

Observation/forecast products on GIS platform

A. K. Mitra

Geospatial Applications Functional Group

01-September-2021

Significant contributions:

Dr. Sankar Nath-Sc-E
Ms Deepashree Paul
Mr Abhimanyu Chuvan
Mr Gauvrav Sharma
Ms Kavita Navria,SA



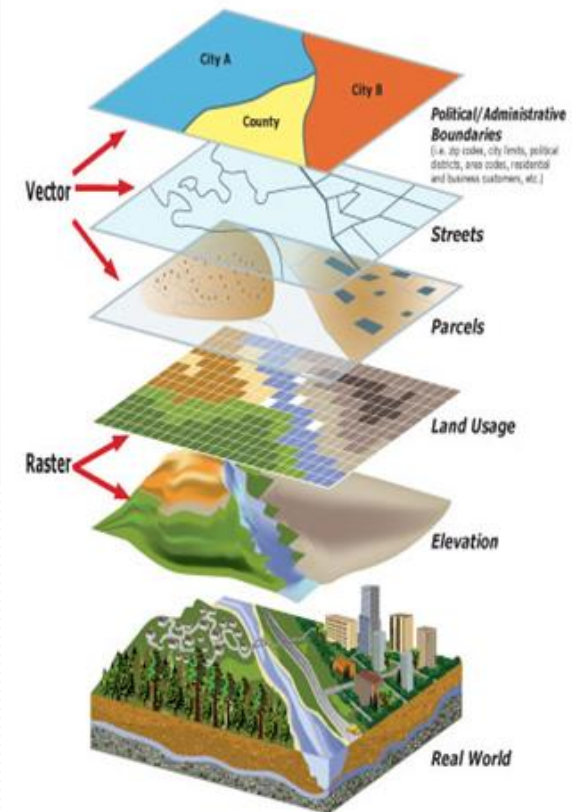
Geospatial- Its Applications In Weather Forecasting

What is GIS?

- G stands for geographic, so we know that GIS has something to do with geography.
- I stands for information, so we know that GIS has something to do with information, namely geographic information.
- S stands for system, so we know that GIS is an integrated system of geography and information tied together.

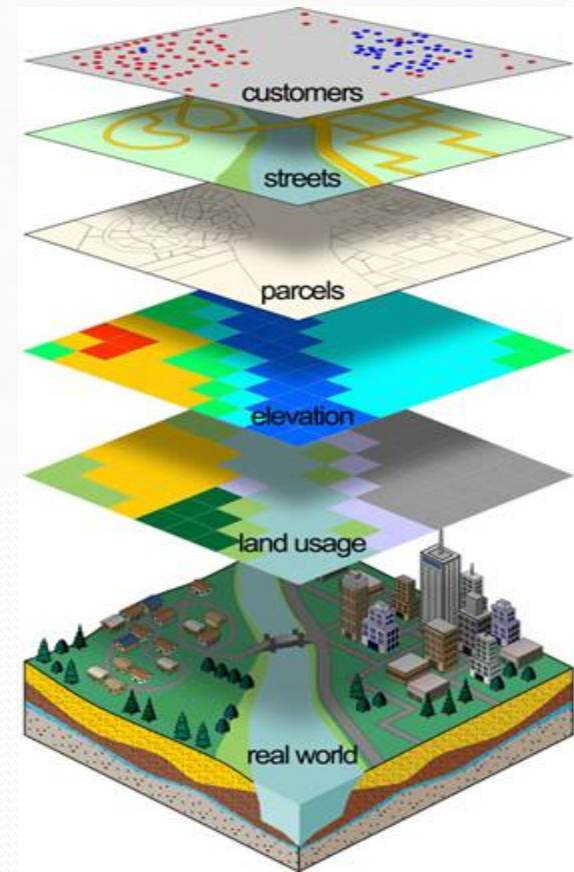
Geographical Information System

- A computer system for - collecting, - storing, - manipulating, - analyzing, - displaying, and - querying geographically related information.
- **GIS gives you the power to:**
 - Create maps.
 - Integrate Information.
 - Visualize scenarios.
 - Present Power ideas
 - Develop effective solutions



Operational Uses of Weather Information in GIS-based Decision Support Systems

- Personal Safety- allow location-based event notification of impending weather threats resulting in advanced warning time
- Energy
- Emergency Management
- Flood management
- Health issues
- Aviation.



So what exactly is a **GIS**?

Is it computer software?

Is it a collection of computer hardware?

Is it a service that is distributed and accessed via the Internet?

Is it a tool?

Is it a system?

Is it a science?

The answer to all these questions is,
“GIS is all of the above—and more.”

What GIS/Geospatial will do.....

To build up the Geospatial tool for **analysis, modeling** (interactively), **simulations** and **visualization** which allows us to make informed **decisions based on the importance** and priority of resources/observational data.

Impact-based Forecasting and Warning

High impact events do not recognize national boundaries. Flash floods, floods, landslides and drought, cyclones, heat/cold waves in particular, give rise to multiple casualties and significant damage to livelihoods and property. In order to significantly reduce losses, communities and individuals need to become more resilient through actions that integrate weather and climate information **in decision-making processes**.

Huge datasets which are generated from running weather forecasting systems present a challenge in terms of processing and presenting these data efficiently. However, once these models are put in place and are running, a large amount of data is generated. Displaying such a large dataset and converting it into meaningful information is demanding. Creation of an optimal database to store the data, automatic creation of high resolution meteorological and weather maps, interactive querying and visualization of the data is extremely challenging and is seldom addressed.

How.....& requisite conditions

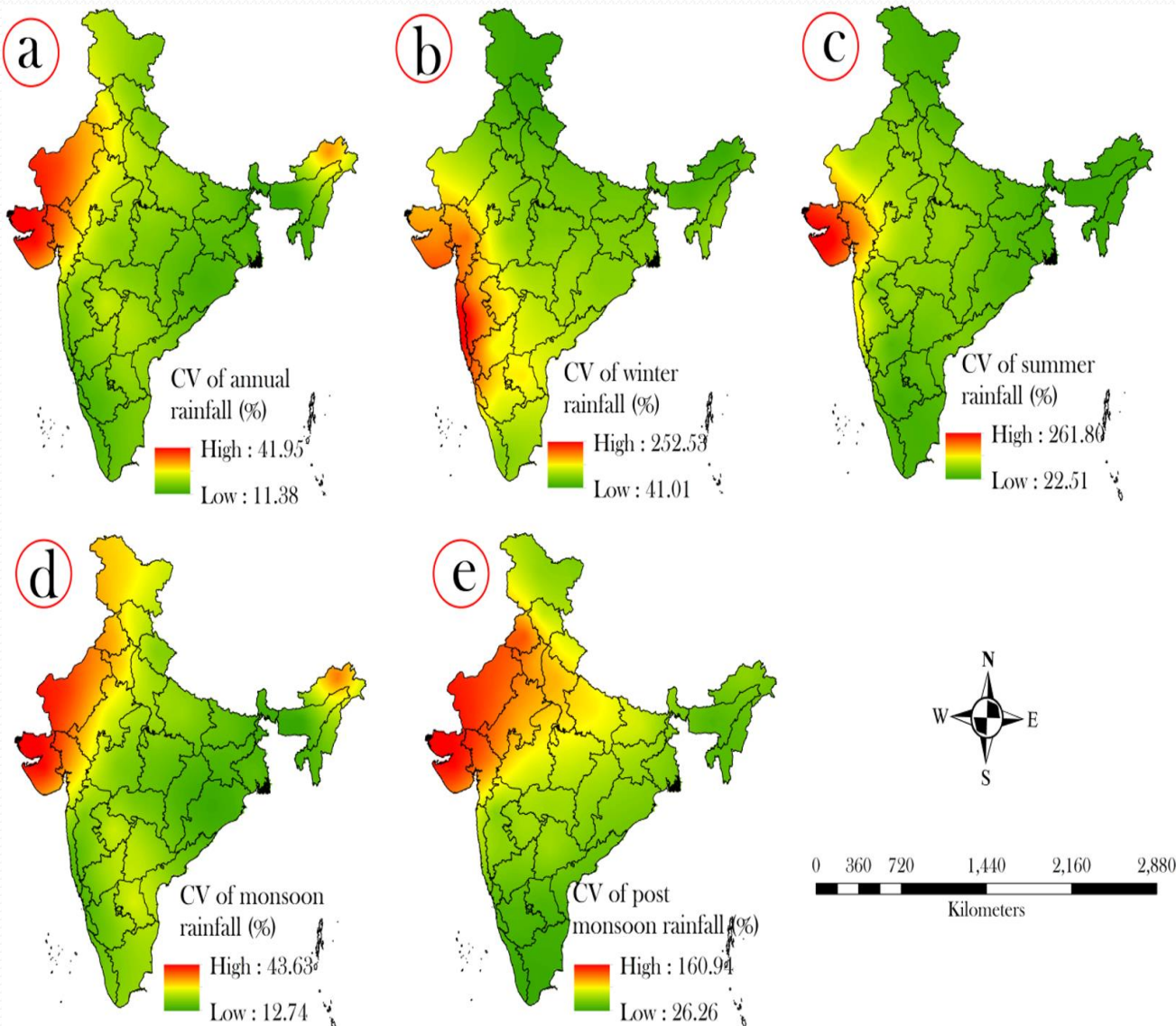
- ❖ To develop an application, for plotting, analysis, visualization, and interpretation of weather data, to serve as an aid in the **prognostication of weather**.
- ❖ Provision for superimposition of synoptic weather maps of the past with the present for tracking of movement of weather systems, computation of their persistence, tendencies and trends.
- ❖ Conditions:
 - ✓ Data sources have to be reliable, relevant, and trustworthy
 - ✓ Map rendering should be fast, and maps should be easy to publish
 - ✓ Map layers should be interactive to track dynamic changes
 - ✓ All data should be rapidly updated based on regular data flows
 - ✓ Maps should be smoothly integrated with other business apps



Geospatial Applications

Decision making process

Spatial mapping of variations of average annual and seasonal rainfall over India using GIS.



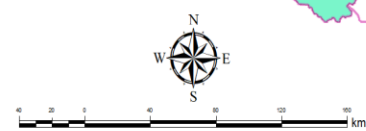
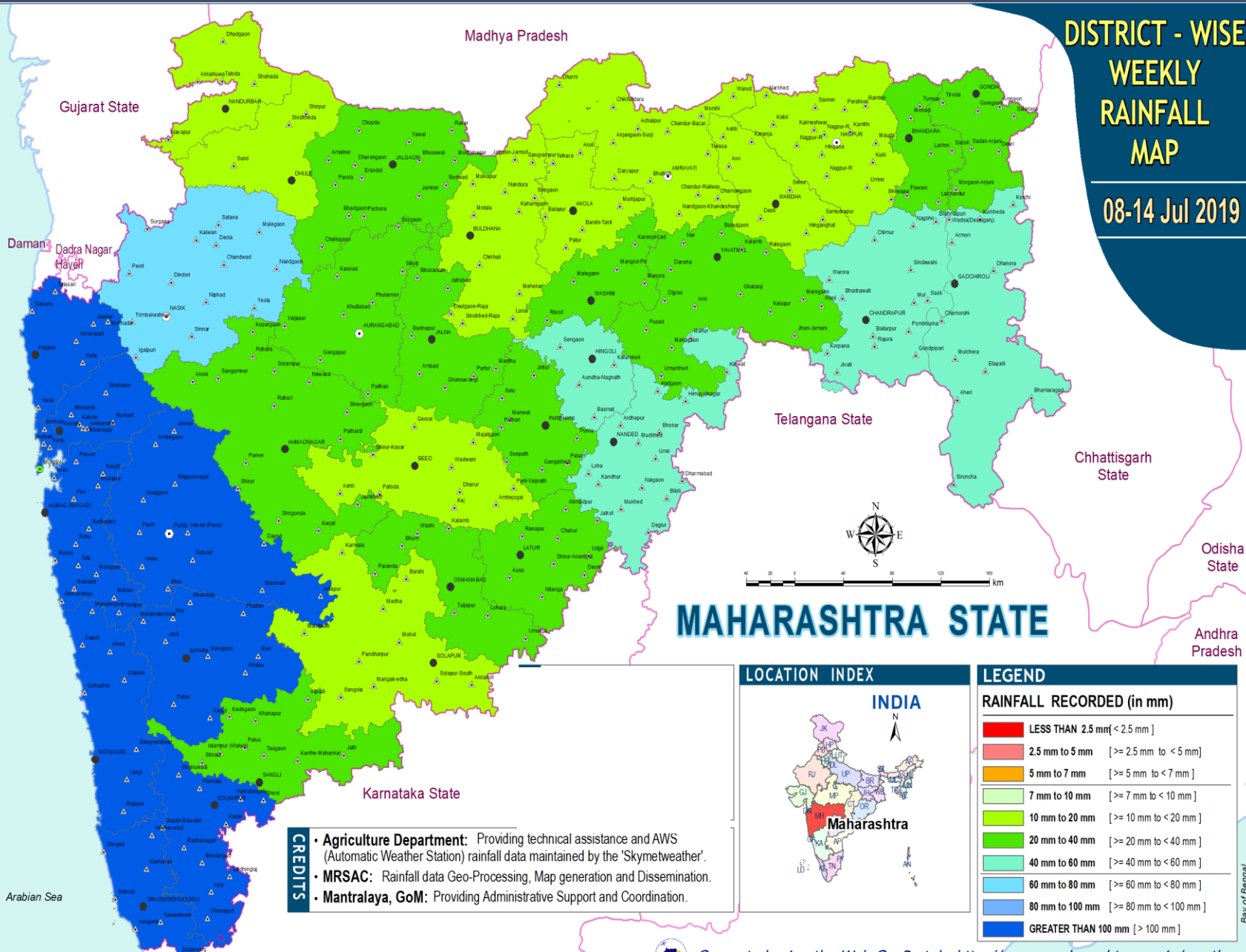
The findings of spatial mapping of rainfall variation showed that the meteorological sub-divisions of Western India were recorded highest rainfall fluctuations. The minimum rainfall fluctuation was registered in Assam and Meghalaya. [long-term Spatio-temporal changes in rainfall using the data from 1901 to 2015]



DISTRICT - WISE WEEKLY RAINFALL MAP - Maharashtra

DISTRICT - WISE WEEKLY RAINFALL MAP

08-14 Jul 2019



MAHARASHTRA STATE

LOCATION INDEX



LEGEND

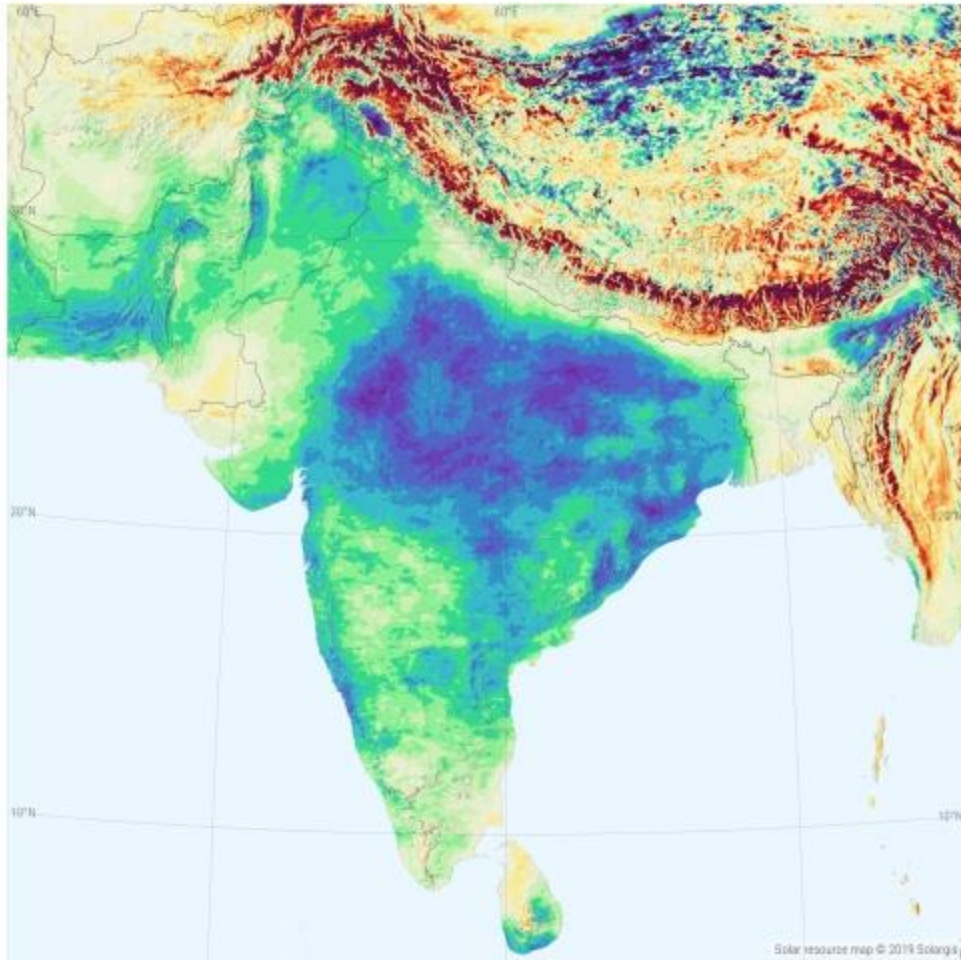
RAINFALL RECORDED (in mm)	
■	LESS THAN 2.5 mm [< 2.5 mm]
■	2.5 mm to 5 mm [>= 2.5 mm to < 5 mm]
■	5 mm to 7 mm [>= 5 mm to < 7 mm]
■	7 mm to 10 mm [>= 7 mm to < 10 mm]
■	10 mm to 20 mm [>= 10 mm to < 20 mm]
■	20 mm to 40 mm [>= 20 mm to < 40 mm]
■	40 mm to 60 mm [>= 40 mm to < 60 mm]
■	60 mm to 80 mm [>= 60 mm to < 80 mm]
■	80 mm to 100 mm [>= 80 mm to < 100 mm]
■	GREATER THAN 100 mm [> 100 mm]

- CREDITS**
- **Agriculture Department:** Providing technical assistance and AWS (Automatic Weather Station) rainfall data maintained by the 'Skymetweather'.
 - **MRSAC:** Rainfall data Geo-Processing, Map generation and Dissemination.
 - **Mantralaya, GoM:** Providing Administrative Support and Coordination.

Impact of solar resource variability

GHI difference 2019
Indian Subcontinent

SOLARGIS



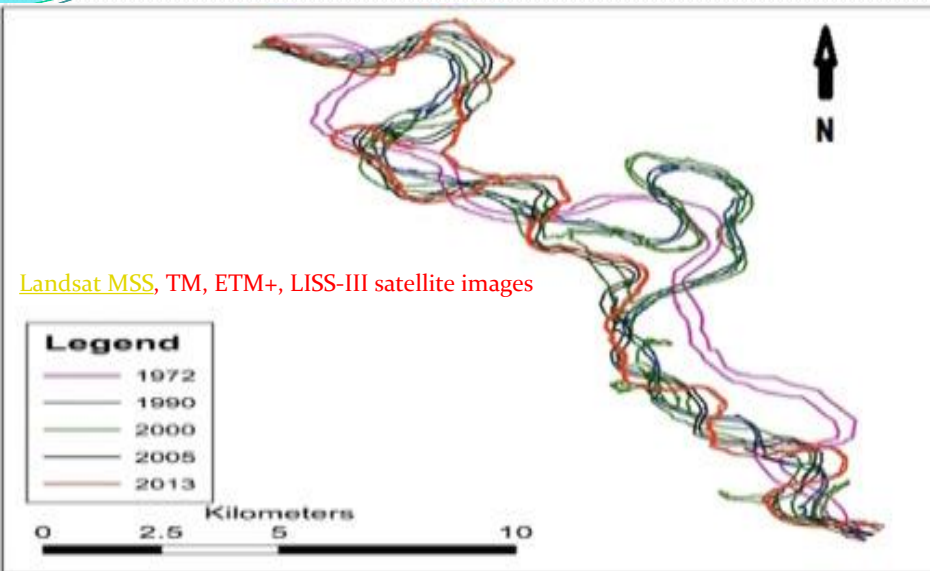
Global horizontal irradiation (GHI): Relative difference between 2019 and long-term average (LTA) of yearly totals from a period 1999-2018



Global Horizontal Irradiation (GHI) is the most important weather factor affecting the energy production of solar photovoltaic power plants. Therefore, having reliable information on recent values of GHI is critical for understanding whether your solar portfolio is performing optimally or not.

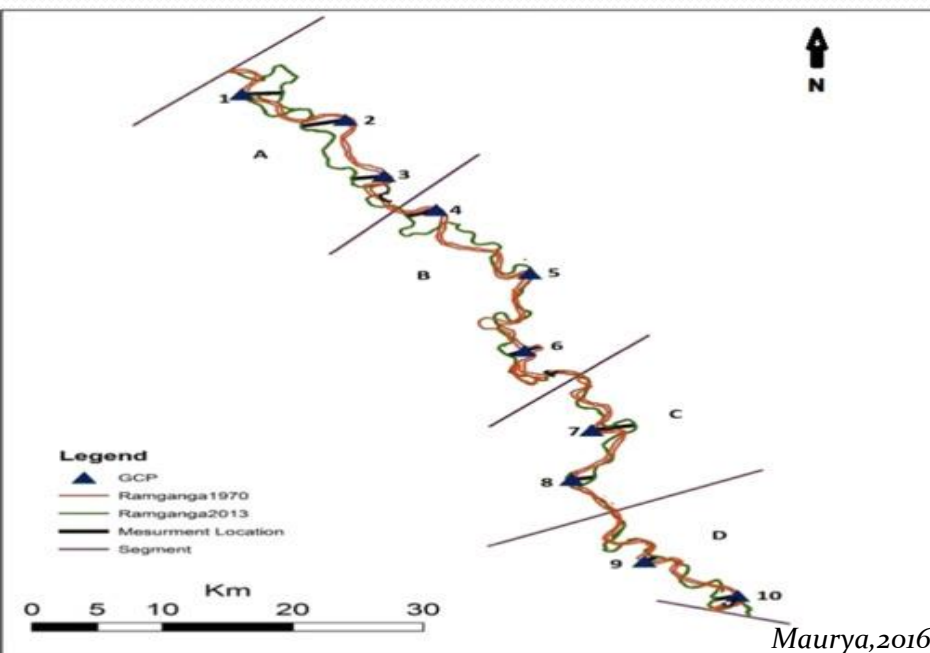
Maps showing recent values can be used as a preliminary and approximate reference, and they can help identify the need for running a more detailed energy assessments:

Course change detection of river using remote sensing and GIS



River course change is a natural phenomenon which takes place majorly due to flood occurrence. Rivers flowing downhill, from river source to river mouth, do not necessarily take the shortest path.

It is clear that the maximum river course changed in B segment.

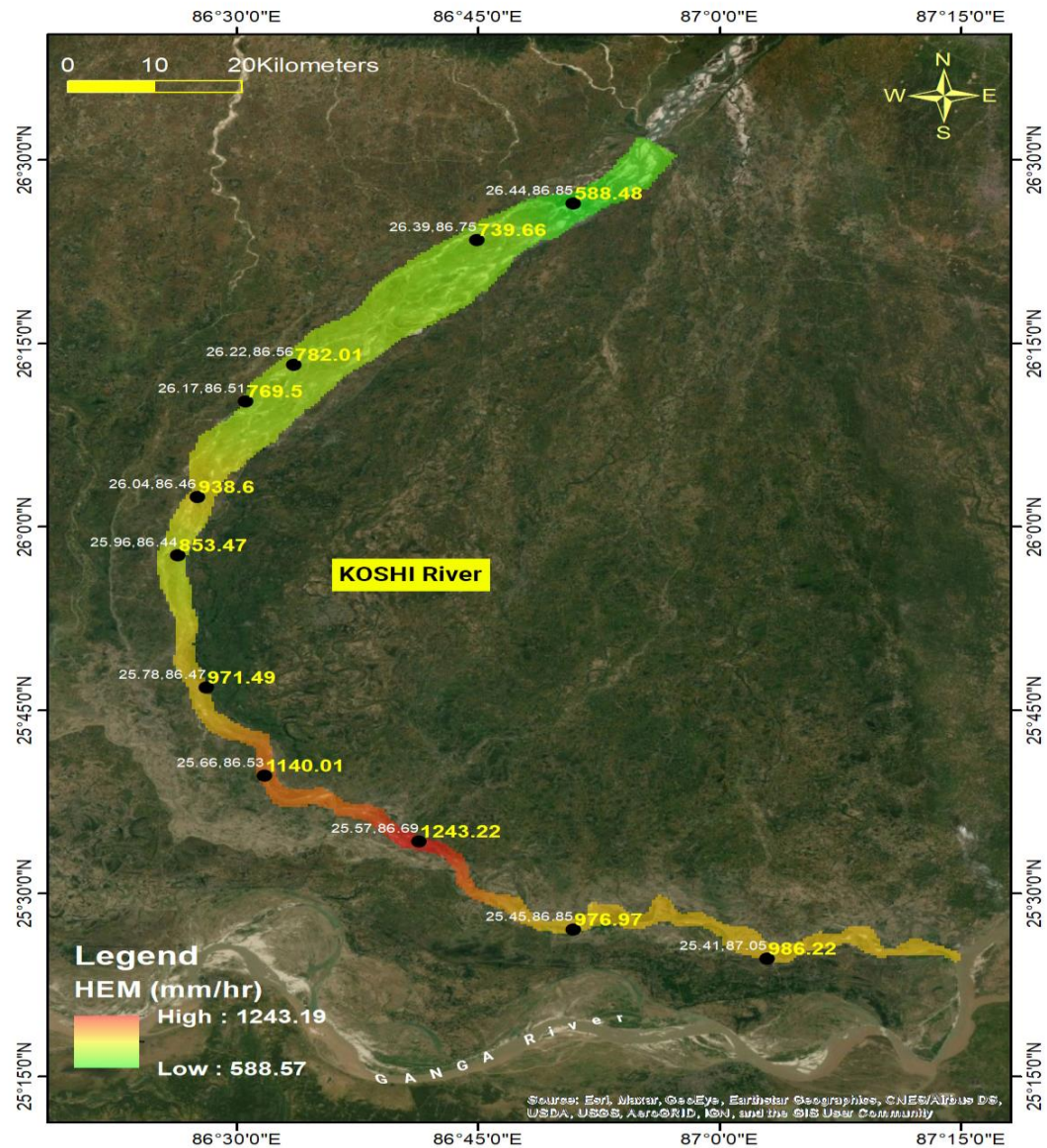


The Ramganga river course has been shifting and the overall shifting is towards the southwest direction in different places which leads to the village erosion.

This study may be helpful for the overall river management and planning for future prevention of food, changing coursing, loss of properties.

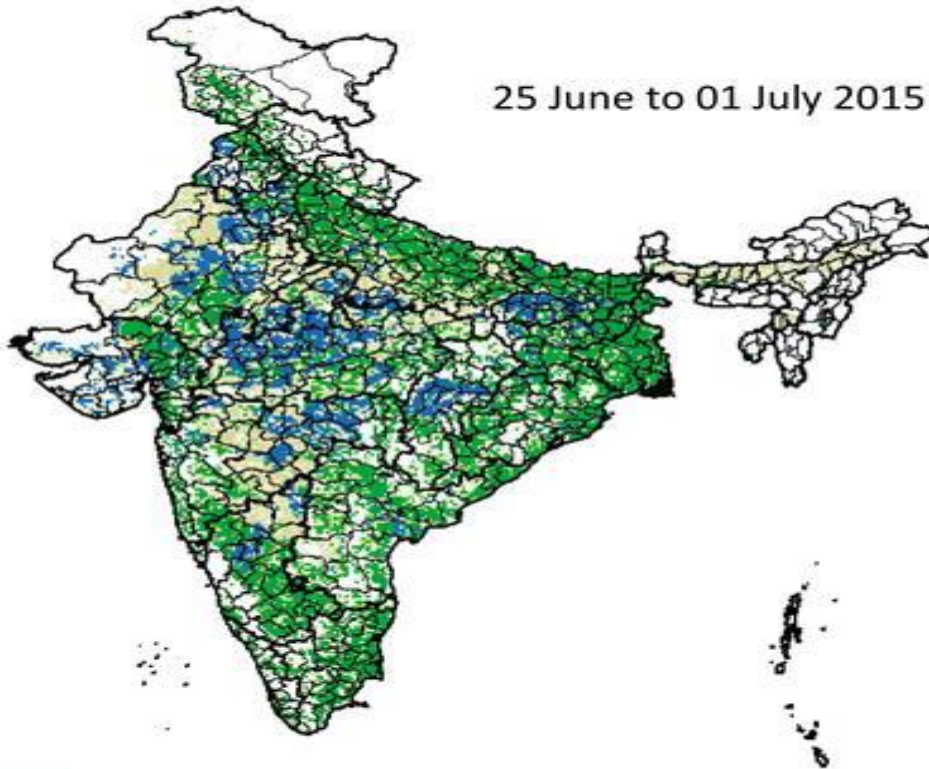
KOSHI river on GIS using INSAT3DR data :

Monsoon 2020



Sowing Suitability using INSAT and AMSR-2 data

25 June to 01 July 2015



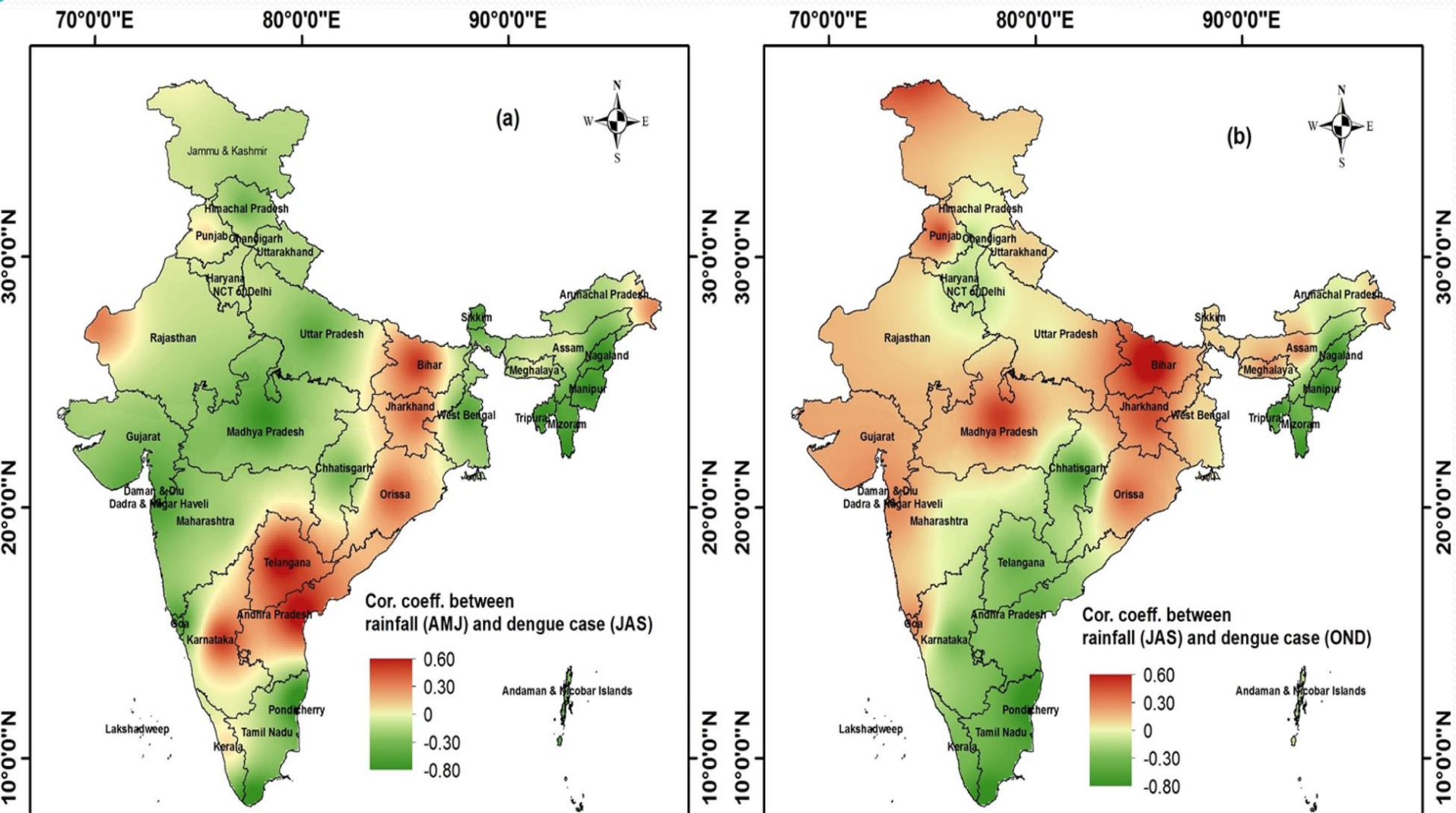
- Probably sown area
- Conducive area for sowing
- Permanent agricultural area

भारत मौसम विज्ञान विभाग INDIA METEOROLOGICAL DEPARTMENT



- LEGEND:
- EXCESS (+20% OR MORE)
 - NORMAL (+15% TO -15%)
 - DEFICIENT (-20% TO -50%)
 - SCANTY (-60% TO -99%)
 - NO RAIN (-100%)
 - NO DATA

El Niño Southern Oscillation as an early warning tool for dengue outbreak in India



Relationship between (a) rainfall index (April, May, June) and dengue case index in monsoon season (July, August, September); (b) rainfall index (July, August, September) and dengue case index in post-monsoon season (October, November, December).

Cyclone Track

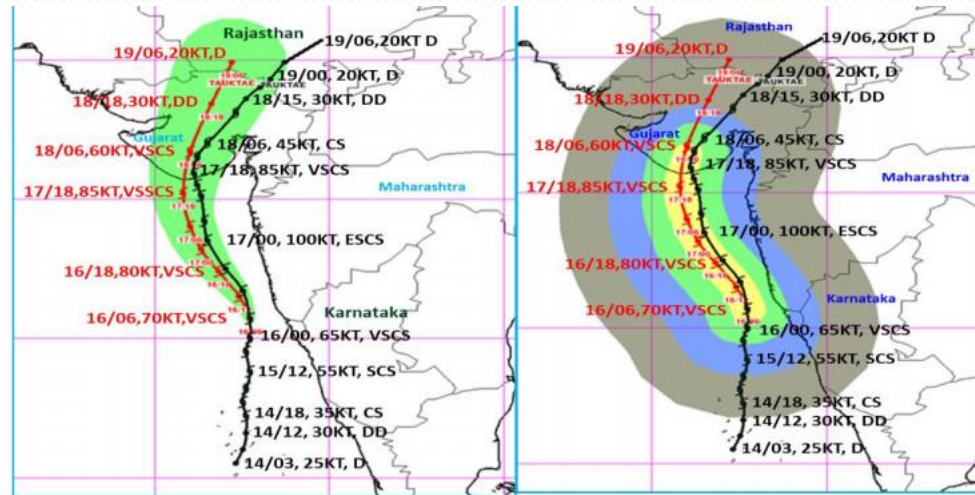


Fig.8 (a-b): Observed track (14-19 May) and forecast track issued at 1430 hours IST of 16th May based on 1130 hrs IST observations of 16th May (**about 36 hours prior to landfall**) demonstrating accuracy in track, intensity and landfall.

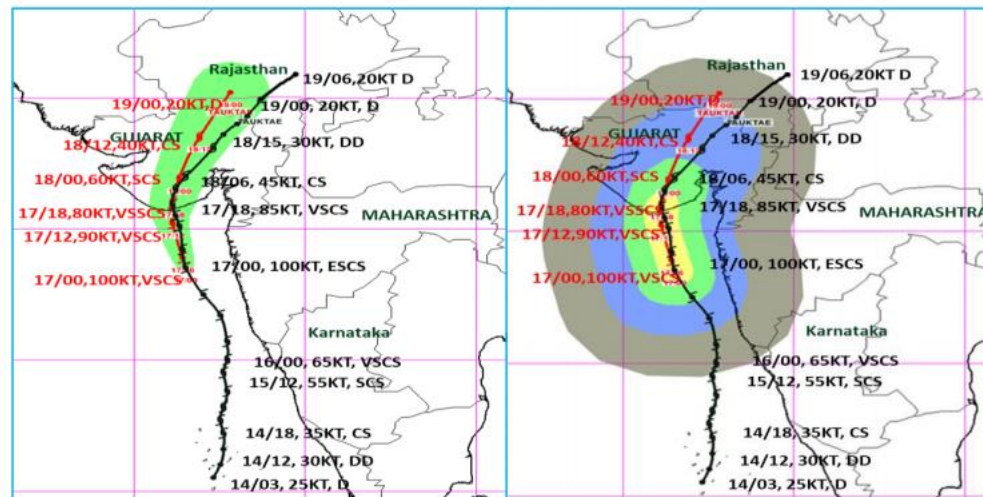


Fig.9 (a-b): Observed track (14-19 May) and forecast track issued at 0830 hours IST of 17th May based on 0530 hrs IST observations of 17th May (**about 15 hours prior to landfall**) demonstrating accuracy in track, intensity and landfall.



IMD`s Initiative in GIS

Formation and tasks assigned (Nov. 2020)

File No.DGM/Sectt./05/2019
India Meteorological Department
Ministry of Earth Sciences
Mausam Bhawan, Lodi road,
New Delhi-110003

Dated-November, 2020

Office Order

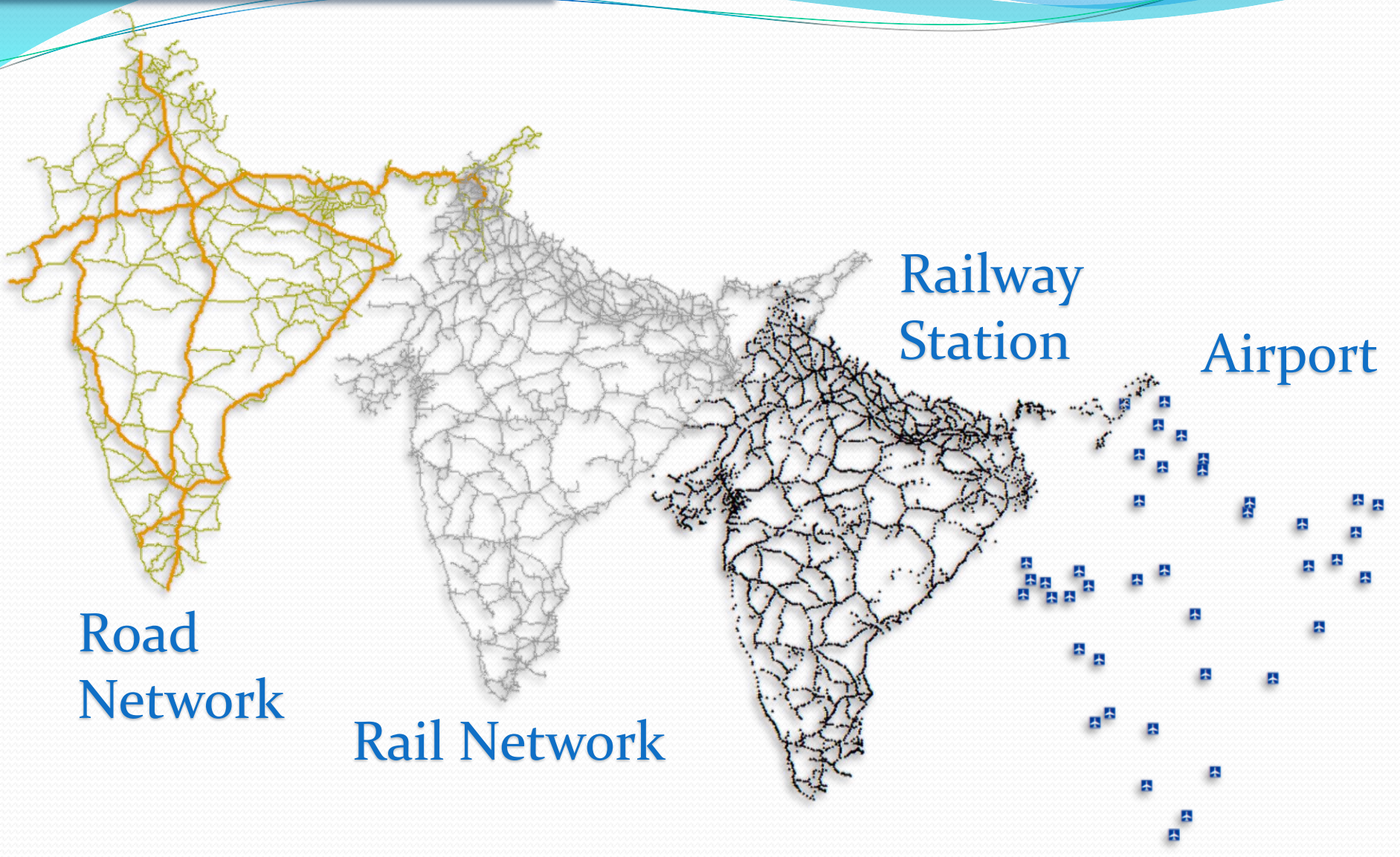
In order to enhance the capabilities related to the use of geospatial technologies in observations and various forecasts and warnings the competent authority has constituted the following functional group on Geospatial Applications

- | | |
|--|---------------------|
| 1. Dr. A.K.Mitra, ScE(Satmet Division) | - Group Head |
| 2. Shri Sankar Nath, Sc E (ISSD) | - Member |
| 3. Ms. Arpita Rastogi, Sc-C (UAID) | - Group Coordinator |
| 4. Shri Gaurav Sharma, Project Sc-C(AASD) | - Member |
| 5. Dr. Shailesh Parihar, Project Sc-B(Satmet Division) | - Member |
| 6. Shri Abhimanyu Chauhan, Project Sc-B (Satmet Division) | - Member |
| 7. Shri Anshul Chauhan, Project Sc-B (UAID) | - Member |
| 8. Ms. Deepashri Paul, SA (RMC New Delhi) | - Member |
| 9. Ms. Rhythm Naswa, SA(UAID) | - Member |
| 10. Shri Avisek Hazra, SA (RMC Kolkata) | - Member |
| 11. Ajay Kumar Maurya, SA (RMC, Guwahati) | - Member |
| 12. Ashwini Kumar Prasad, SA (CRS Pune) | - Member |
| 13. Shri Pankaj Kumar, SA (RMC Chennai) | - Member |
| 14. Ms. R.V.Deepa, SA (RMC Chennai) | - Member |
| 15. Shri Nusrat Ullah, JRF(EMRC) | - Member |
| 16. Ms. Saloni Joshi, JRF(AASD) | - Member |

17. Mr Shivendra, Sc-C, Chandigarh
18. Mr Manish, Sc-C, Lucknow
19. Dr. Kuldeep Srivastava, Sc-E,ISSD
20. Mr. Manik, Sc-C, Hydology

1. The said group will work for hosting the following in GIS platform
 - i. Observational products (viz.,Max/Min temperature, hourly/three hourly/cumulative rainfall, relative humidity, wind speed, wind direction, thunderstorm, hailstorm, squall, lightning etc).
 - ii. Climatological products (viz., Max/Min temperature, rainfall, relative humidity, wind speed, wind direction, thunderstorm, hailstorm, squall, lightning etc).
 - iii. Preparation of hazard map.
 - iv. GFS,WRF, GEFS and HWRF model products.
 - v. Meteograms/EPsgram at each grid point.
 - vi. City forecasts, district level forecasts, marine forecasts, cyclone warning, coastal area bulletin, sea area bulletins, fisherman warnings, port warnings etc).
 - vii. Forecast products for Tourism, Highway, Railway, Energy, Health etc .
 - viii. Layering of informations.
2. The said group will work / interact through VC / Physical meeting and e-mail etc. on regular basis.
3. Quarterly progress report of the group will be submitted by the Group Head to the competent authority.
4. All the above officials will work in this group in addition to their normal duties.
5. Group head can co-opt any new members, if required.
6. All concerned divisions/sub offices should coordinate and provide the requirements to the group.

Database Update



Road Network

Rail Network

Railway Station

Airport

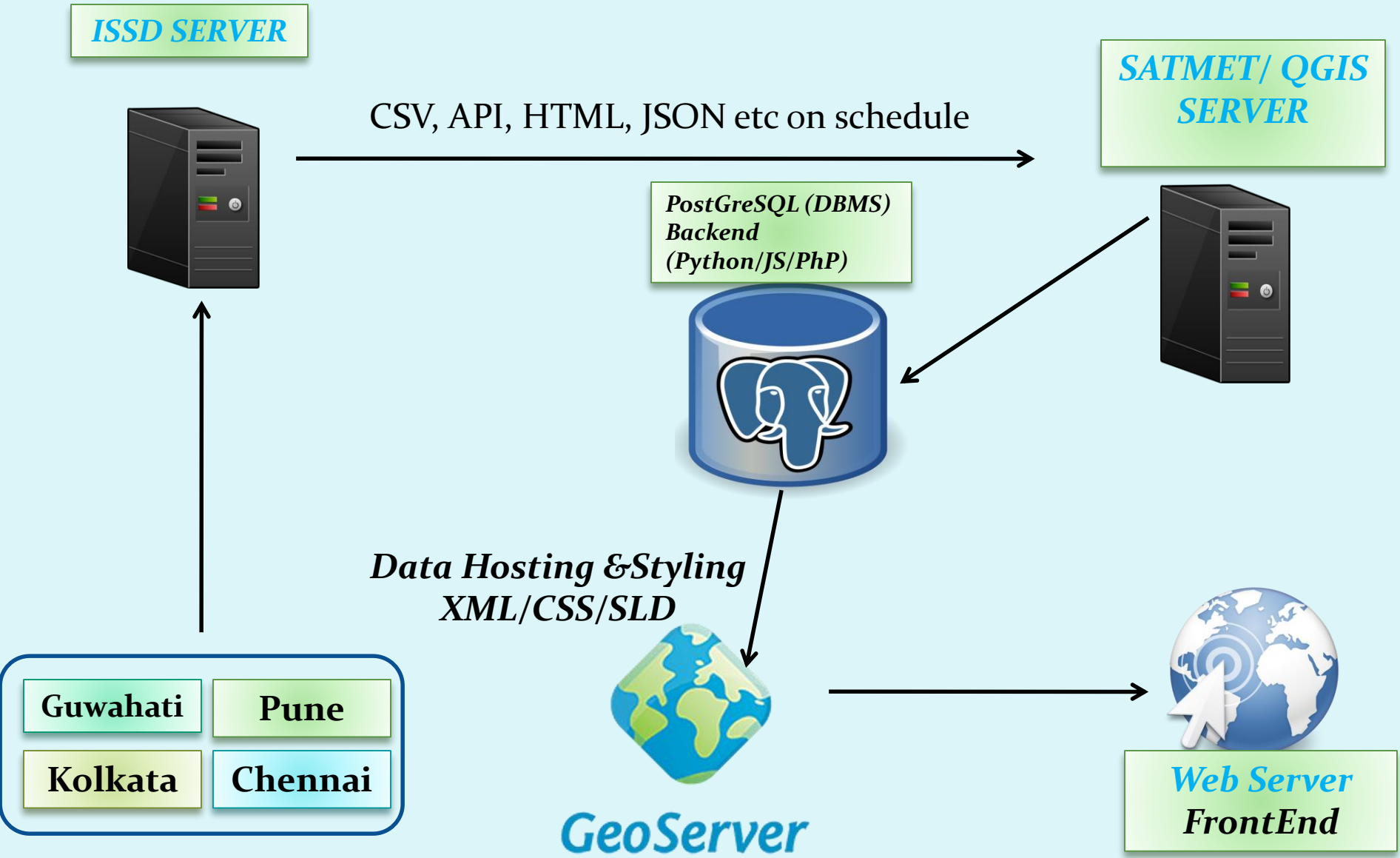
IMD Geo-Spat Specifications

Architecture	: Built on GeoServer with multiple plug-ins from QGIS, ArcGIS and many more.
Development	: Backend : Python, Php, Frontend : Bootstrap,html, js, MATLAB
Database	: PostGreSQL, PostGIS Can be incorporated with MySQL, Oracle in future
Operating System	: Cross platform Support
Customization	: Web Based

Features of Geo-Spat

- ✓ Various data support
 - CSV, SHP, JSON, TIFF, IMG, PNG, JPEG, HTML,HDF,nc
- ✓ Display and Navigation tools
 - Zoom in, Zoom out
- ✓ Selection tools
- ✓ Legend / Labeling
 - Single Symbols, Quantities and Unique Values
- ✓ Layer Management
 - On/Off Layers

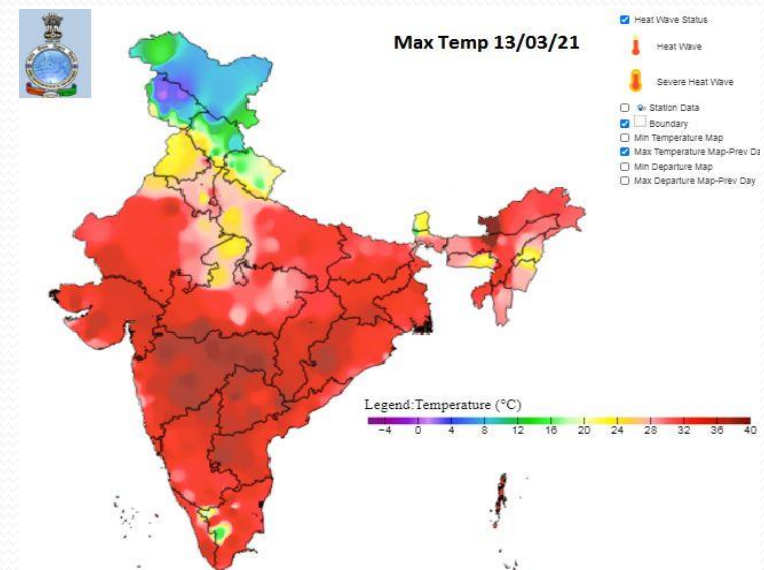
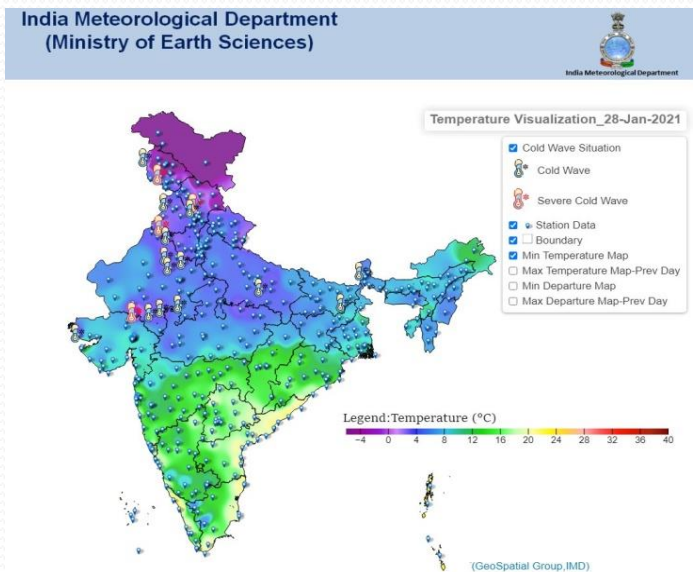
IMD Geo-Spat Architecture



GIS based Temperature Maps dedicated to temperature visualization for following parameters:

- Minimum Temperature
- Maximum Temperature
- Minimum Departure
- Maximum Departure
- Heat wave and warm nights
- Cold Wave and Cold Day

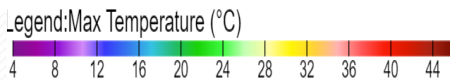
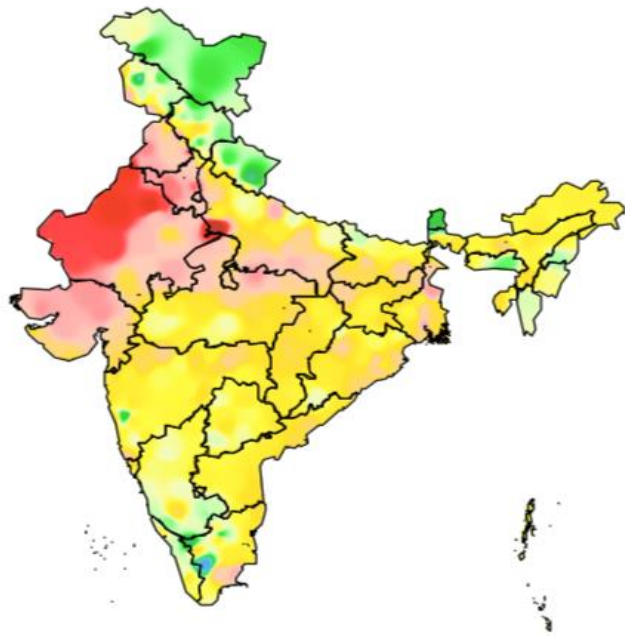
➤ Single Map page is able to cover all the above parameters with Visualization done for Present Date & 5-Days Forecast .



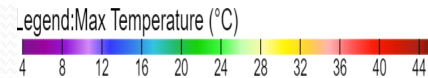
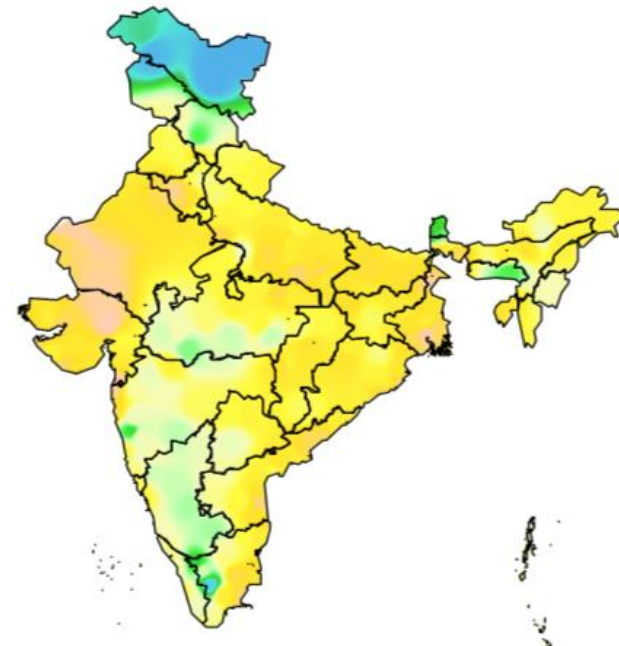
Impact Based Temperature Maps

Minimum and Maximum Temperature shows progress of Summers and Winters over Indian Peninsula:

Maximum Temperature Map



Minimum Temperature Map



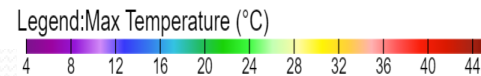
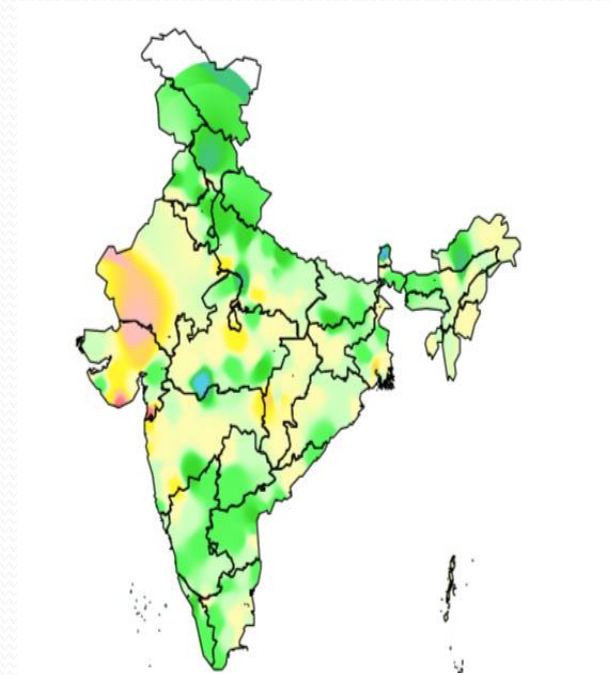
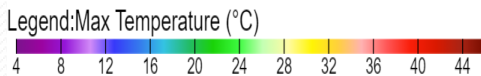
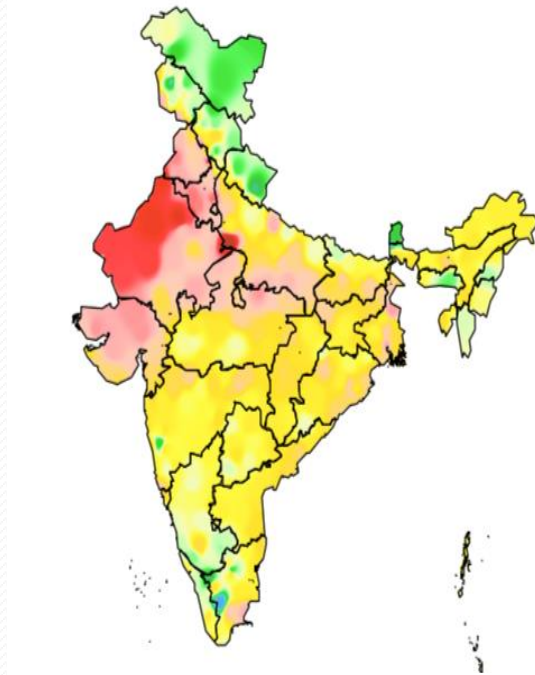
Impact Based Temperature Maps

- Minimum and Maximum Departure Temperature Maps are used to find the maximum and minimum anomalies from normal for a particular period.

This plays Pivotal role in declaration of Cold Waves & Heat Wave .

Maximum Temperature Departure Map

Minimum Temperature Departure Map



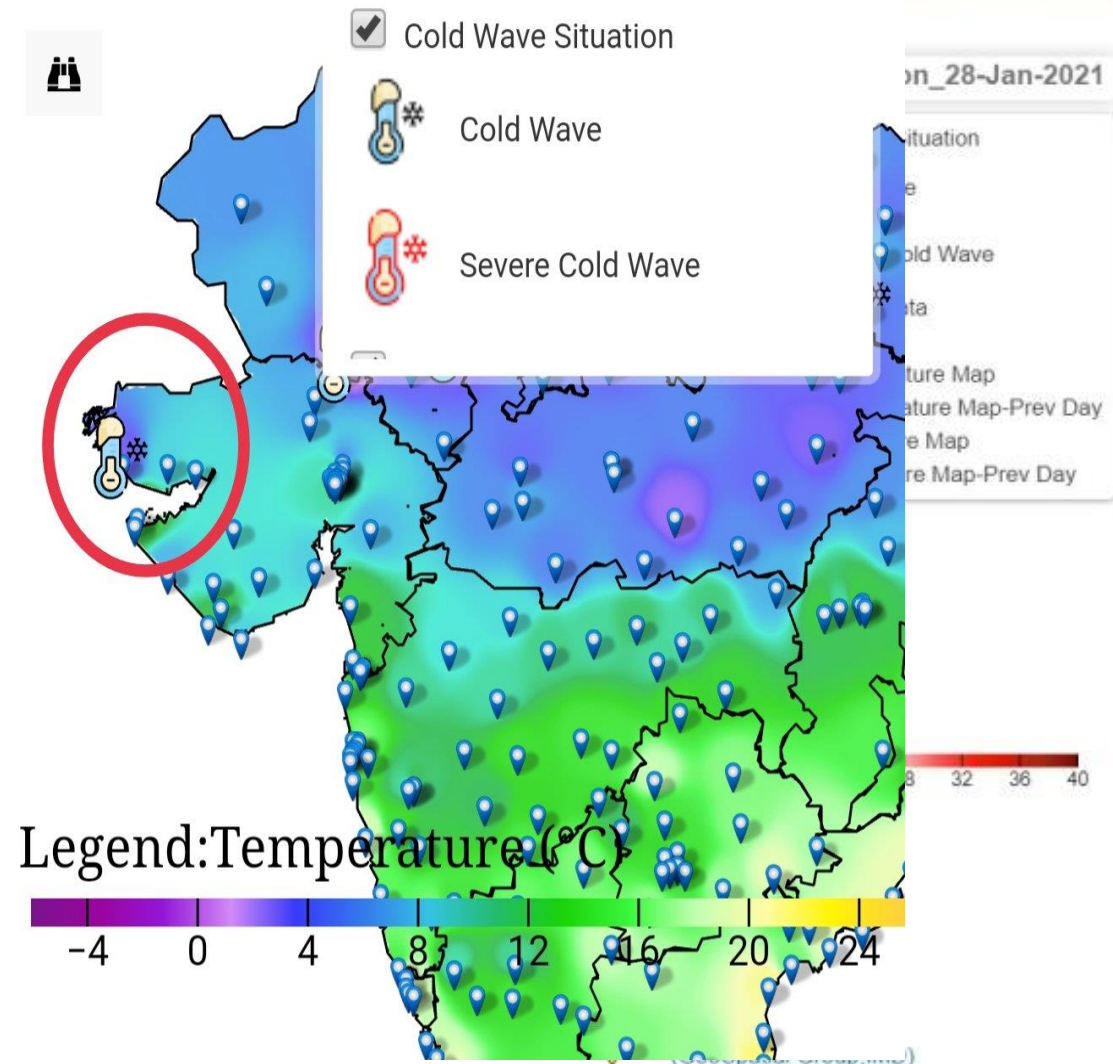
Imp

India Meteorological Department
(Ministry of Earth System Sciences)

Temperature Visualization_30-Jan-2021

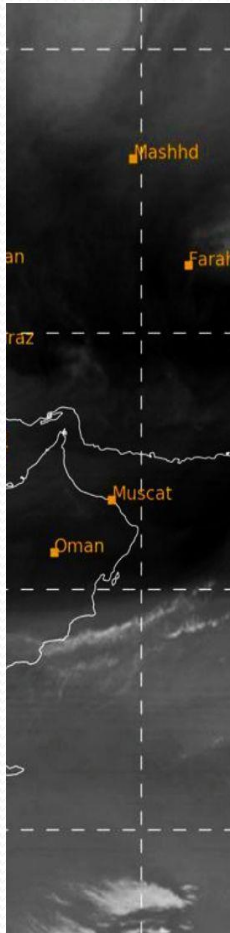


Impact based



Warning

Discomfort over Northwest India due to high temperature and humidity is well brought out by [#Geospatial](#) map of maximum temp/departure with dry upper level



PIB India
@PIB_India

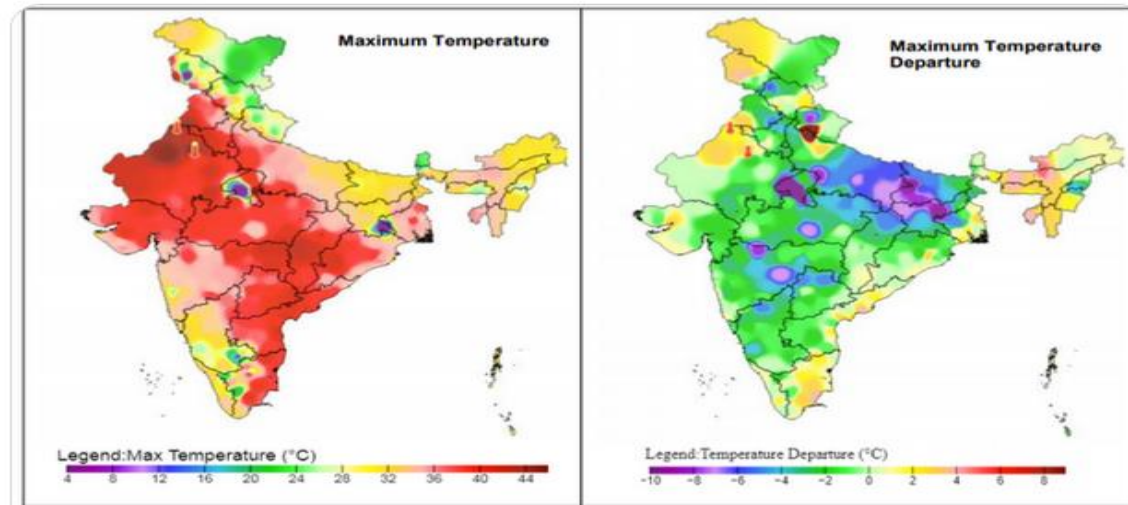
[#WeatherUpdate](#)

No Heat Wave Conditions likely over the country

Heat Wave conditions were observed in some pockets over West [#Rajasthan](#), yesterday

static.pib.gov.in/WriteReadData/...

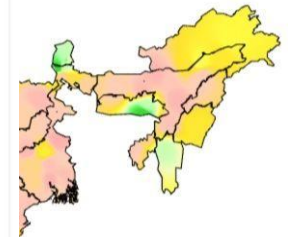
Read here: pib.gov.in/PressReleasePa...



Mausam Bhawan, Lodi Road, New Delhi – 110 003
Phones: 24611068, 24618241-47; Fax No. 24699216, 2423220, 24643128

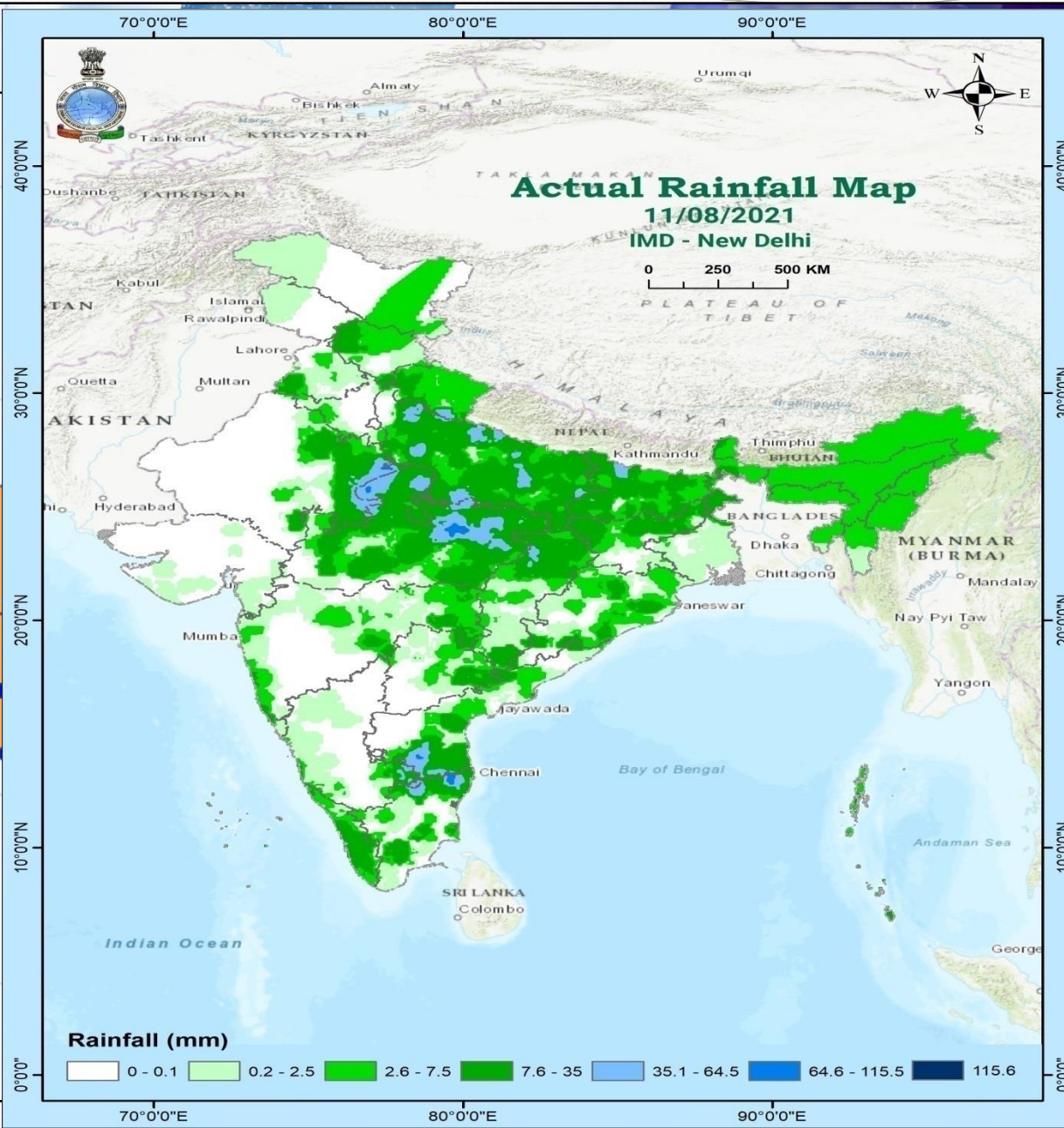
India Meteorological Department and 2 others

5:48 PM · May 31, 2021 · Twitter Web App

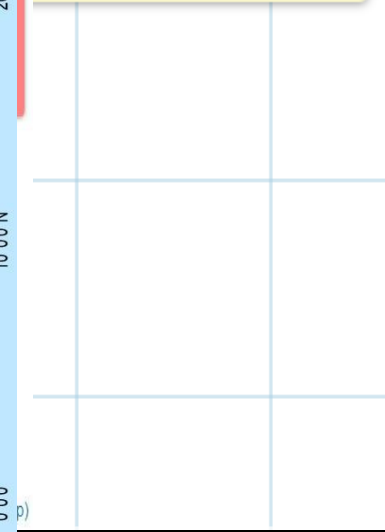
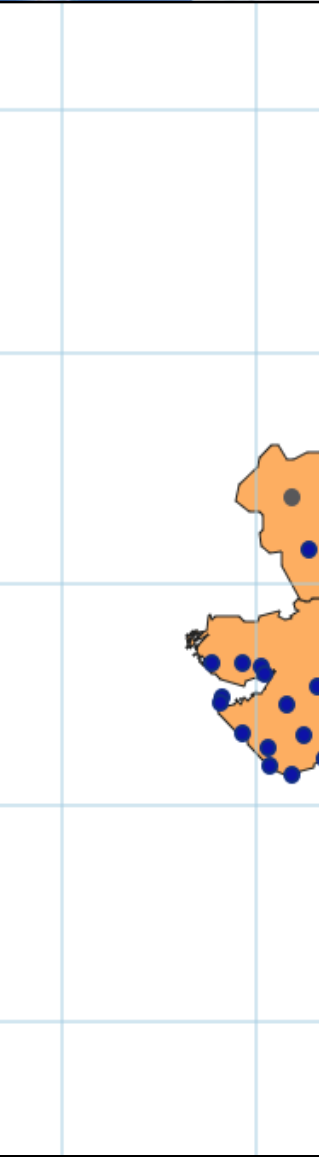


np 25/06/2021

3 Hourly/24 Hourly/Cloudiness



ll 3 Hourly (mm)
 pell (upto 10 mm/hr)
 ate Spell (10 - 20 mm/hr)
 r Spell (20 - 30 mm/hr)
 tense Spell (30 - 50 mm/hr)
 e Intense Spell (50 - 100 mm/hr)
 ionally Heavy Spell (>100 mm/hr)
 ness
 l SKY
 Y CLEAR SKY
 Y CLOUDY
 RALLY CLOUDY
 Y
 _10m_graticules_5
 lia_State_Boundary





Development of Web-GIS Display for **NWP Models**

BASIC PRODUCT AND DATA DETAILS

- In NWP Web-GIS Display three different models are used as of now.
 - 1.GFS
 - 2.NCUM
 - 3.IMD-WRF
- Three Parameters has been tested.
 - 1.24 Hr Accumulated Rainfall
 - 2.Tmax
 - 3.Tmin
- GFS and NCUM model data has been utilized for 5 days and IMD-WRF For three days.
- Currently GFS and NCUM has 15 layers each (5days X 3 variables= 15)& IMD-WRF has 9 Layers(3 days X 3 variables=9).
- Model data format: grib2 and netcdf.

GFS Model-

- 1) Initially updated daily 5 days forecast layer
- 2) Generating and publishing huge file in Geoserver using Phisnet of GFS (12.5KM)
- 3) All geodata frames are updated daily in PostGIS and then the layer is published automatically in GeoServer..
- 4) In this way all the daily 15 layers of GFS model of Rainfall, Tmax and Tmin are shown on the web and can be updated in future

NCUM Model-

- 1) Initially updated daily 5 days forecast layer
- 2) Generating and publishing huge file in Geoserver using Phisnet of GFS (10 KM)
- 3) All geodata frames are updated daily in PostGIS and then the layer is published automatically in GeoServer..
- 4) In this way all the daily 15 layers of GFS model of Rainfall, Tmax and Tmin are shown on the web and can be updated in future

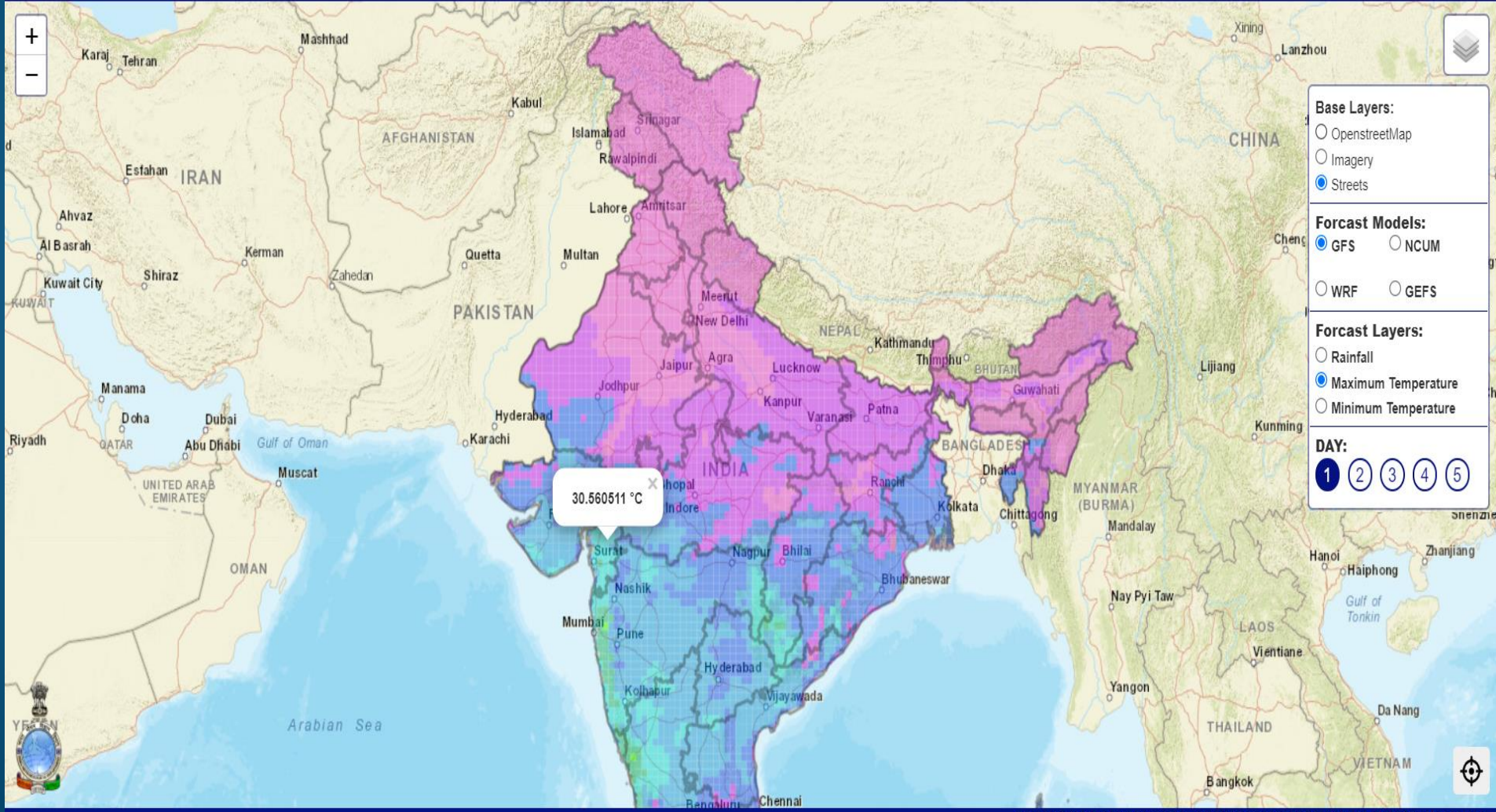
Further Enanchmnet –(Advantage of Phisnet and publish layer on Geoserver)

- 1) With the number of models, its parameters can also be increased.
- 2) update forecast layer 3 and 6 hourly based on Requirement of Model.
- 3) High resolution model forecasts can also be visualize.

Multilayer model (GFS and NCUM) Forecast in GIS Platform for Rainfall, TMAX and TMIN



INDIA METEOROLOGICAL DEPARTMENT (MINISTRY OF EARTH SCIENCES) INTERACTIVE MAP FOR MODELS FORECAST



Multilayer model (GFS and NCUM) Forecast in GIS Platform for Rainfall, TMAX and TMIN

GFS Model

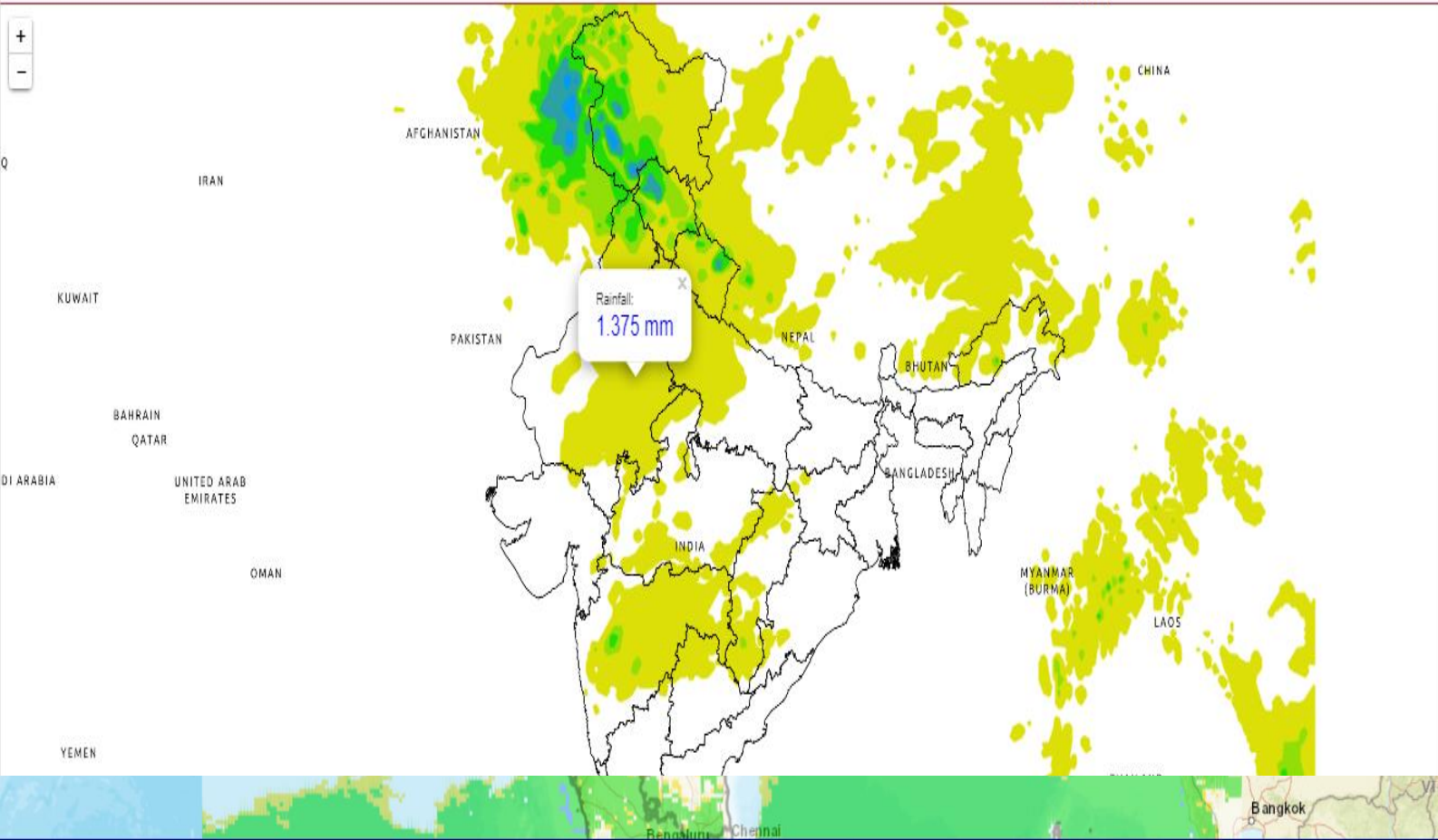
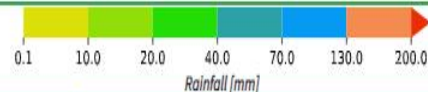
Home / NWP

Rainfall Temperature Max Temperature Min

2021-03-23 UTC00 + 1d : 2021-03-23 [UTC00-24]

Latitude: 27.074 Longitude: 75.735

Rainfall: 1.375 mm



rs:
etMap

Models:
 NCUM
 GEFS

ayers:
n Temperature
1 Temperature

3 4 5

Zhanjiang
ong
Da Nang
Bangkok
VIETNAM

AGRO-GIS COMPONENT

- 1) Direct and value added forecast[Rainfall, Tmax, Tmin, RHI, RHII, Wind speed, Wind Direction and Cloud cover] at District Level .
- 2) Crop specific Advisory at District Level in Regional and English Language.
- 3) Nowcast for next 3 hours. At District Level.
- 4) Warning at District Level for next 5 Days.

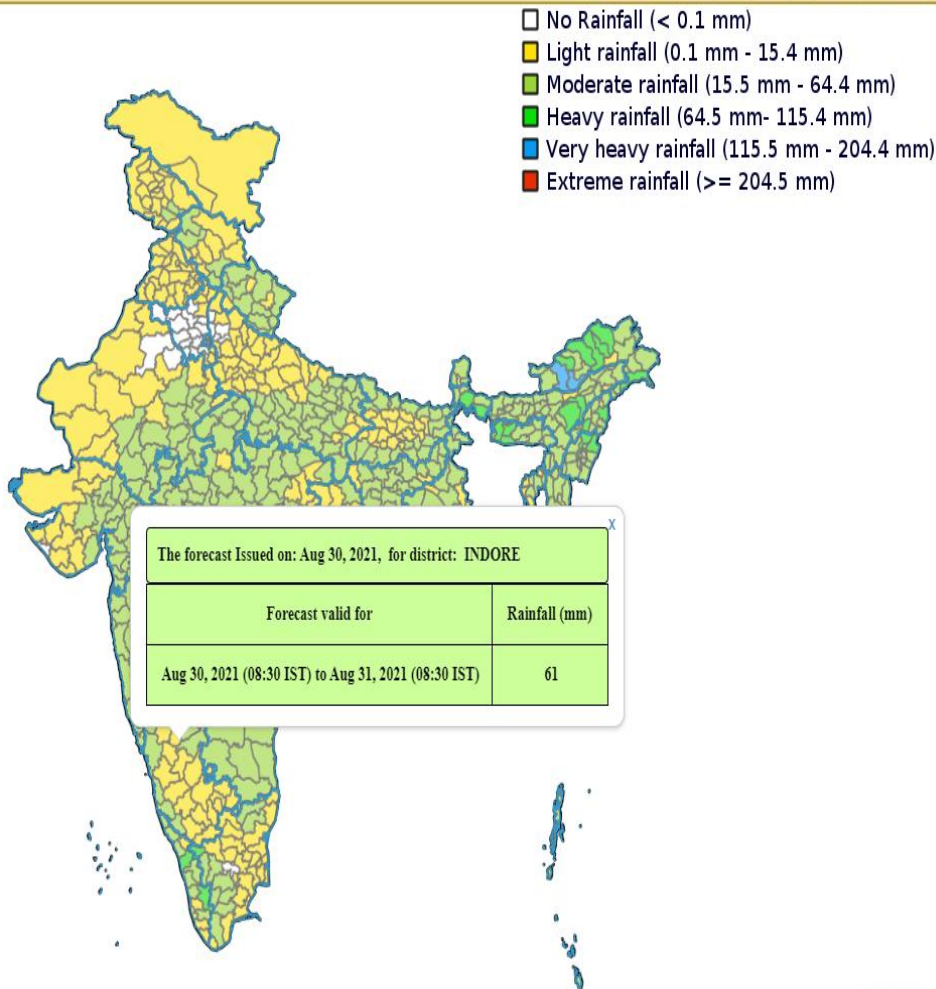


Components: Agromet Forecast, advisory, nowcast and warning in GIS Layers

WEATHER FORECAST | CROP ADVISORY | NOWCAST | WEATHER WARNINGS

Rainfall | Temperature (Max) | Temperature (Min) | Cloud Cover | Wind | Humidity (Max) | Humidity (Min)

Day 1 | Day 2 | Day 3 | Day 4 | Day 5



- GFS Model Forecast and Value added as Tuesday and Friday (Twice in Week)
- Crop advisory in English and Regional
- Nowcast for next 3 hours
- Warning for next 5 days



Crop Specific Advisory

WEATHER FORECAST CROP ADVISORY NOWCAST WEATHER WARNINGS

English Regional



Untitled - Google Chrome
about:blank

[DOWNLOAD ADVISORY \(PDF\)](#)

The crop advisory issued on: Aug 27, 2021, for next 5 days of district: BUHRHANPUR

Crop	Advisory
SOYABEAN	सोयाबीन फसल में फूल लगने की अवस्था में इल्लियों द्वारा फूलों के खाने से अफलन की स्थिति से बचाने हेतु सलाह है की लैम्डा सायहेलोथ्रिन 4.90 एस.सी. (300 मिली/है.) या इन्डोक्साकार्ब 15.8 ई.सी. (333 मिली/है.) या फ्लूबेंडियामाइड 39.35 एस.सी. (150 मिली/है.) या स्पायनेटोरम 11.7 एस.सी. 450 मि.ली. या क्लोरएन्ट्रानिलिप्रोल 18.5 एस.सी. (150 मिली/है.) का छिड़काव करें ।
COTTON	कपास की फसल में कुछ पौधे मुरझाते हुए घेरे-घेरे में दिखाई देने पर उसमें कार्बन्डाजिम 1 ग्राम या कॉपर आक्सीक्लोराइड 3 ग्राम प्रति लीटर पानी के हिसाब से टोहा दें ।

Highway Navigation Feature and Forecast

Bhopal, Madhya Pradesh, 462001, India

Ahmedabad, Ahmadabad City Taluka, Ahmedabad Di

Clear +

Open/Close

Station_Name	Min_Temp	Max_Temp	Weather
Ahmedabad-Navrangpura (I)	38.7	40.0	Mainly Clear sky
Ahmedabad-Rakhiyal	38.5	40.0	Mainly Clear sky
Ahmedabad-Chandkheda	39.1	40.0	Mainly Clear sky
Ahmedabad-Satellite Area (I)	38.5	40.0	Mainly Clear sky
Ahmedabad-Ambli-Bopal	39.2	40.0	Mainly Clear sky
Ahmedabad-Raikhad	38.4	40.0	Mainly Clear sky
Ahmedabad-Pirana	38.6	40.0	Mainly Clear sky

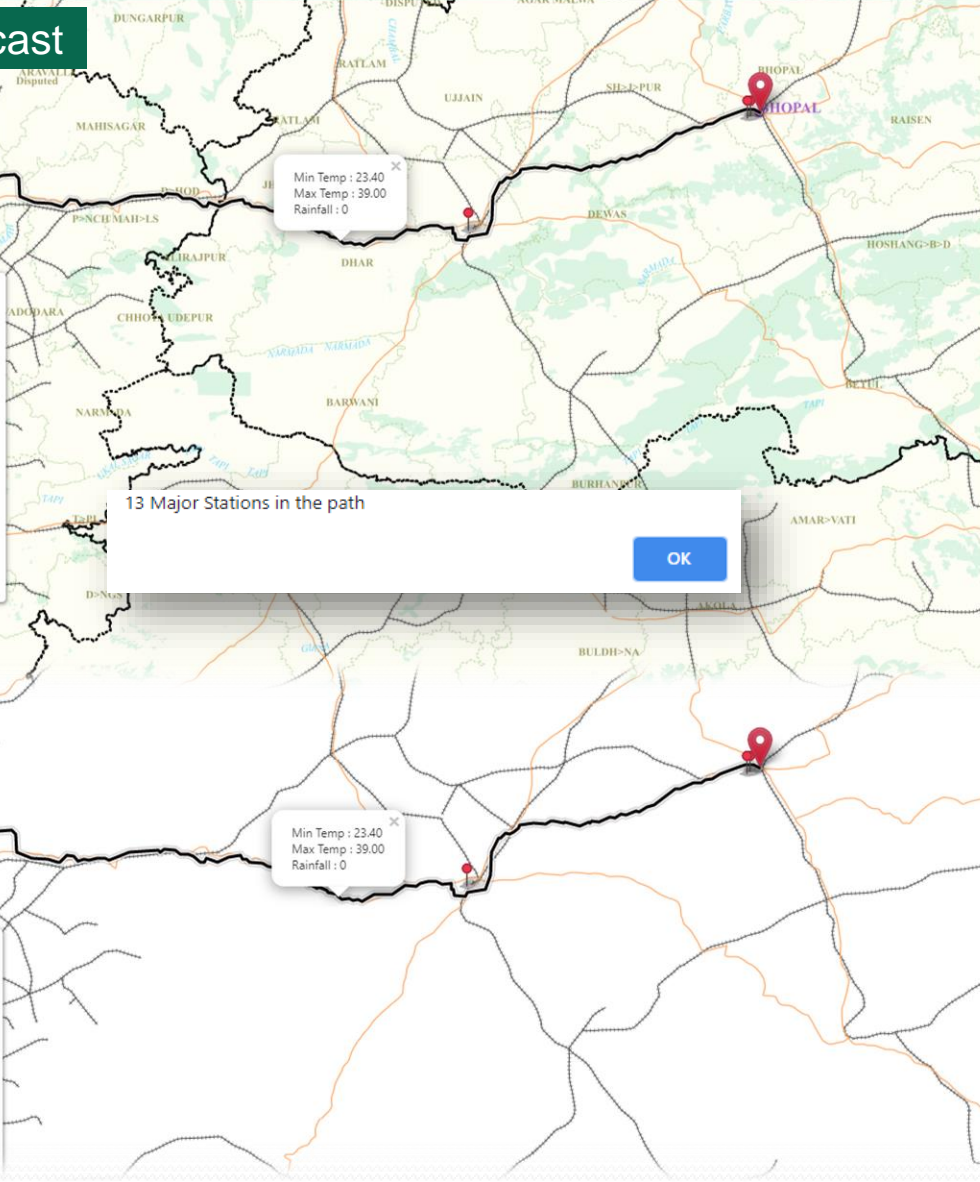
Bhopal, Madhya Pradesh, 462001, India

Ahmedabad, Ahmadabad City Taluka, Ahmedabad Di

Clear +

Open/Close

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Stations

- 7 Day Forecast
- Current Weather
- Nowcast

Basemaps

- Imagery
- Terrain
- BaseLayer

Administration

- State
- District
- Taluka

Transport

- Railway Network
- Road Network

Annotation

- Metro Cities
- State Capital
- Indian Cities
- Outer Boundary
- River

Current Weather

Station Name	Date	Time (UTC)	Wind Direction (Degrees)	Wind Speed (KT)	Temperature (Celsius)	Humidity (Percentage)	3hr Rainfall (mm)	6hr Rainfall (mm)	12hr Rainfall (mm)	24hr Rainfall (mm)
Bhopal-Arera Hills	2021/04/08	9	250	2.91	38.6	17	0.0	0.0	null	null

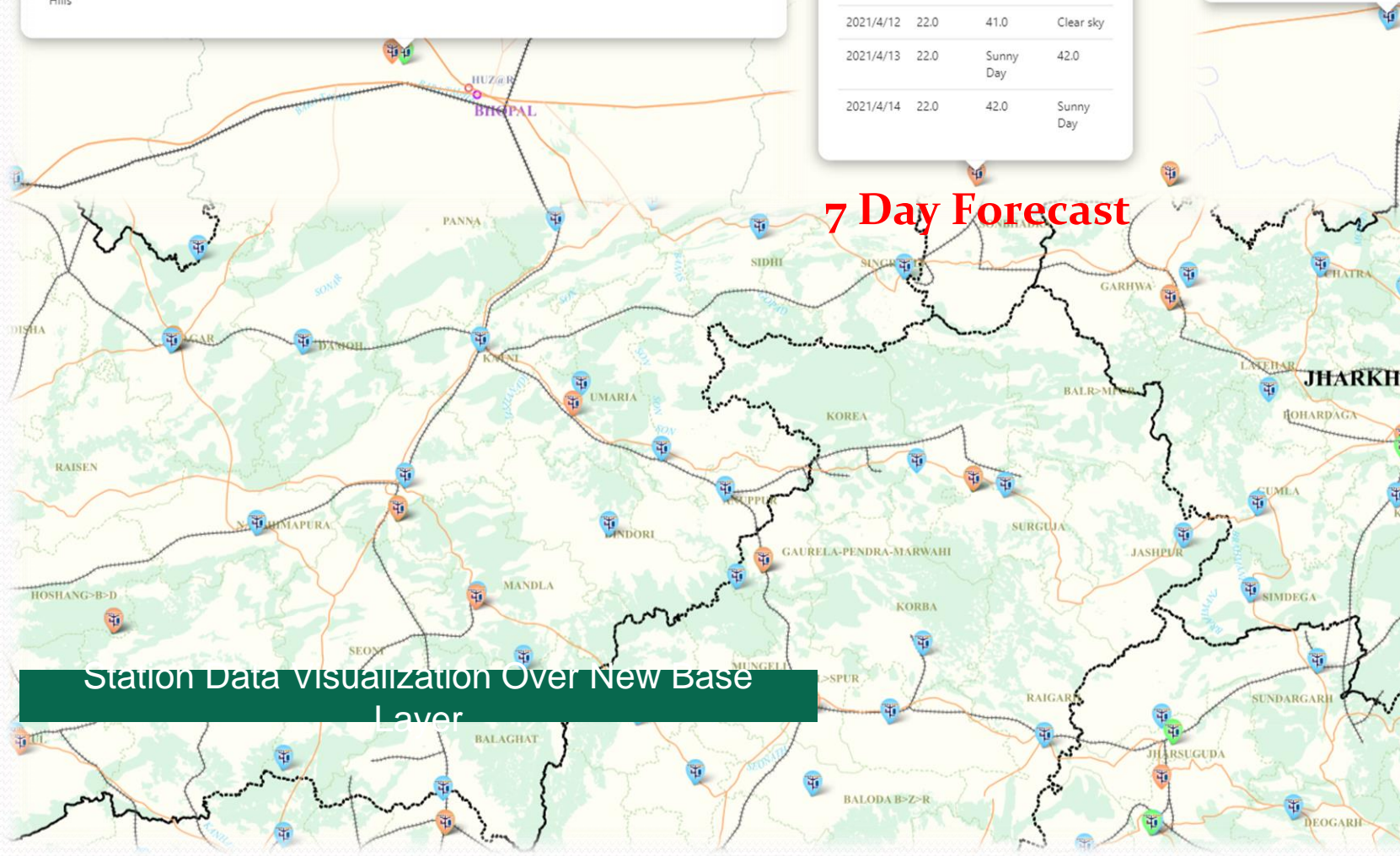
Station Name: Bhopal-Airport

Date	MinTemp	MaxTemp	Weather
2021/4/8	21.4	40.5	40.0
2021/4/9	20.0	40.0	Clear sky
2021/4/10	21.0	41.0	Clear sky
2021/4/11	21.0	41.0	Clear sky
2021/4/12	22.0	41.0	Clear sky
2021/4/13	22.0	Sunny Day	42.0
2021/4/14	22.0	42.0	Sunny Day

Nowcast

Station	Date	TOI (IST)	Valid_Upto (IST)	Nowcast
Satna	2021-04-08	14:00	17:00	Light Thunderstorm Low Lightning probability

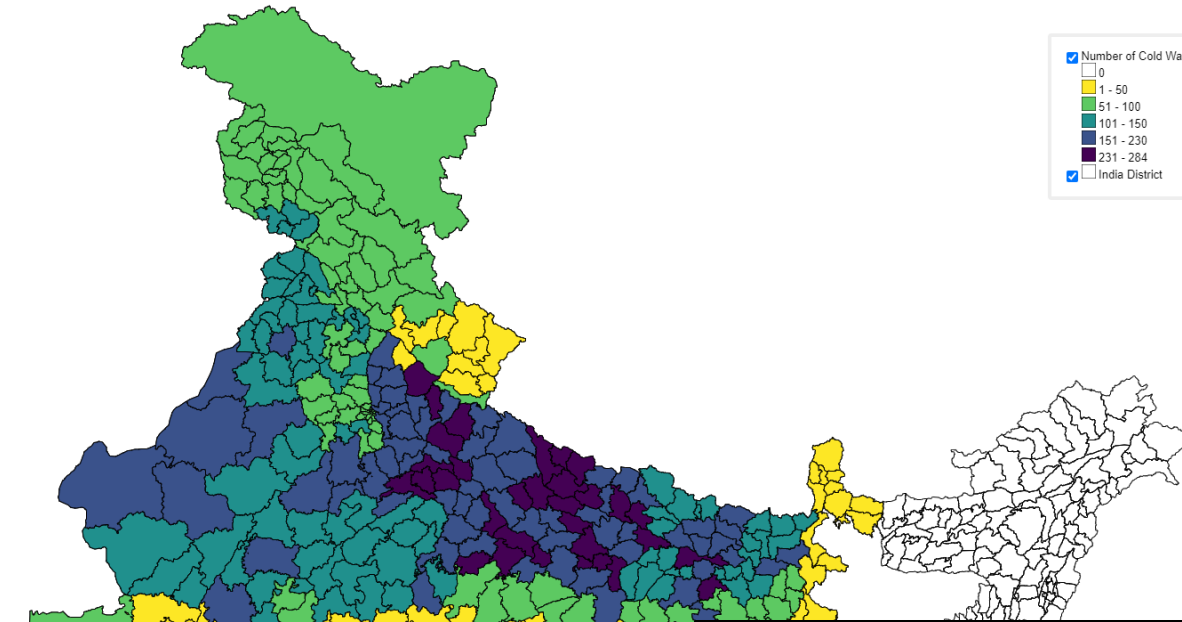
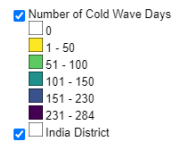
7 Day Forecast



- Stations**
- 7 Day Forecast
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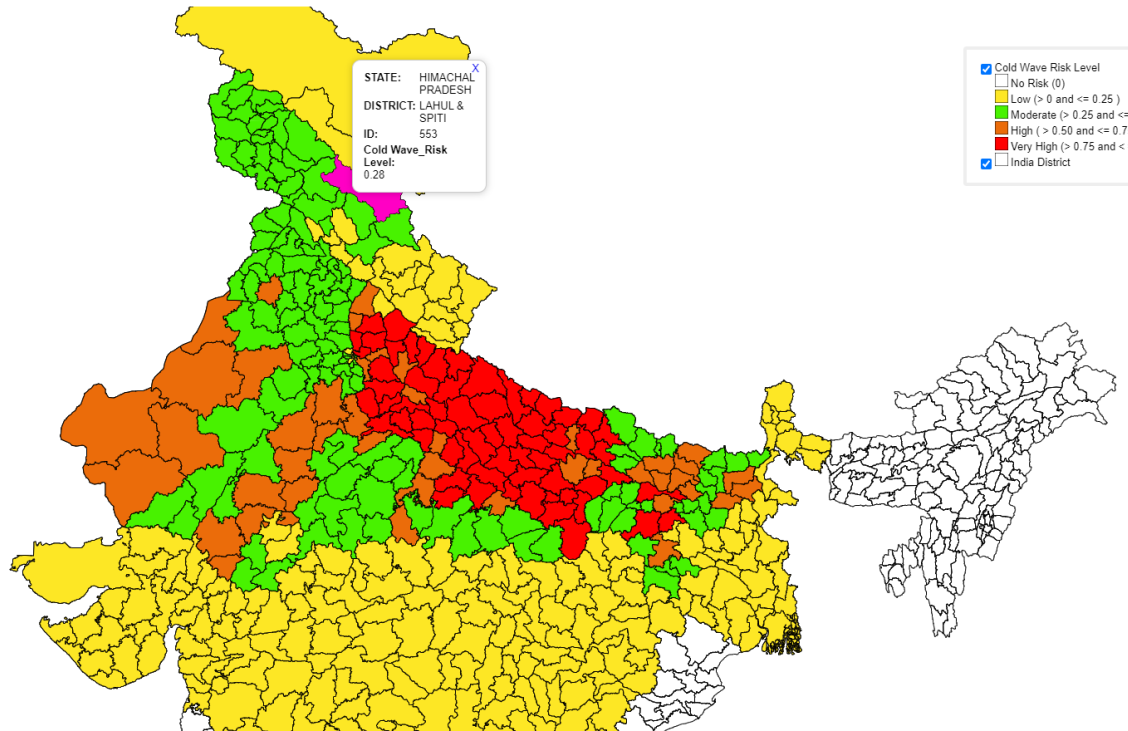
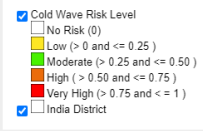
Station Data visualization Over New Base Layer

Climatological Products



Disasterous Cold Wave Risk Level
Annual

STATE: HIMACHAL PRADESH
DISTRICT: LAHUL & SPITI
ID: 553
Cold Wave_Risk Level: 0.28



Future Tasks

1. AI/ML
2. Mobile Friendly
3. Web-GIS-based spatial decision support system (Remote Sensing/RADAR)
4. Editing of digitized features,
5. Linking of external non-spatial data,
6. linking of GTS (global telecommunication satellite) data with GIS.
7. WebGeo Container

GIS Outreach and Engagement