloom weavers affected 47,208

EMPLOYMENT, LIVELIHOODS, AND SOCIAL PROTECTION

- Workers affected 48.61 lakh
- MSME (no. of enterprises) 830
- MGNREGS (count of impacted assets) 5,637
- KVIB (units) 139
- Markets, Vending Zones under Urban Local Bodies (units) 20,900

ROADS

- National highways affected 272 km
- State highways affected 5,240 km.
- Rural roads affected 6,251 km

POWER

- 05 nos. 400 kV towers, 27 nos. of 220 kV towers, 21 nos. 130 kV towers
- 5,030 km of 33 kV lines, 38,613 km of 11 kV lines
- High Tension Poles damaged 200
- Distribution Transformers 11,077
- LT lines damaged 79,485 km

PUBLIC BUILDINGS

- Public buildings damaged 6,441

WATER AND SANITATION

- Rural PWSs affected 1088; Urban PWSs affected 337; Rural individual toilets damaged 1,08,427

HOUSING

Total houses damaged 3,61,743

- **Rural** 2,95,703
- **Urban** 66,040

HEALTH AND NUTRITION

- Health facilities affected 1,031
- Anganwadi centres damaged 2,513
- Storage warehouses damaged 23
- Take Home Ration production units affected 39

AGRICULTURE, FISHERIES, AND LIVESTOCK

- Area of perennial crops damaged 19,734 ha
- (Puri, Khurda, Jajpur, Cuttack, and Jagatsinghpur—92% of area damaged and 94% of crop production losses)
- 50 fishing settlements (1, 50,000 traditional fishermen) affected.
- Fish landing centres of Puri district damaged most
- 6,416 traditional marine fishing boats, 8,828 nets, 2,524 fish ponds, 157 aquaculture ponds covering an area of 77 ha, 3 fishing harbours, 6 fish landing centres, 5 fish farms damaged.
- 1,208 fishing craft damaged or lost (Puri 533, Cuttack 209).
- Large animals affected 24.5 lakh
- Small animals affected 10 lakh
- Poultry birds killed 54 lakh
- Cattle sheds damaged 1.24 lakh

TELECOMMUNICATIONS

- Base Transceiver Stations damaged 6,138

WATER RESOURCES

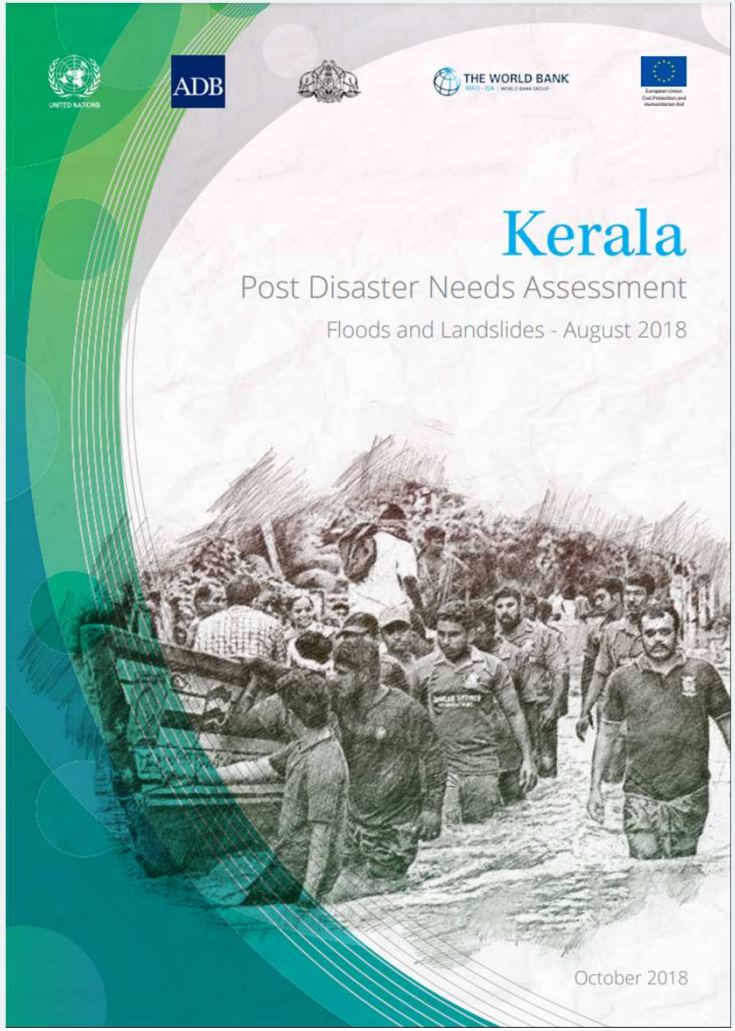
- Length of embankments damaged 22.67

ENVIRONMENT

- Trees damaged 21.9 lakh

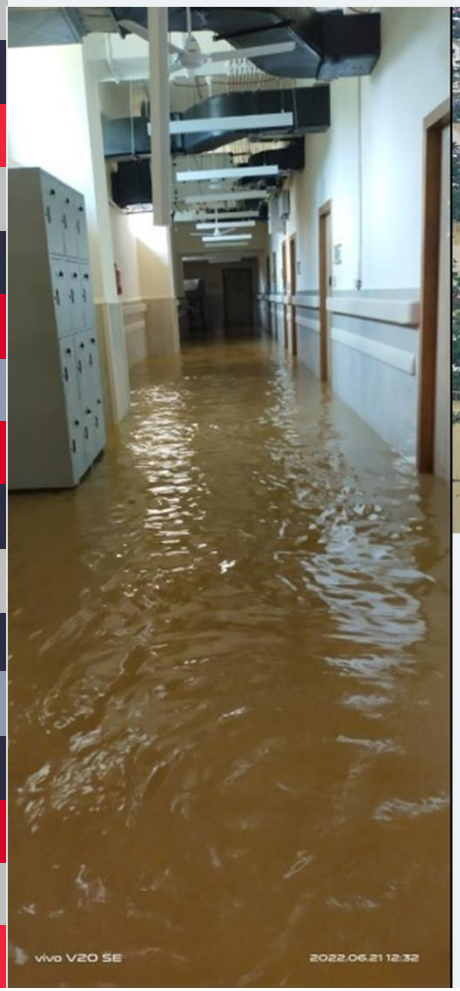
nidm
Resilient India - Disaster Free India

Similar case in Kerala



Sector	Damage	Loss	Total Effect (D + L)		Total Recovery Needs	
	INR Crores	INR Crores	INR Crores	USD Million	INR Crores	USD Million
Social Sectors						
Housing, Land and Settlements	5,027	1,383	6,410	916	5,443	778
Health and Nutrition	499	28	527	75	600	86
Education and Child Protection	175	4	179	26	214	31
Cultural Heritage	38	37	75	11	80	11
SUB-TOTAL	**5,739**	**1,452**	**7,191**	**1,028**	**6,337**	**906**
Productive sectors						
Agriculture, Fisheries and Livestock	2,975	4,180	7,155	1,022	4,498	643
SUB-TOTAL	**2,975**	**4,180**	**7,155**	**1,022**	**4,498**	**643**
Infrastructure sectors						
Water, Sanitation and Hygiene	890	471	1,361	195	1,331	190
Transportation[a,b,c]					10,046	1,435
Power[b,c]					353	50
Irrigation[b,c]					1,483	212
Other infrastructure[b,c]					2,446	349
SUB-TOTAL	**890**	**471**	**1,361**	**195**	**15,659**	**2,236**
Cross-cutting sectors						
Environment	26	0.04	26	4	148	21
Employment and Livelihoods	881	9,477	10,358	1,480	3,896	557
Disaster Risk Reduction	17	583	599	86	110	16
Gender and Social Inclusion	0.9	0	0.9	0.13	35	5
Local Governance	28	0	28	4	32	5
SUB-TOTAL	**953**	**10,060**	**11,013**	**1,574**	**4,221**	**604**
TOTAL (A)	**10,557**	**16,163**	**26,720**	**3,819**	**30,715**	**4,389**
Integrated Water Resources Management (B)	0	0	0	0	24	3
GRAND TOTAL (A+B)					**30,739**	**4,392**
GRAND TOTAL (ROUNDED OFF)					**31,000**	**4,400**

Same thing happened in Assam



(Rs. crore)

Year	2021-22	2022-23	2023-24	2024-25	2025-26	Total
Union share	22184	23294	24466	25688	26969	**122601**
States' share	6799	7137	7491	7864	8261	**37552**
Total (Union + States' share)	**28983**	**30431**	**31957**	**33552**	**35230**	**160153**
Percentage increase over previous year	-	5	5	5	5	

Annual Allocation for States for Disaster Management

Distribution of Total States Allocation

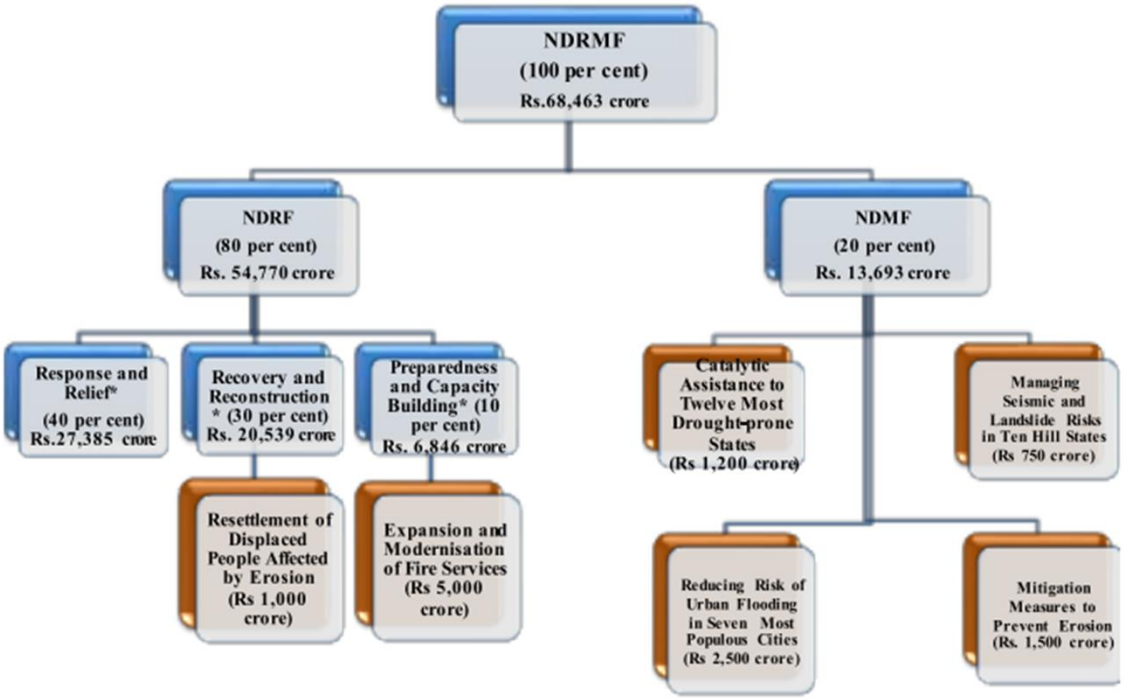
Funds (percentage distribution)	Amount
SDMF (20)	32031
SDRF (80)	128122
i) Response and Relief (40)	64061
ii) Recovery and Reconstruction (30)	48046
iii) Preparedness and Capacity Building (10)	16015
Total (SDMF + SDRF) (100)	**160153**

Distribution of Total National Allocation

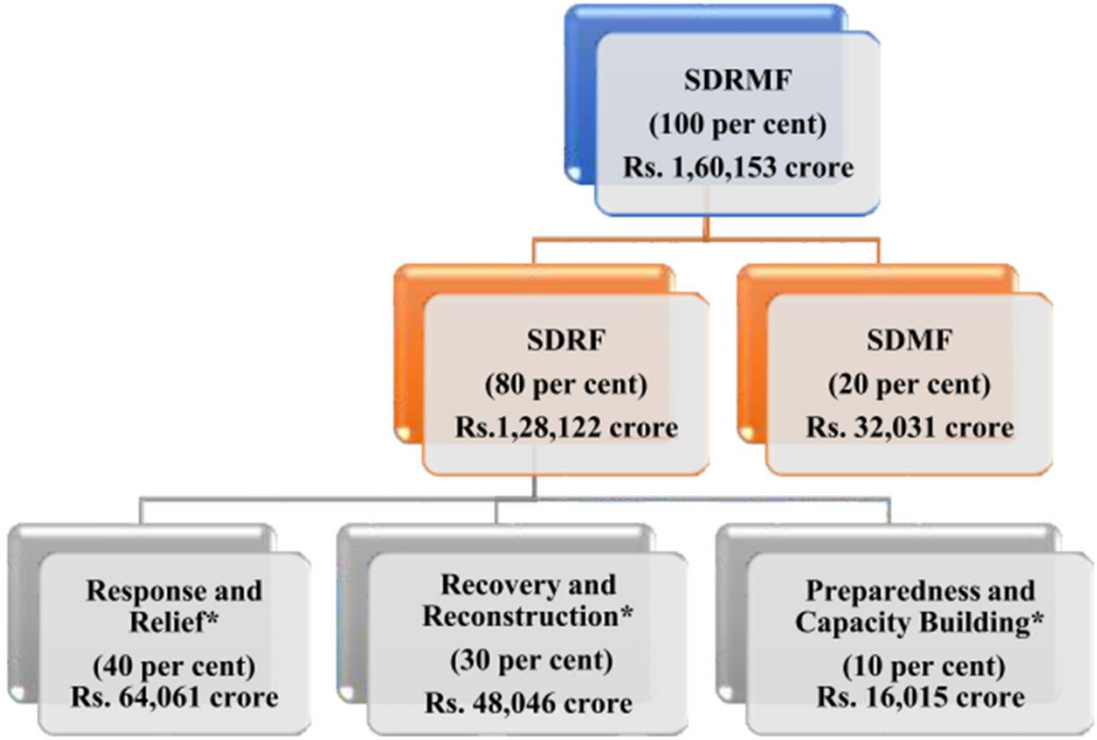
Funds	Amount (Rs. crore)	Percentage Share
NDMF	13693	20
NDRF	54770	80
Total (NDMF+NDRF)	**68463**	**100**

Windows of NDRF

Windows of NDRF	Amount (Rs. crore)	Percentage Share
Response and Relief	27385	40
Recovery and Reconstruction	20539	30
Preparedness and Capacity Building	6846	10
Total NDRF Corpus	54770	80

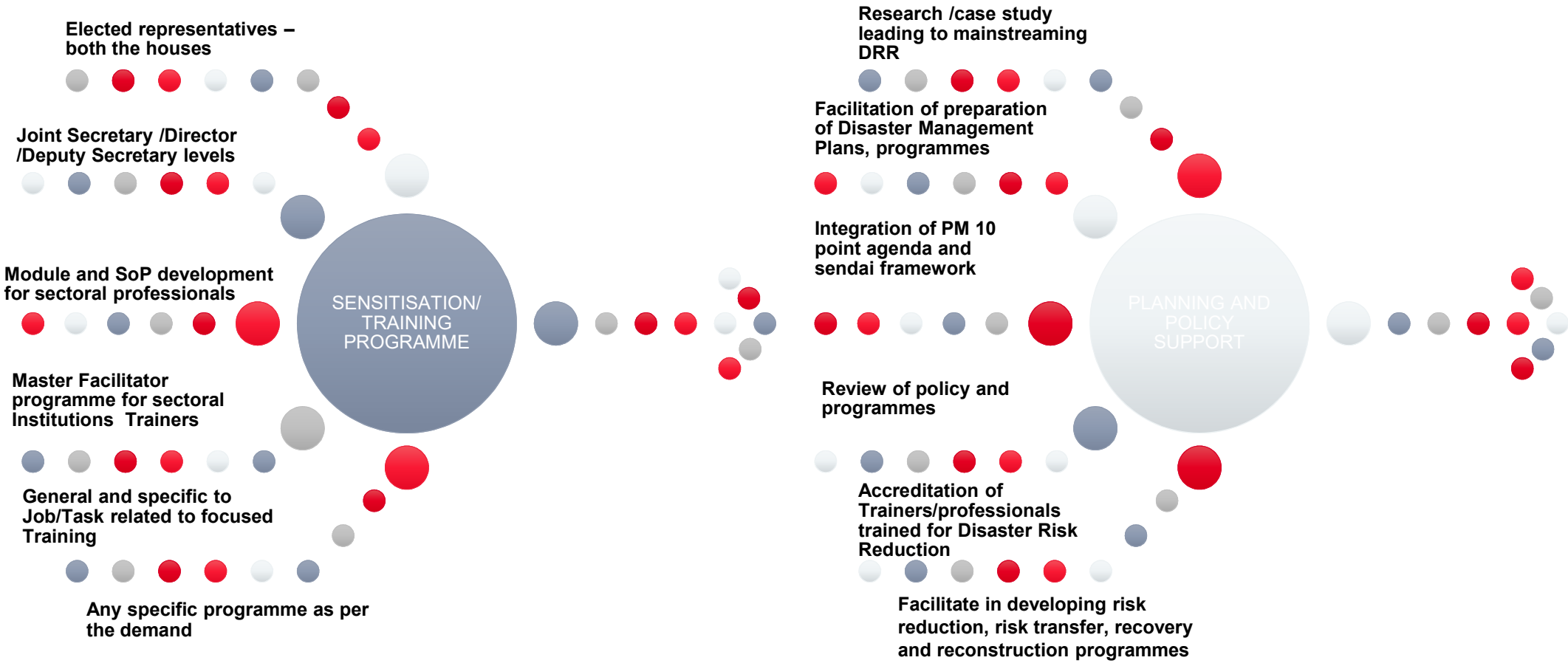


** Reallocation within the three sub-windows is recommended, subject to the condition that earmarked allocations under the respective sub-window is duly fulfilled.*



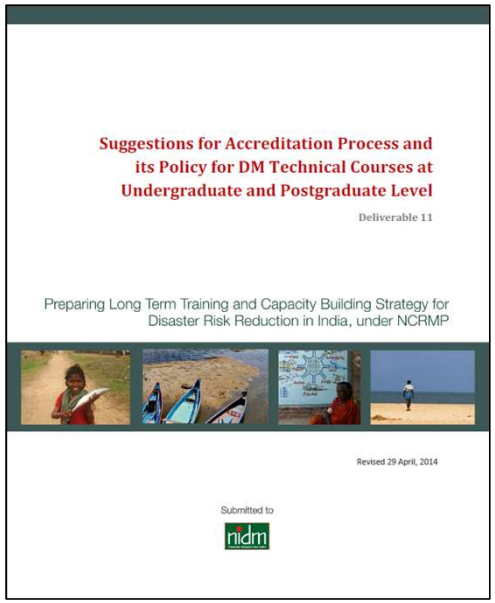
** Reallocation within the three sub-windows is recommended.*

ACTION FOR STREAMLINING NIDM ACTIVITIES



IUINDRR-NIDM

India Universities & Institutions Network on Disaster Risk Reduction
National Institute of Disaster Management, MHA, GoI



- This report has been produced as Deliverable 11 of the study on preparing long-term training and capacity building strategy for disaster risk reduction in India.
- This study on accreditation process, quality management and certification process of disaster management in undergraduate and postgraduate technical education has been carried out as part of the larger initiative on preparing a long-term training and capacity building strategy for disaster risk reduction under the National Cyclone Risk Mitigation Project.

About IUINDRR-NIDM Network:

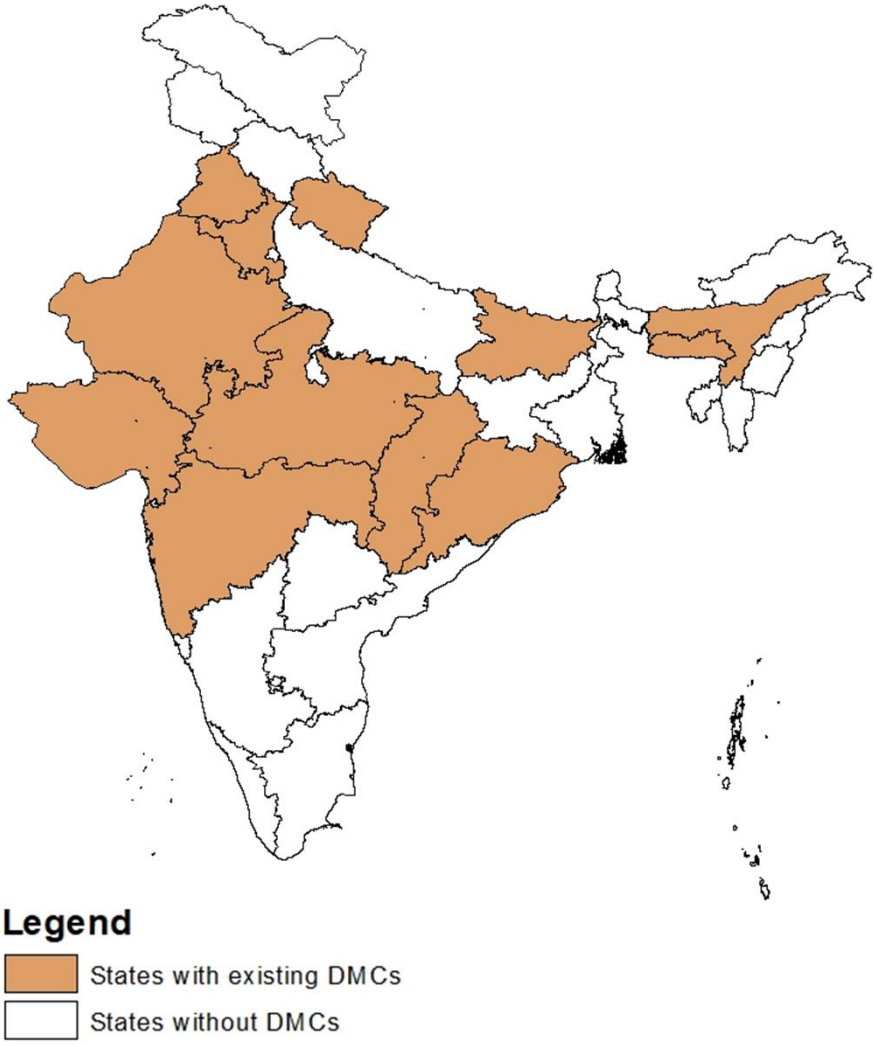
India Universities & Institutions Network on Disaster Risk Reduction (IUINDRR-NIDM) is an initiative taken by National Institute of Disaster Management under Ministry of Home Affairs, Government of India in pursuance of Agenda 6 from Hon'ble Prime Minister's 10 point agenda on Disaster Risk Reduction (DRR).

Aim:

- Helping in bridging the social science and science gap between the institutes and faculty members,
- Exchanging the information, knowledge and data amongst universities,
- Helping in developing pool of experts, and
- Enhancing multi-disciplinary joint research programs.

Key outcomes

NIDM OUTREACH PROGRAMME



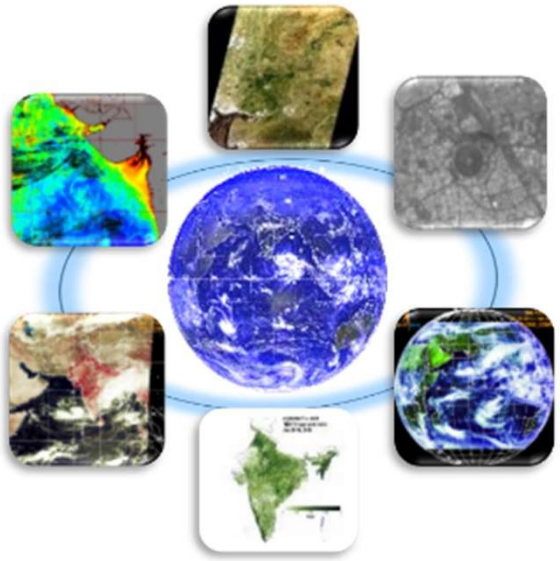
Project Description

- **The aim of the project would be to strengthen the existing centres for disaster management in 12 states and set up new institutes in the rest of the states and union territories.**
- **The idea is to build the resources of the SIDMs and handhold them until they function independently and adequately.**
- **The primary objective of the SIDMs would be to systematically accelerate the capacity building initiatives at the state and local levels to involve all sections of society.**

Project Duration

- 5 years for States with existing DMCs
- 10 years for States/UTs without DMCs

THANK YOU FOR PATIENCE



MOSDAC Geospatial Data Services and Tools for Disaster Risk Management

Breakdown of natural disasters in India per type of event and nature of losses

Source : World Bank

	Natural disasters	Material loss	Human loss
Floods	52%	63%	32%
Cyclones	30%	19%	32%
Landslides	10%	-	2%
Earthquakes	5%	10%	33%
Droughts	3%	5%	1%
Total	100%	100%	100%

Dr. Nitant Dube
Group Director, MOSDAC Research Group
Deputy Project Director, Alert and Forewarning Services, Disaster Management Support Programme
Space Applications Centre, ISRO. Ahmedabad

Meteorological and Oceanographic Satellite Data Archival Centre

https://mosdac.gov.in

Indian Store-house for Meteorological and Oceanographic Data

- **8** Indian Satellite**, 200** Products and **25** applications Total of **17 million** products disseminated to **139 countries**
- Weather and Ocean State Forecast to users

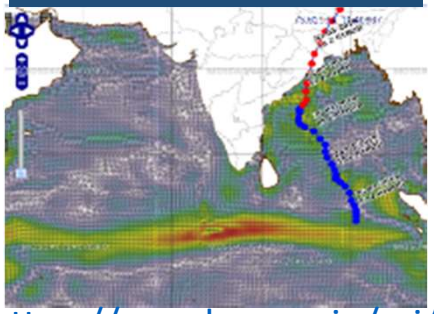
Major Applications

- Automated Ocean Forecast to ships **(Ocean-Eye) 85** Ships of SCI currently registered
- Cyclone Track and Intensity forecasting **(SCORPIO)**
- Nowcasting of Heavy rain and Cloud burst **(Netra)**
- Rip current forecast for **175** beaches (**Safe Beach**)
- **Solar and Wind forecast** along with a visualization tool provided to POSOCO for Grid management
- State Portal for Alert Services (**DMSP**)

Data Analytics and Visualization

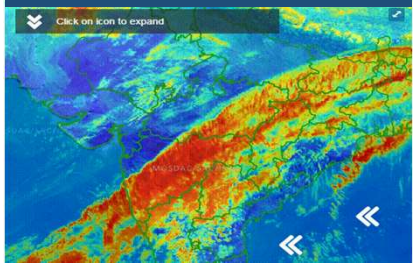
- An Integrated data visualization system for Earth Observation, In-situ data & Forecast Information (https://mosdac.gov.in/live)

Ocean Eye

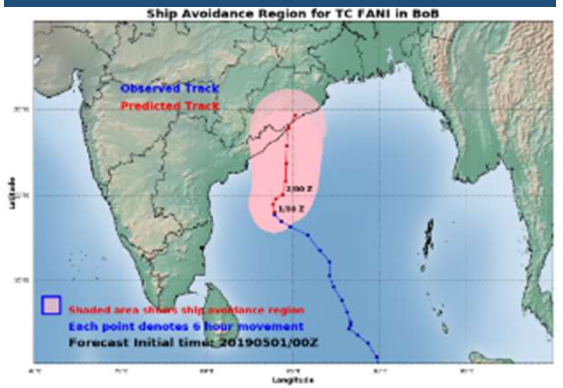


https://mosdac.gov.in/sci/

Advanced Satellite data Visualization



Cyclone



https://mosdac.gov.in/scorpio

Rip Current Forecast

https://mosdac.gov.in/rip_current_forecast

MOSDAC Support for Disaster Risk Management

Meteorological Disasters

Tropical Cyclones

Heavy Rain

Cloud Burst

Lightning

Heat/Cold Waves

Ocean/Coastal Hazards

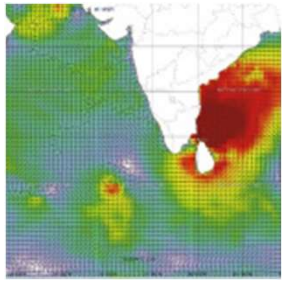
Rip Currents

Oil Spill

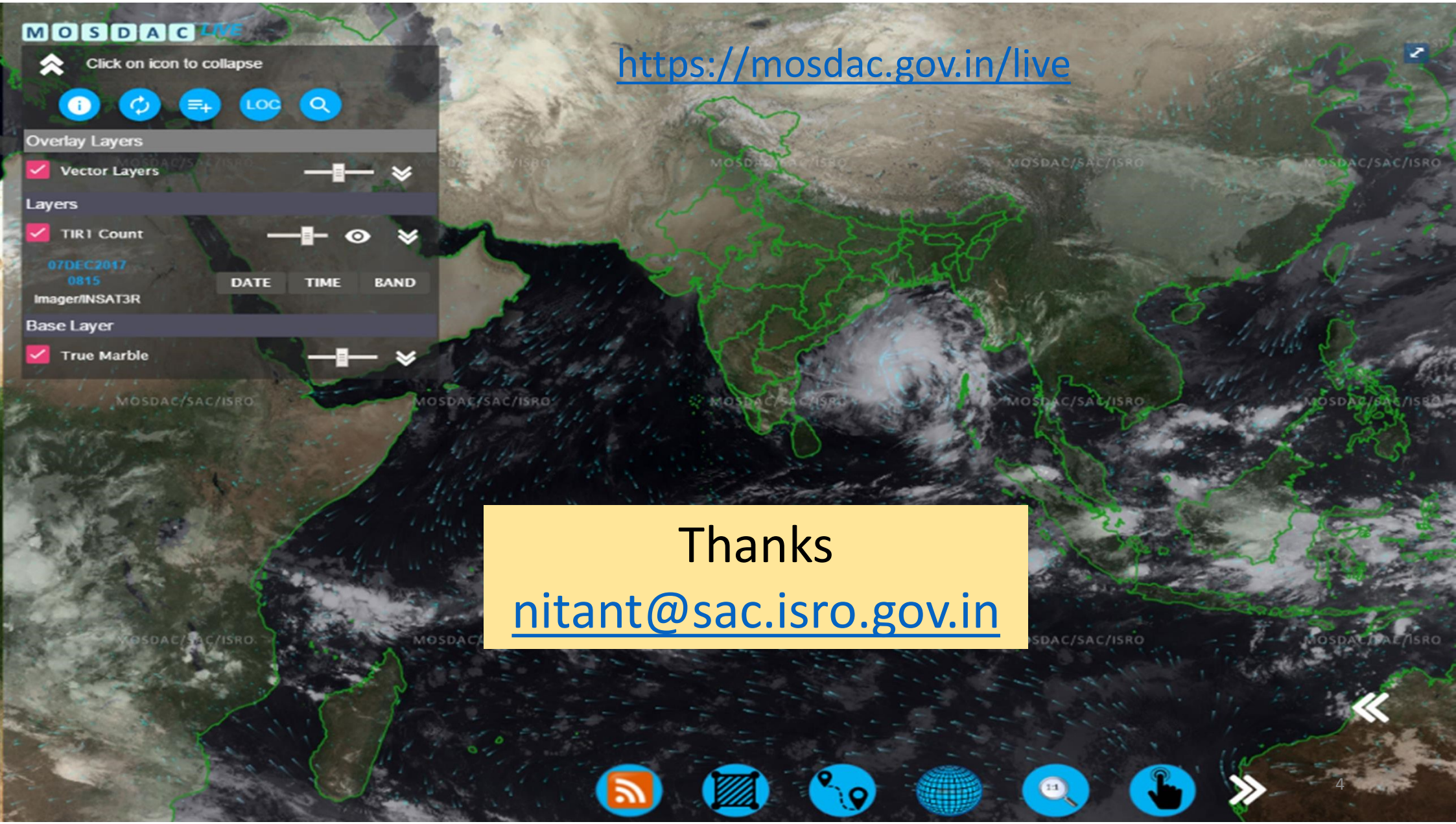
Decision Support Tools

Alert and Forewarning (State Portal)

Ocean Eye

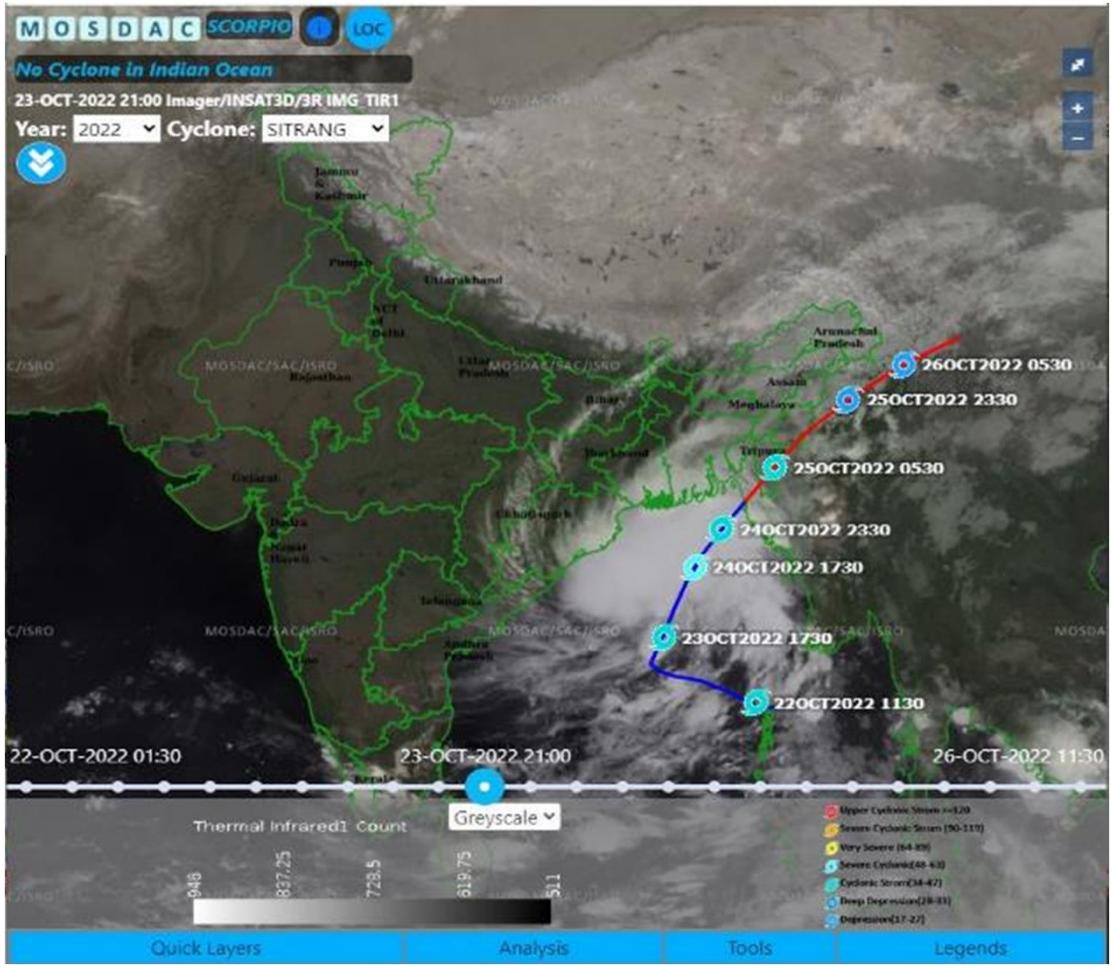


City Weather

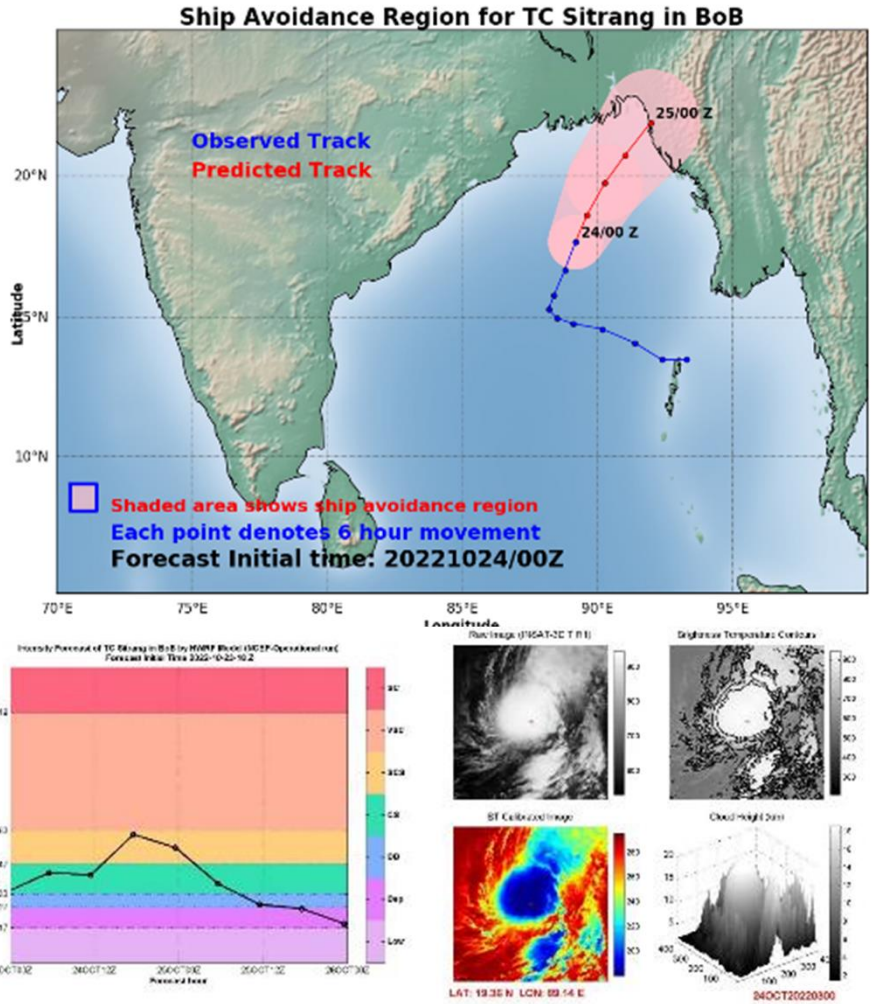

MOSDAC LIVE
Click on icon to collapse
LOC
Overlay Layers
Vector Layers
Layers
TIR1 Count
07DEC2017
0815
Imager/INSAT3R
DATE
TIME
BAND
Base Layer
True Marble
https://mosdac.gov.in/live
Thanks
nitant@sac.isro.gov.in

Cyclone

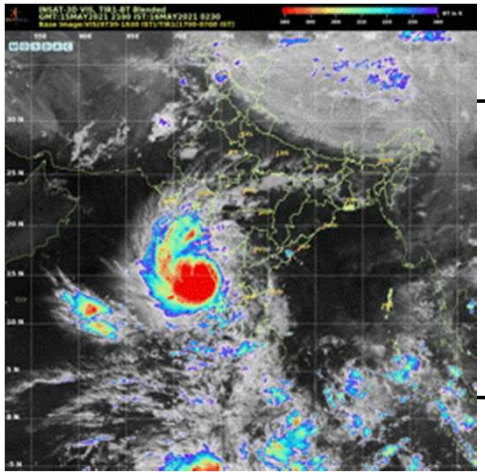
Satellite based **C**yclone **O**bservation and **R**eal time **P**rediction over **I**ndian **O**cean **(SCORPIO)**



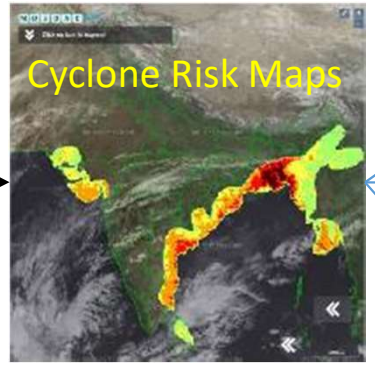
https://mosdac.gov.in/scorpio/



Cyclone



Long Term Archive of Images, Track and Intensity



RADAR Network for Monitoring

Planning

Redundant Electrical and Communication Network

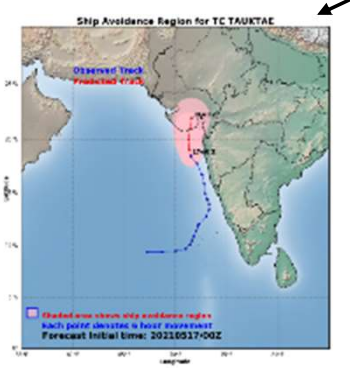
Health and support Infrastructure for Evacuation

Satellite Data Assimilation

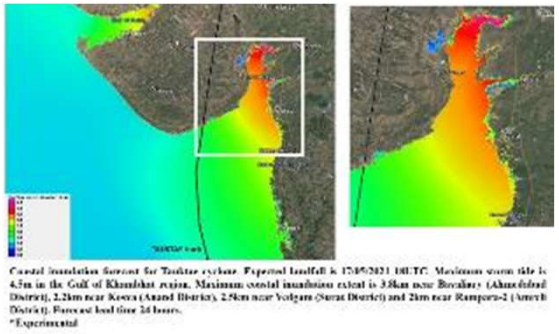
Model

Surge

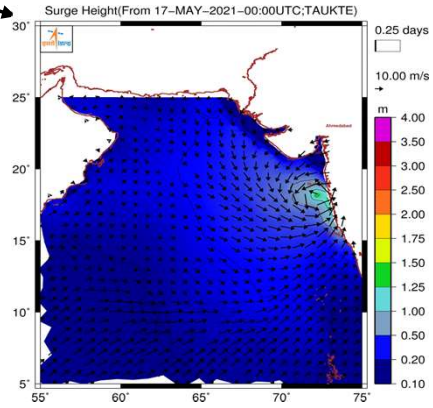
Track & Intensity



Coastal Inundation

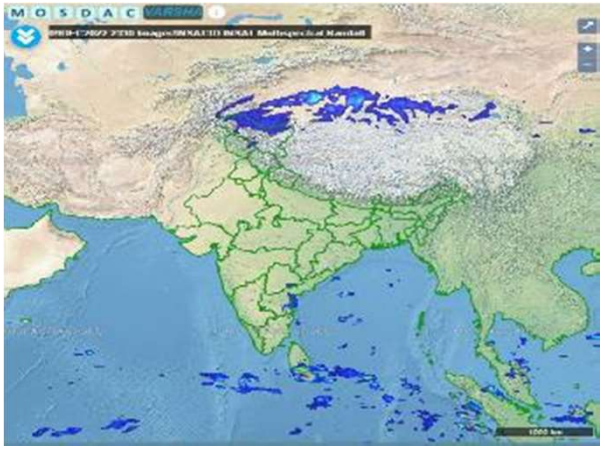


Coastal Inundation forecast for Tauktae cyclone. Expected landfall is 17/05/2021 18UTC. Maximum storm tide is 4.5m in the Gulf of Khambhat region. Maximum coastal inundation extent is 3.8km near Bavaliyar (Ahmedabad District), 2.2km near Kosva (Anand District), 2.9km near Vedgam (Surat District) and 2km near Rampura-2 (Amreli District). Forecast lead time 24 hours.
*Experimental



Heavy Rain

Heavy Rain Current Events

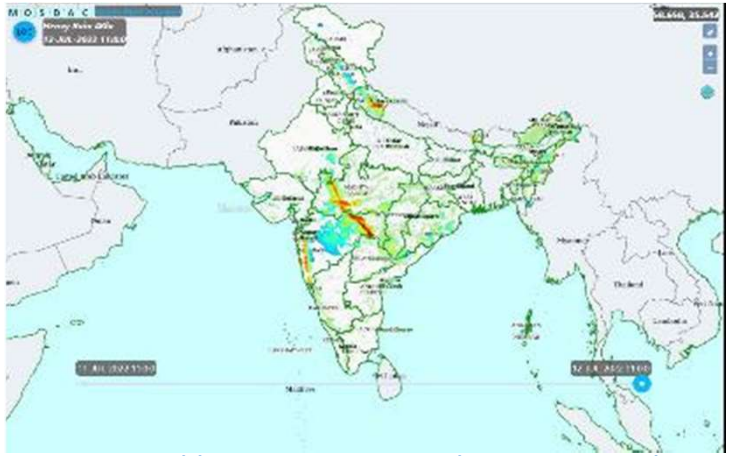


https://mosdac.gov.in/live/index_one.php?url_name=varsha

Heavy Rain Nowcast Next 6 hours

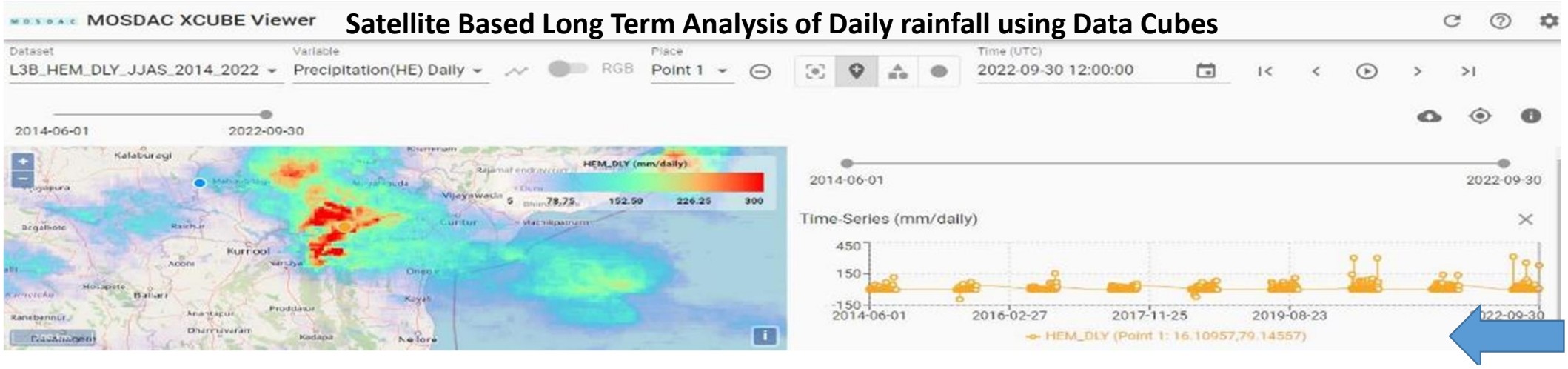
https://mosdac.gov.in/heavyrain/

Heavy Rain Forecast 24 and 48 Hours



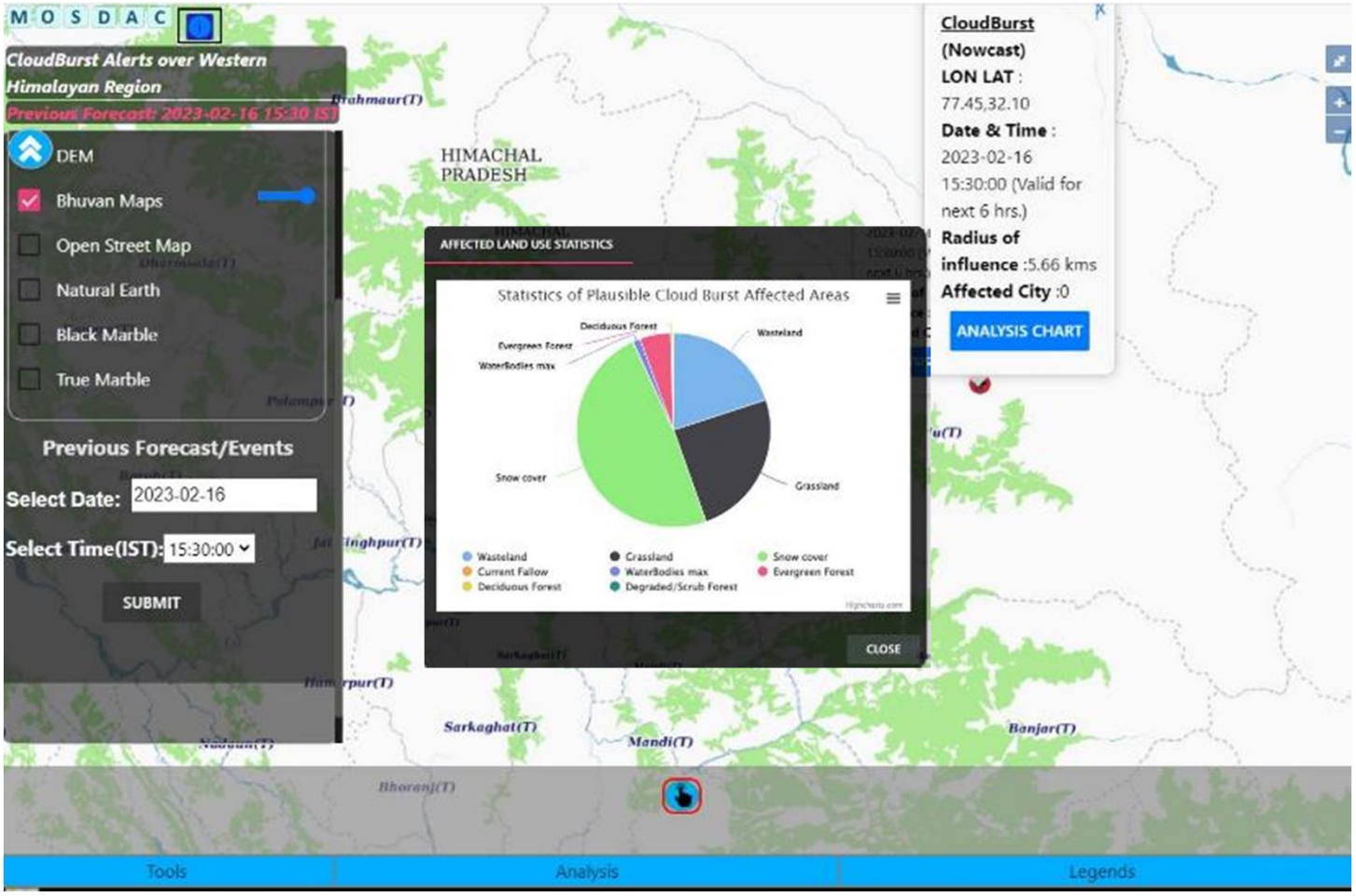
https://mosdac.gov.in/heavy-rain/

Satellite Based Long Term Analysis of Daily rainfall using Data Cubes



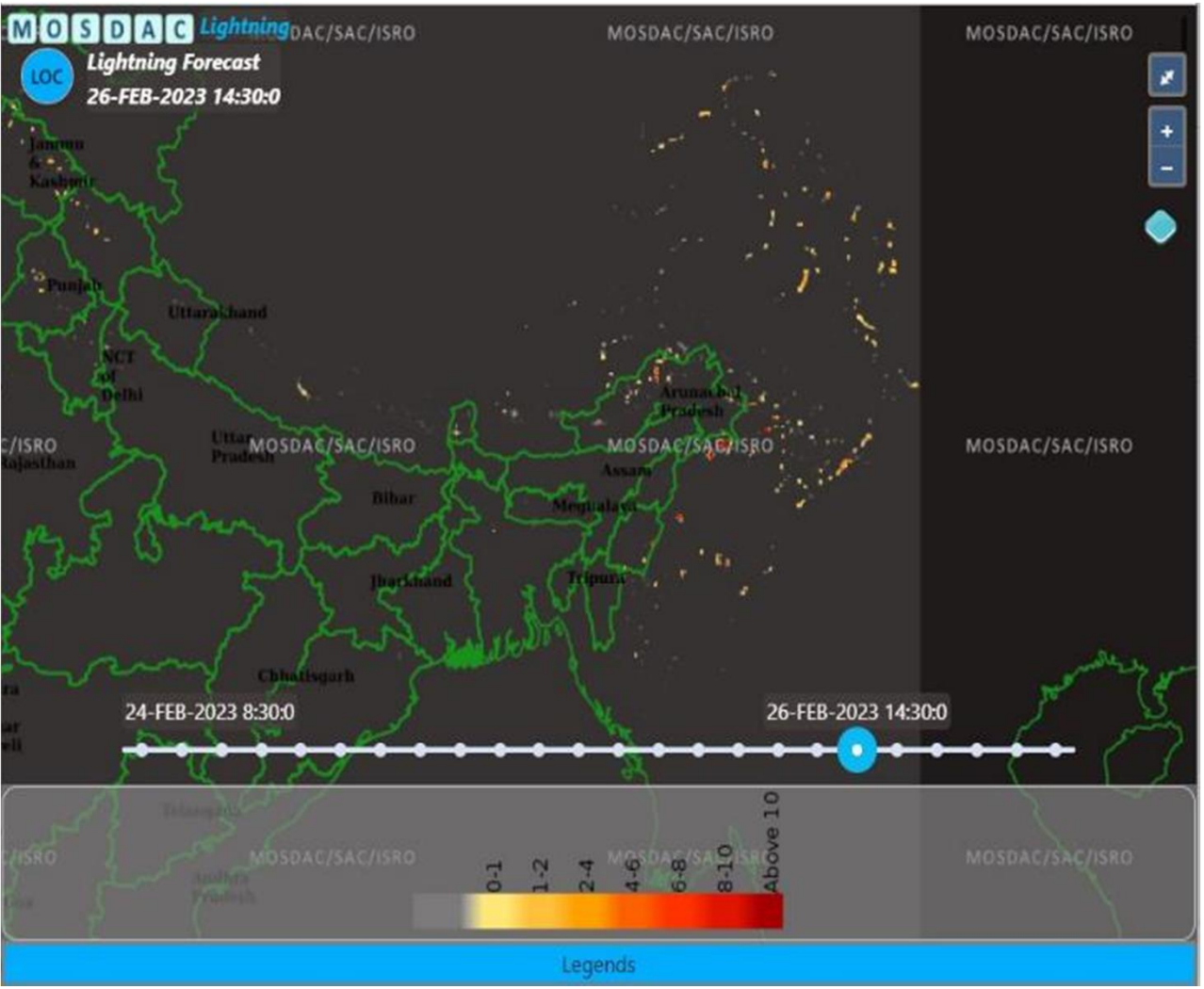
Cloud Burst (Nowcast)

https://mosdac.gov.in/cloudburst/



- **MOSDAC Provides Cloud Burst Nowcast (updated every half hour) and are available as RSS Feeds and can be accessed using MOSDAC Alert API.**
- **Cloud burst events have rainfall rate greater than 100mm/hr.**
- **The geographical extension of the area under the effect of the events are approximately 20-30 square km.**
- **The number of cloudbursts occurring every year ranges from 5 -10.**

Lightning

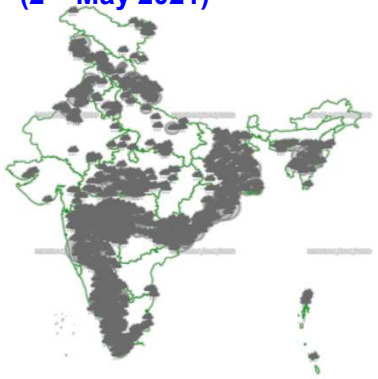


https://mosdac.gov.in/lightning/

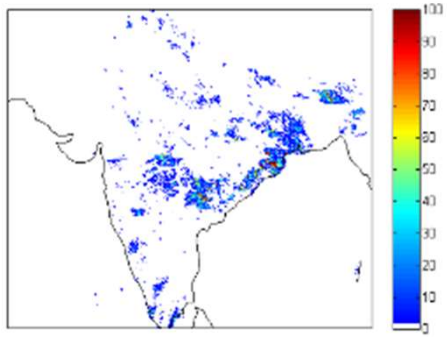
- **MOSDAC Provides lightning forecast (updated every day) and are available as RSS Feeds and can be accessed using MOSDAC Alert API.**

Heavy rain Nowcasts relationship with Lightning

SAC Heavy rainfall alerts (2nd May 2021)

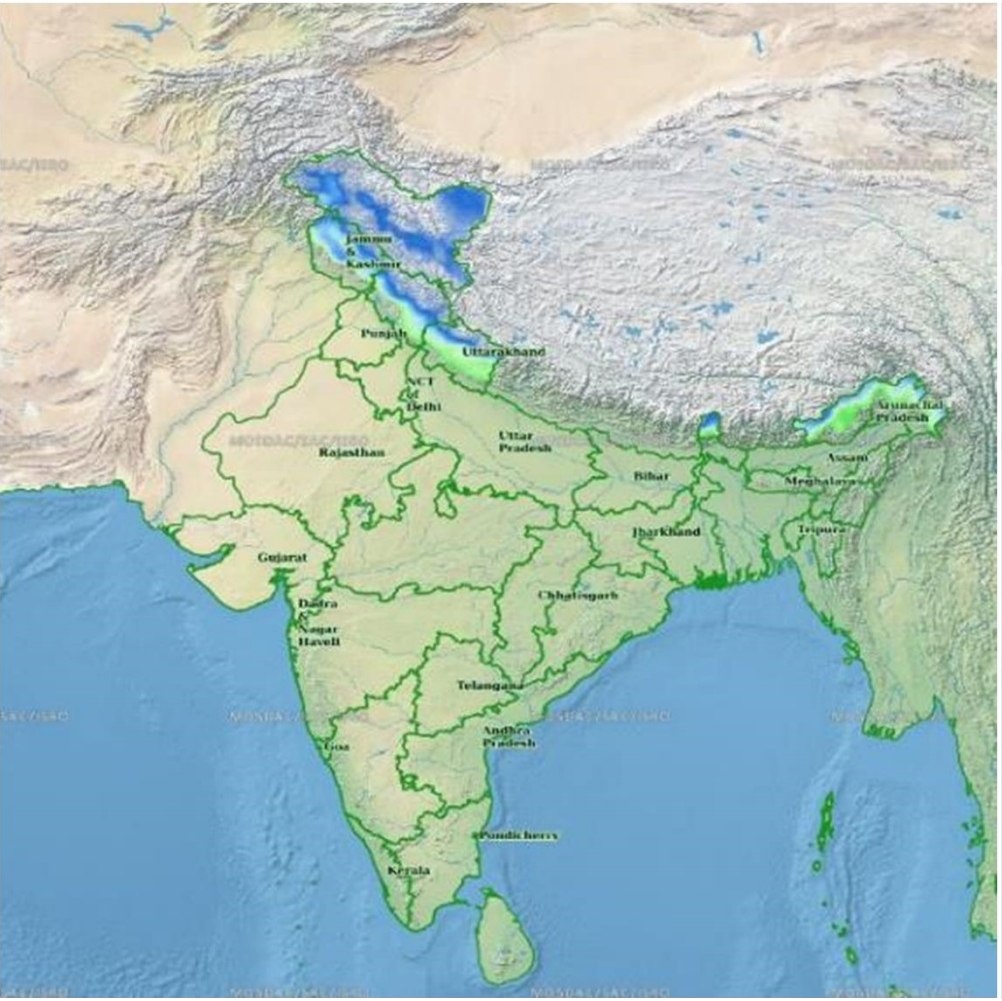


NRSC Lightning data (2nd May 2021)

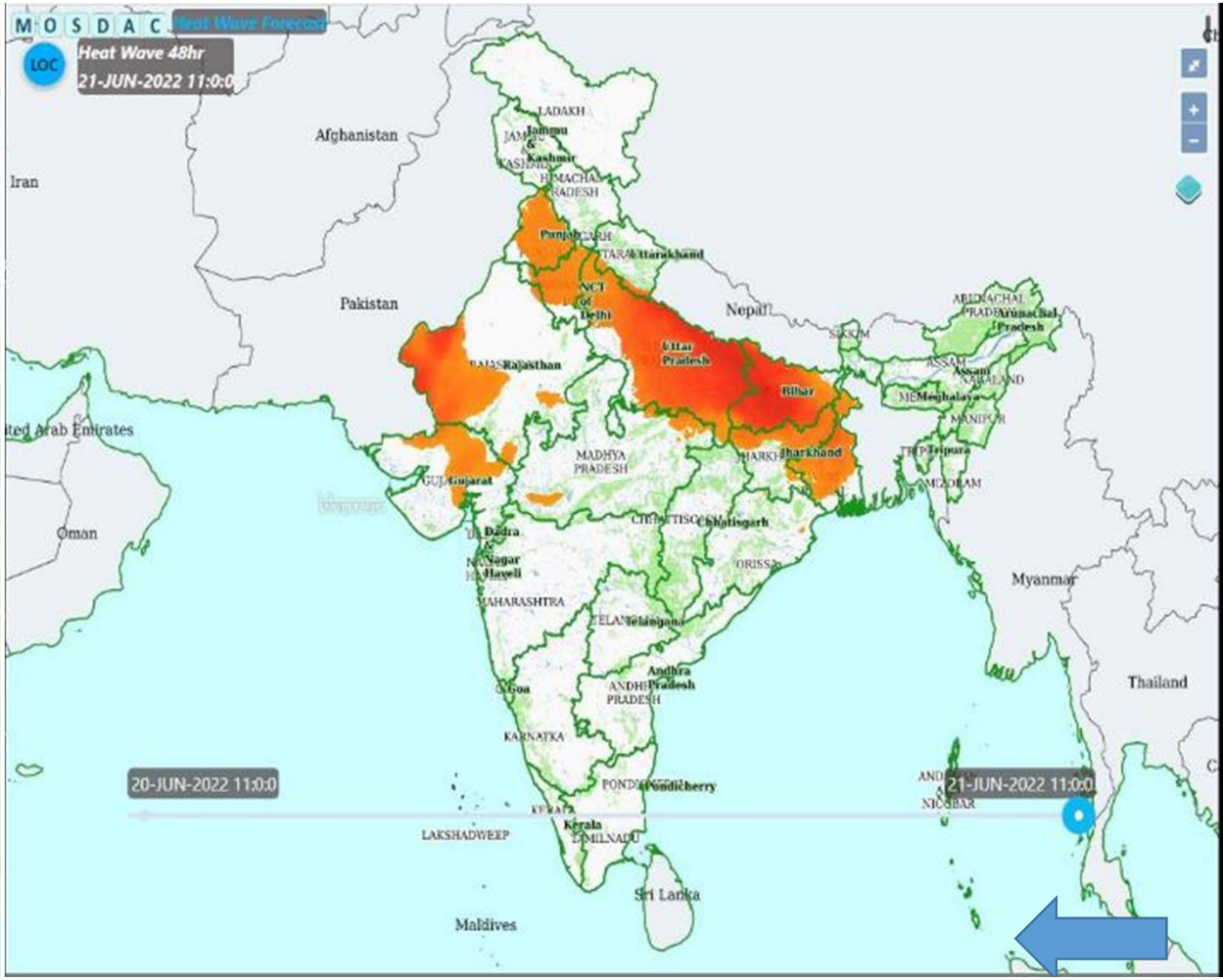


Heat and Cold Waves

https://mosdac.gov.in/coldwave/

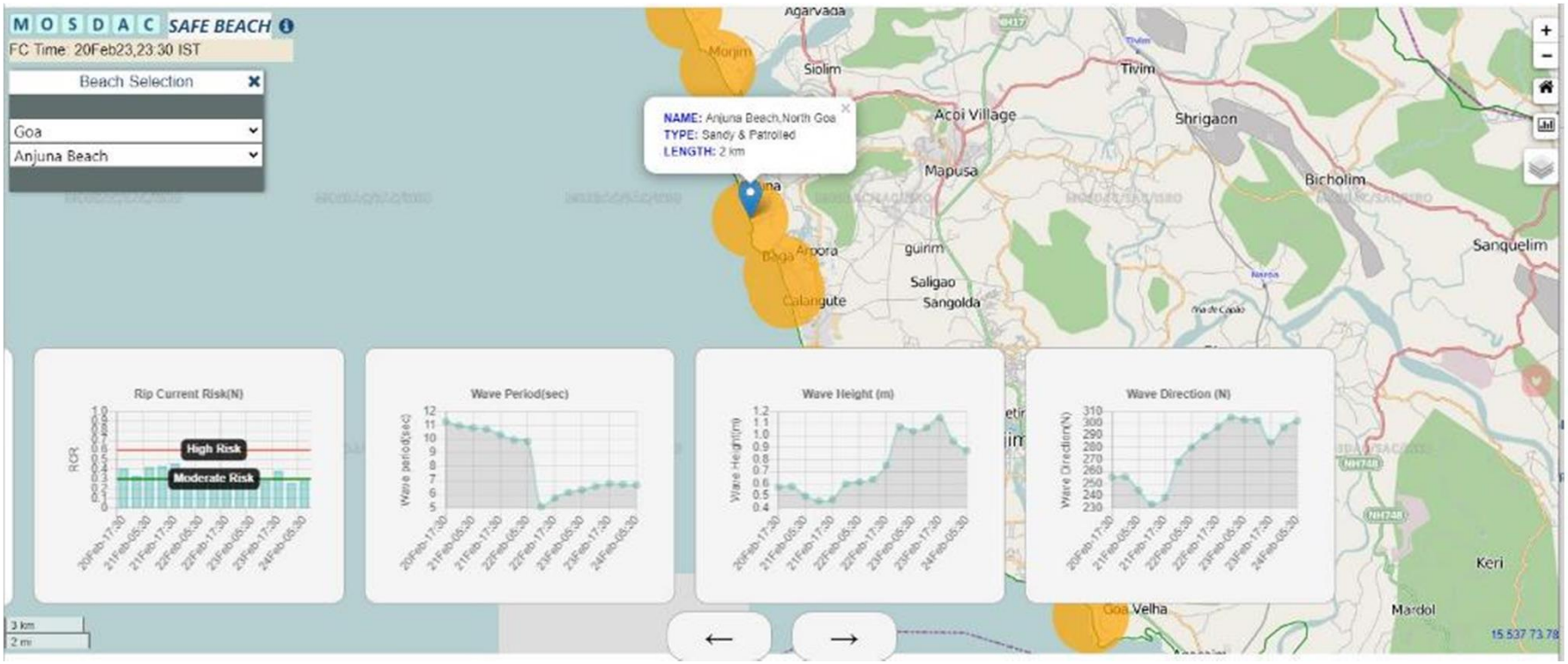


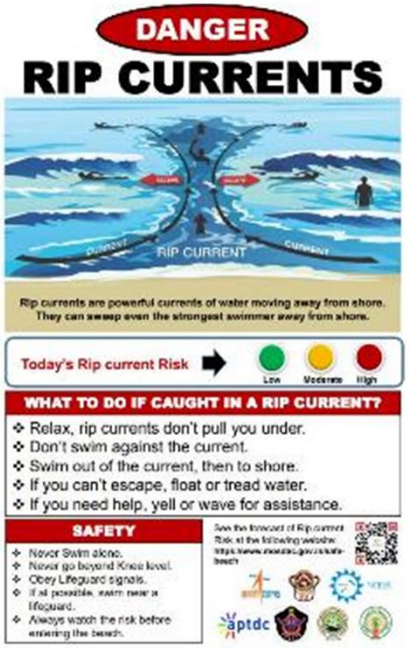
https://mosdac.gov.in/temperature/



Rip Current Forecast (Safe Beach)

https://www.mosdac.gov.in/rip/

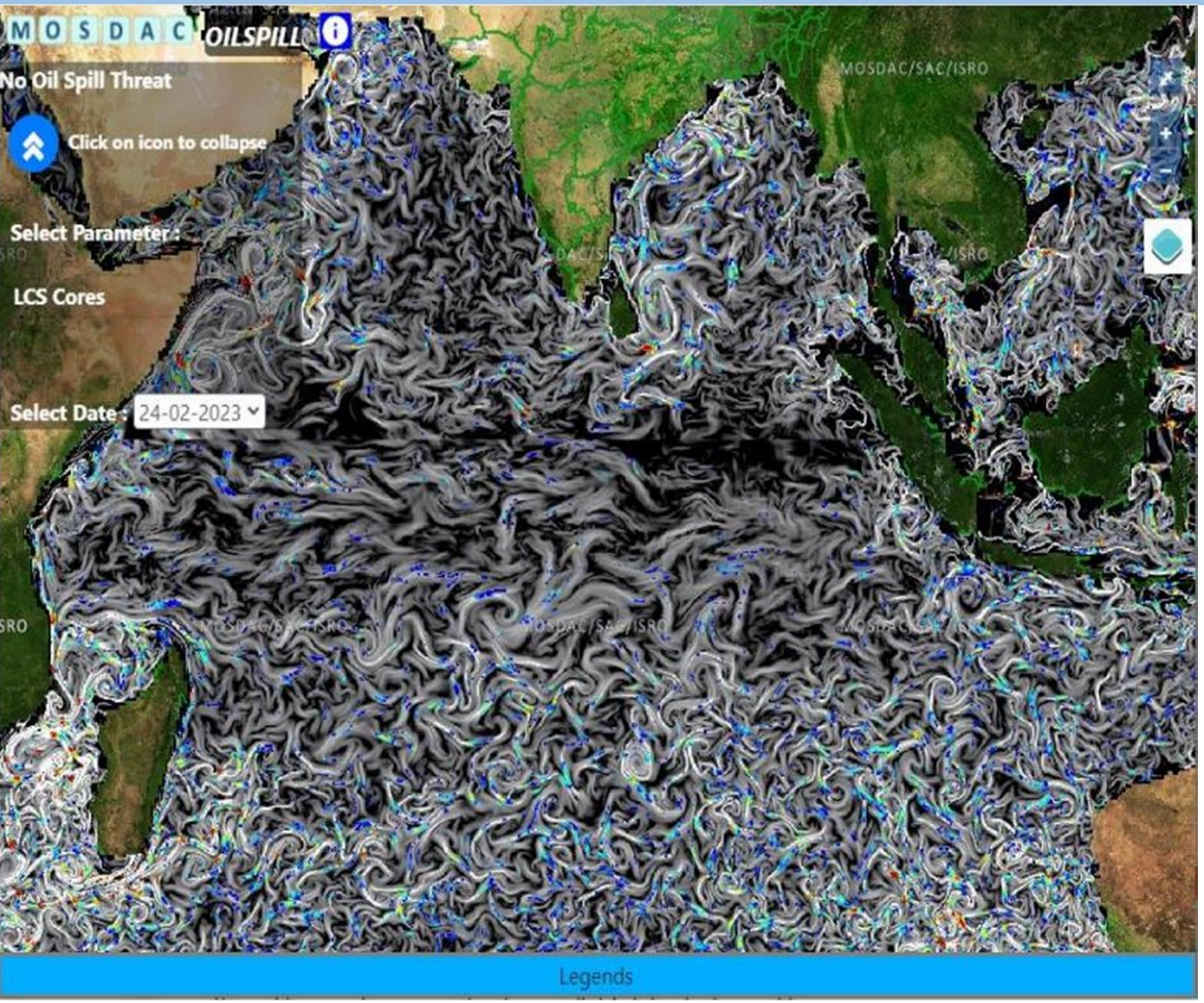




Safe Beach

- "**Safe Beach**" is application for dissemination of Rip current forecast for 175 beaches of India
- 6 Hourly forecast for next 5 days

Oil Spill

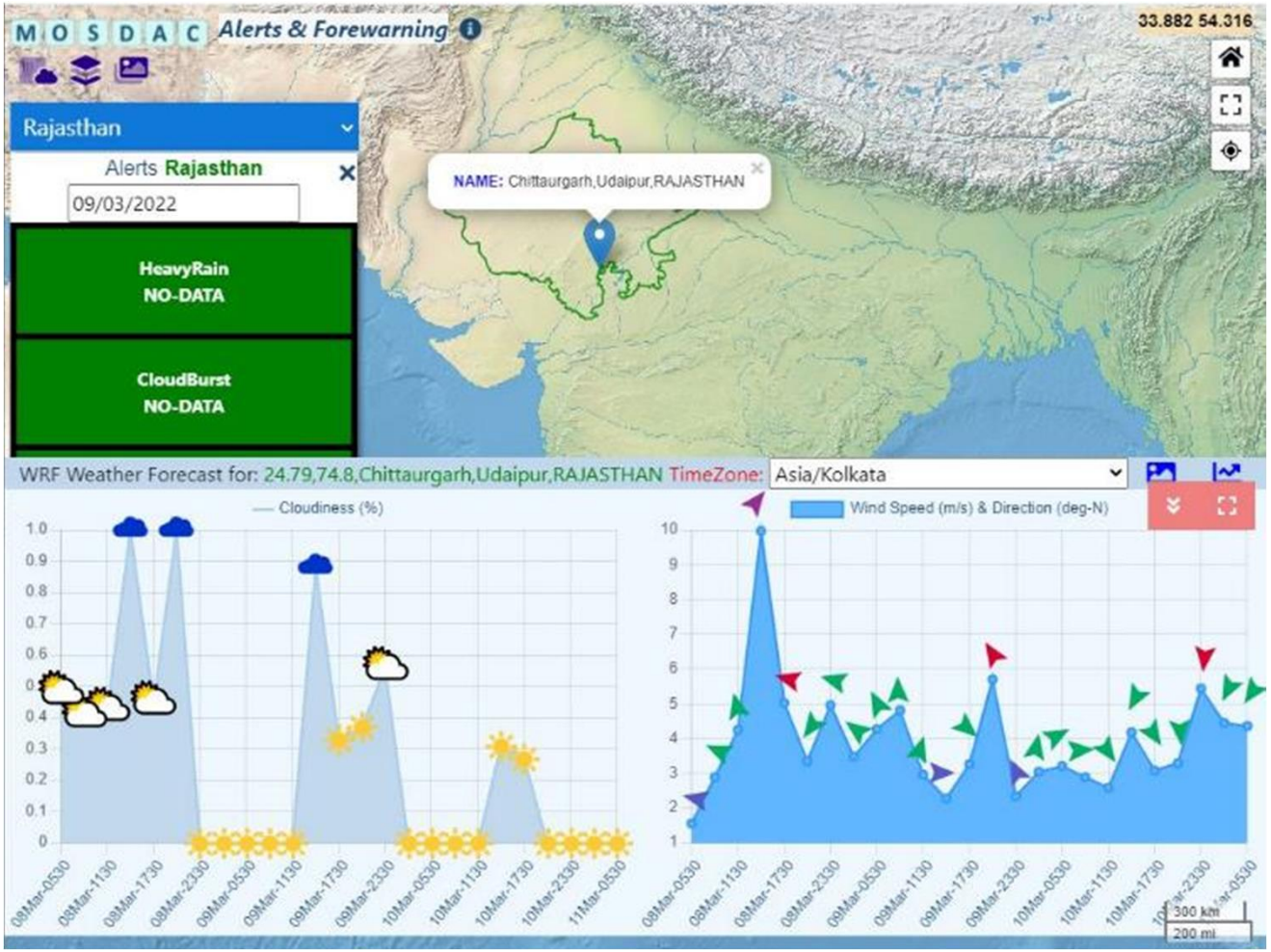


https://mosdac.gov.in/oilspill/

- Lagrangian Coherent structures (LCS) arise in Ocean due to non-linear dynamics of Ocean. These 2-D structures have an ability to facilitate or block the material transport

- Web application for monitoring of Oil spills and its possible progression direction using Altimeter LCS-Cores and Stretching Directions

Alert and Forewarning (State Portal)



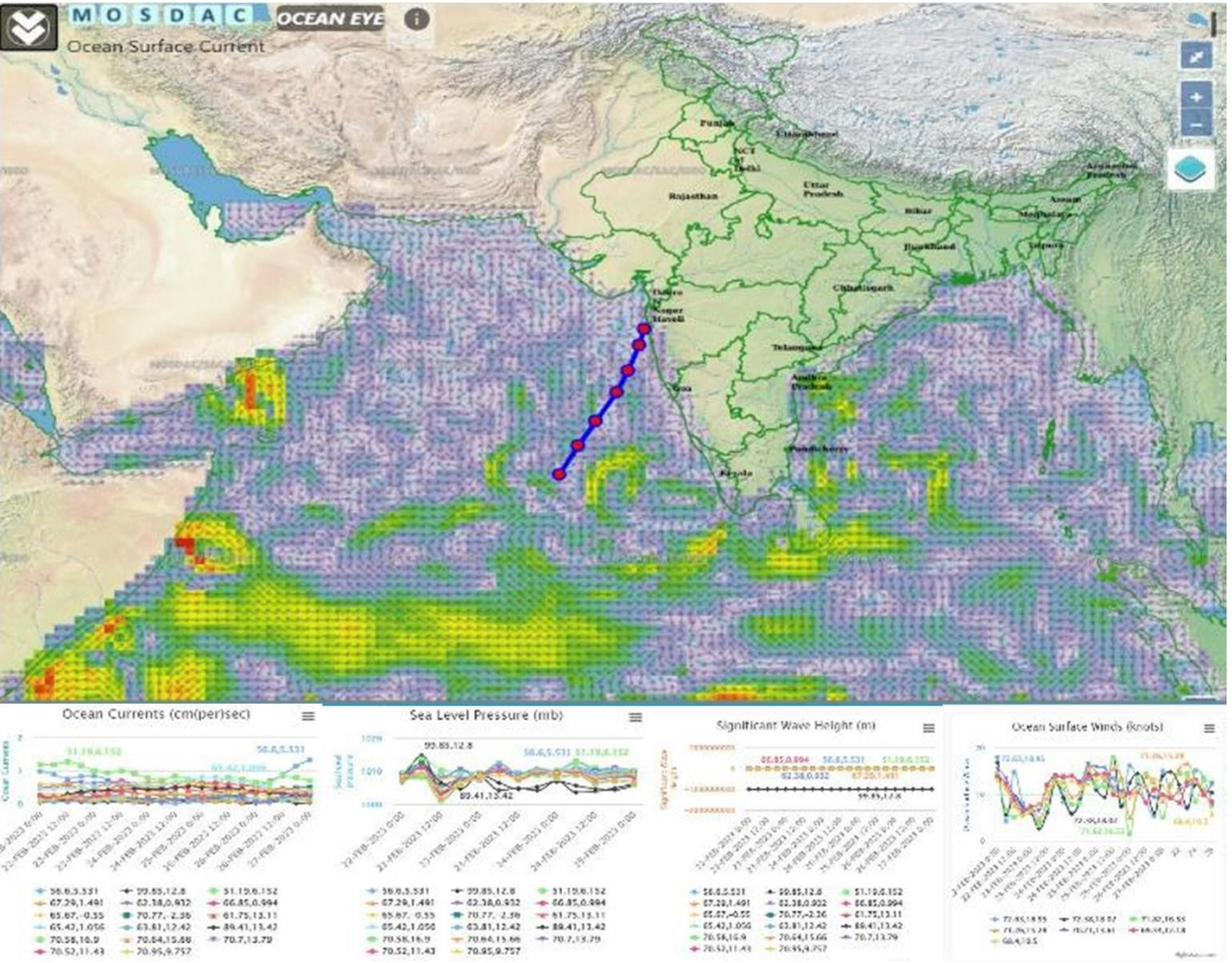
https://mosdac.gov.in/state

State Portal for Alert and Forewarning

- Capability for user to select his state or can see alerts for full India
- **Heavy Rain** and **Cloud Burst** Nowcast (Valid for next 6 hours)
- Also provides capability for user to click on location and see next 72 hours **forecast.**
- Can see the animation of **Blended Satellite images** for the selected state, this provides information on how clouds are moving
- User can select previous date and see the alerts issued for the sate on the selected date.

Ocean-Eye

Ocean Eye (Safe Ship Navigation)



https://www.mosdac.gov.in/sci

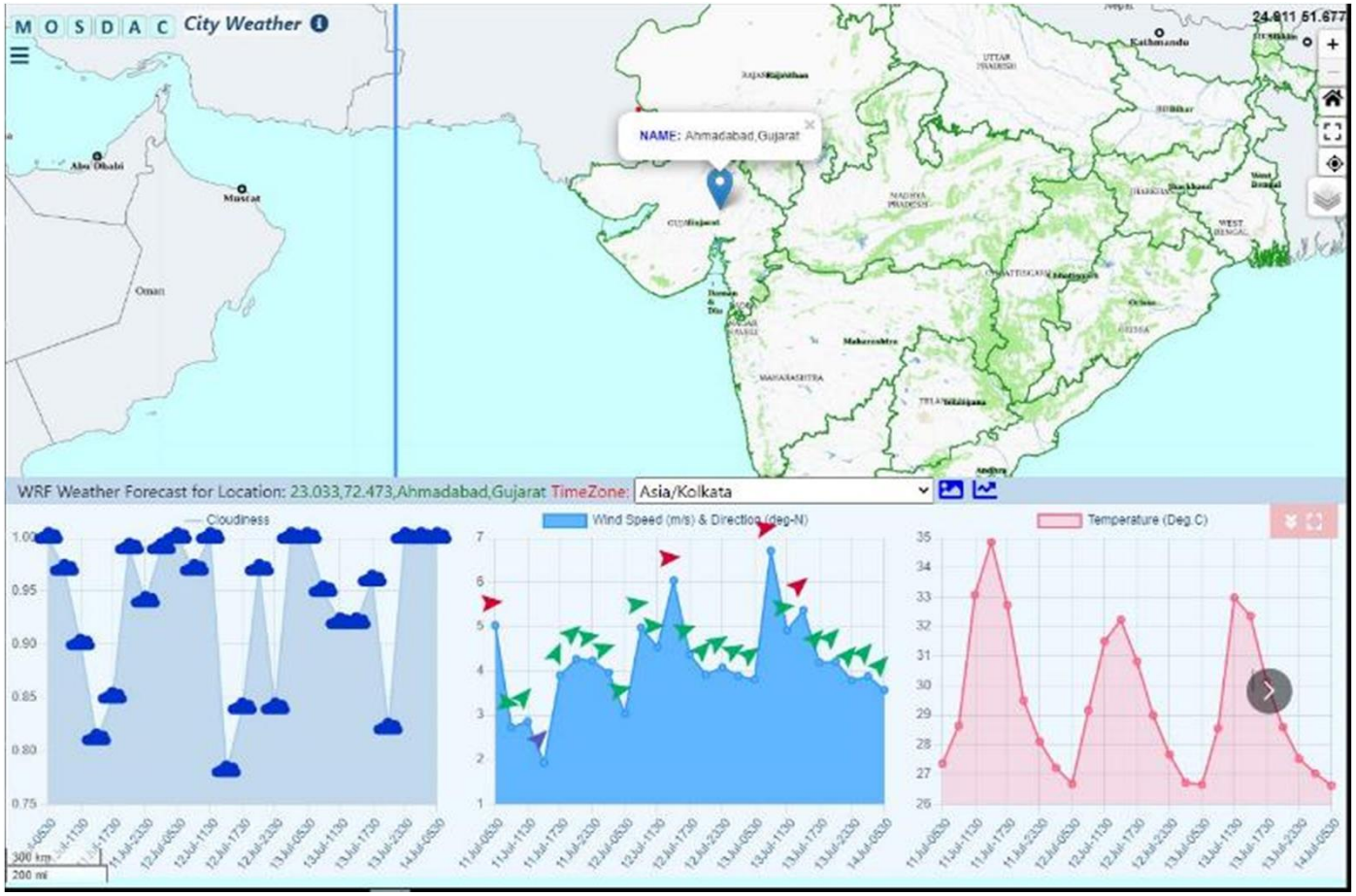
Application uses Ocean State Forecast for every 6 hours for next 5 days

Ocean-Eye Provides

- Automated Ocean Forecast to ships **85** Ships of Shipping Corporation of India are currently registered
- Ocean State Parameters include
  - Ocean Currents
  - Sea Level Pressure
  - Significant Wave Height
  - Ocean Surface Winds
- Suggested Optimal and Safe Ship Route
- Ship Avoidance Region during Active cyclone

City Weather

City Weather (Forecast)



https://mosdac.gov.in/weather

Weather Forecast (5 Km) for every 3 Hrs. for 72 Hrs.

Forecast is generated every day

- **Temperature**
- **Humidity**
- **Cloud**
- **Wind**
- **Rain**