

Improving Climate Services: Climate Adaptation and Early Warning



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How did Climate Services help our Country?

1999 Super Cyclone Odisha

Highest wind speed: 260 km/h

Total fatalities: 15,000

Date: 25 October 1999

Damage: \$4.44 billion (1999 USD)



Early warning
System
+
Disaster Mitigation
Planning



2020 Super Cyclone Amphan

Highest wind speed: 260 km/h

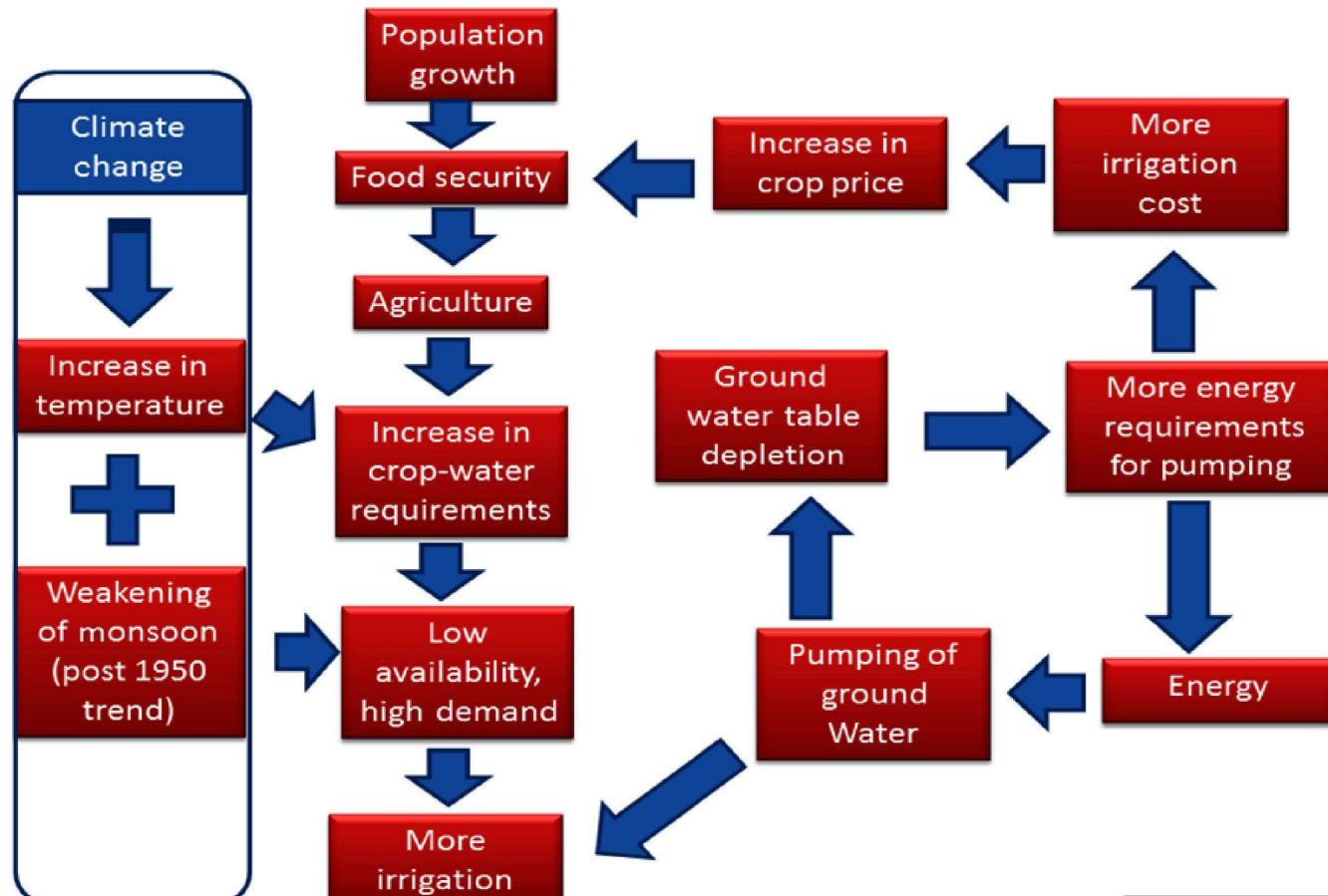
Total fatalities: 118

Date: 16 May 2020

Damage: \$13.7 billion (2020 USD);

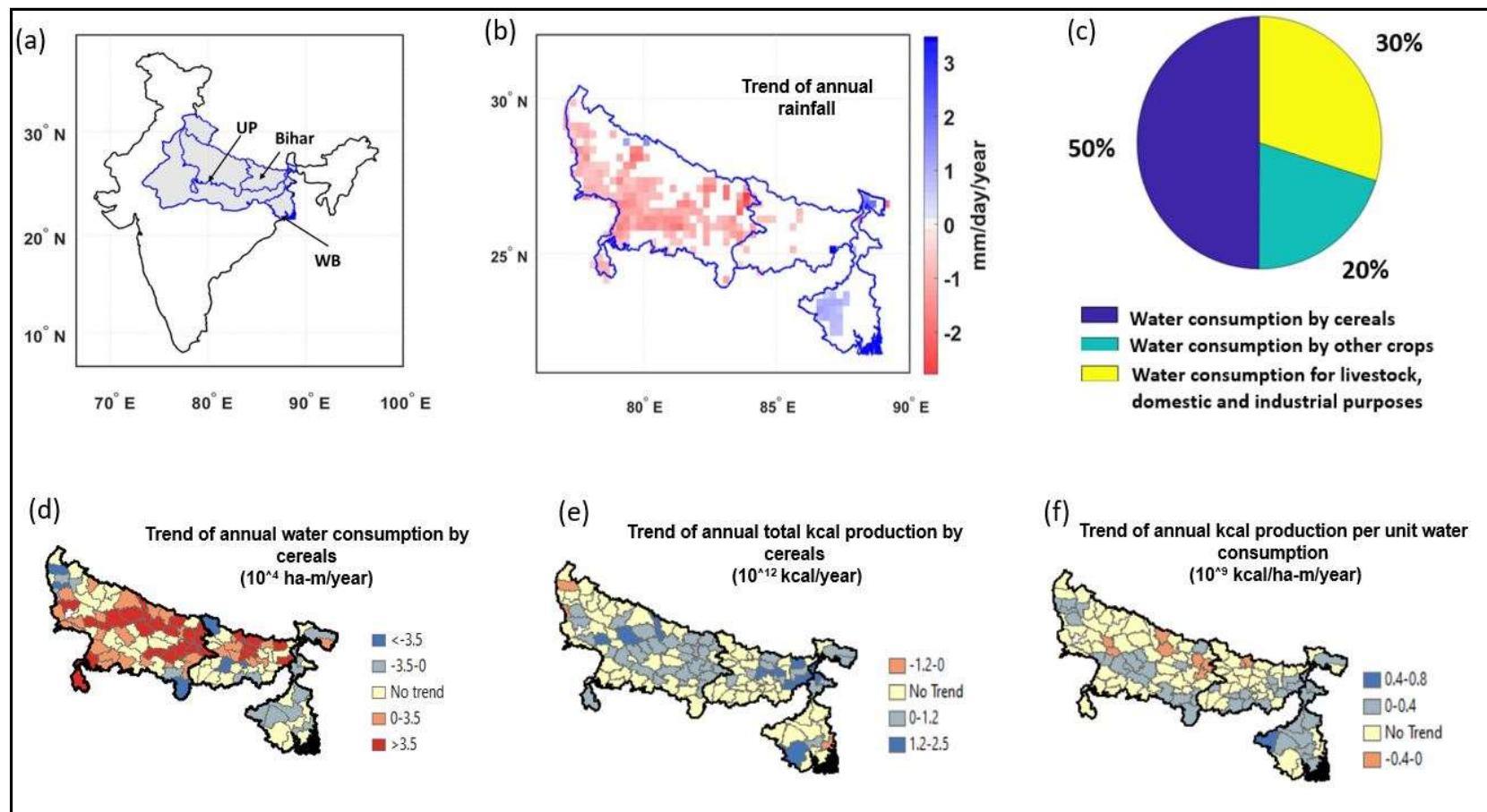
Power of Science!

Food-Energy-Water Scenario in India

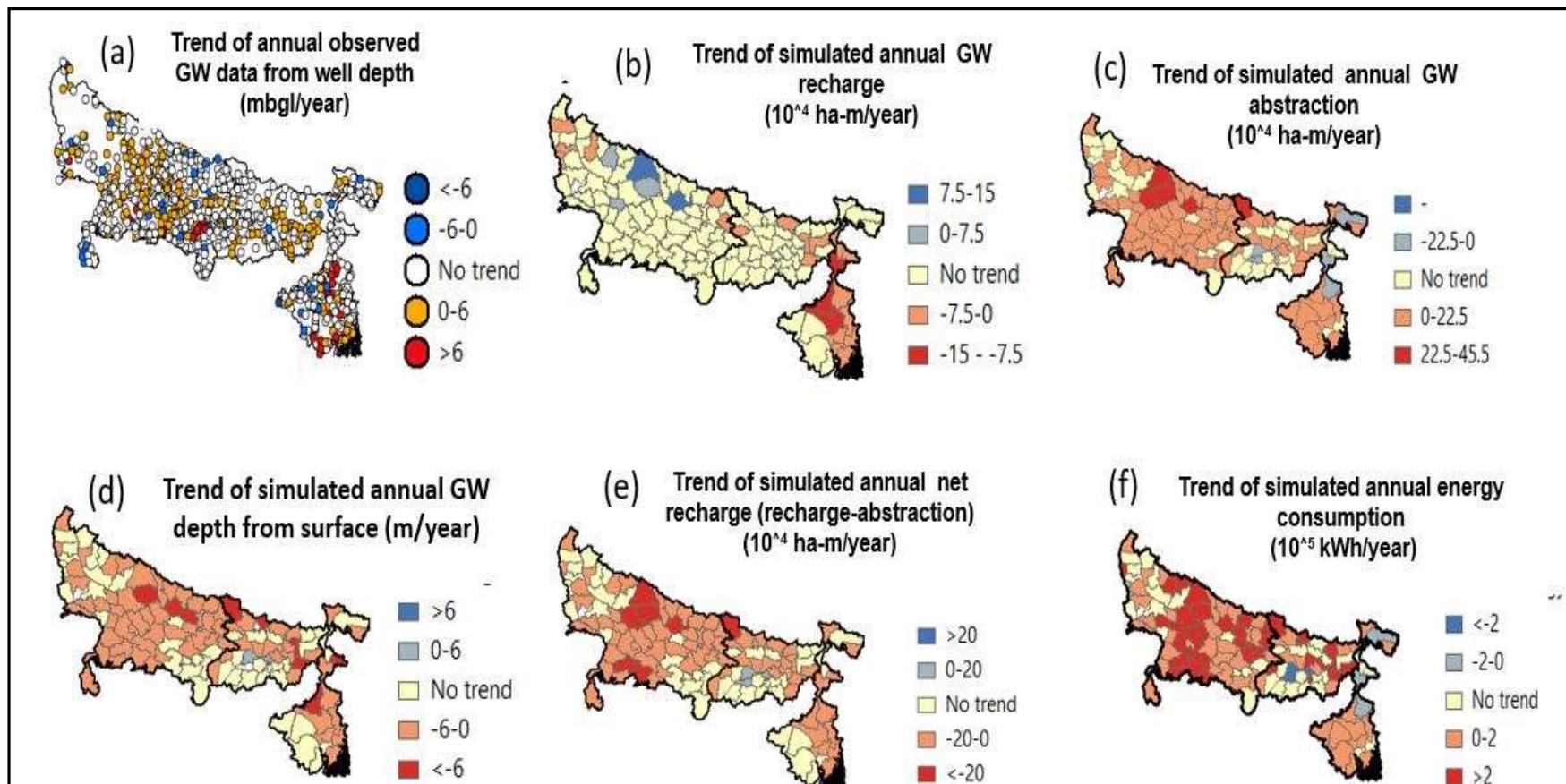


Barik et al. (2017), HESS

Are our agricultural crop practices sustainable?



And Groundwater is depleting!



Optimization

Multiobjective optimization at district level:

Maximize kcal production

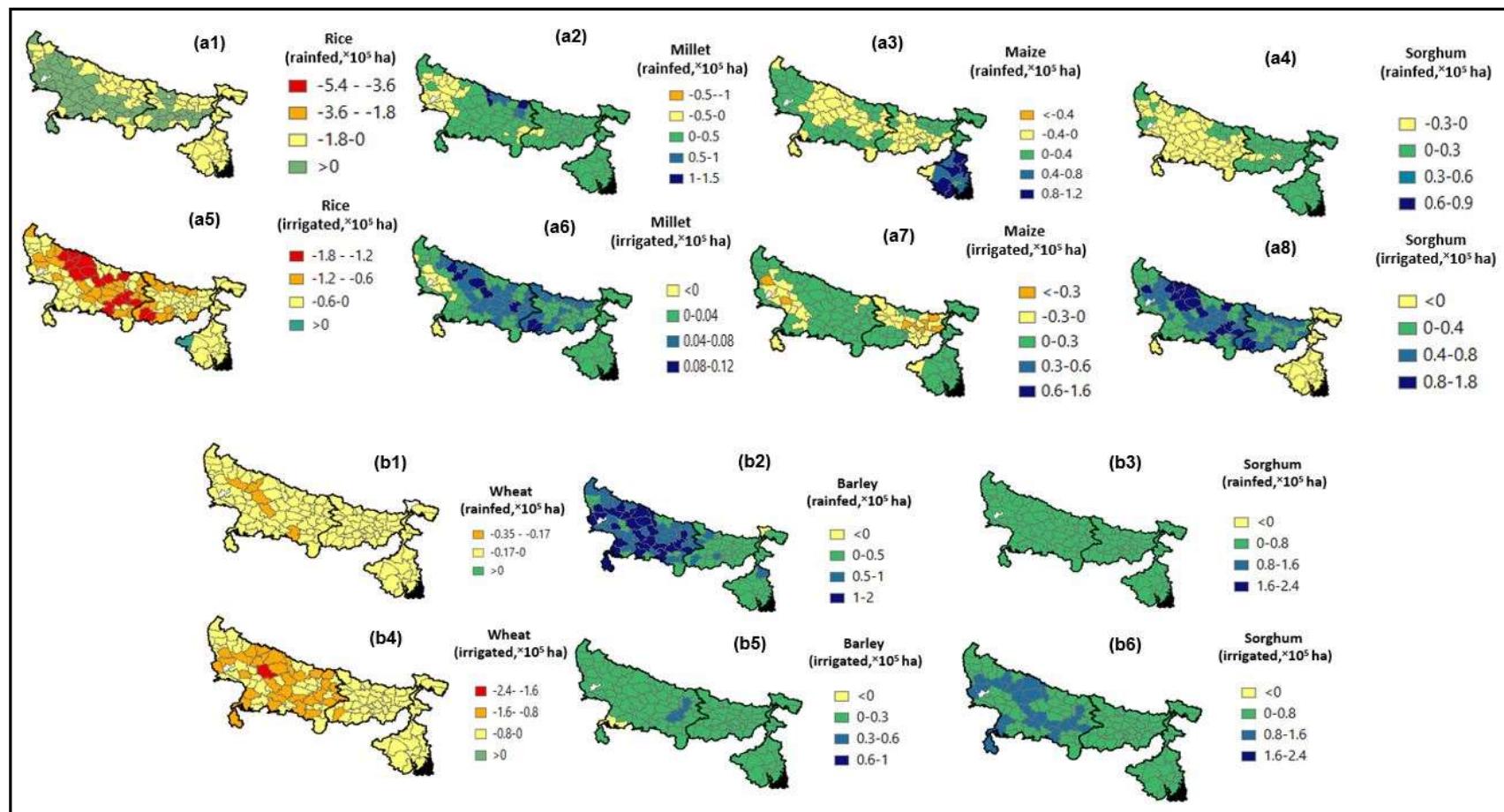
Maximize farmers' profit

Minimize water use

Constraints:

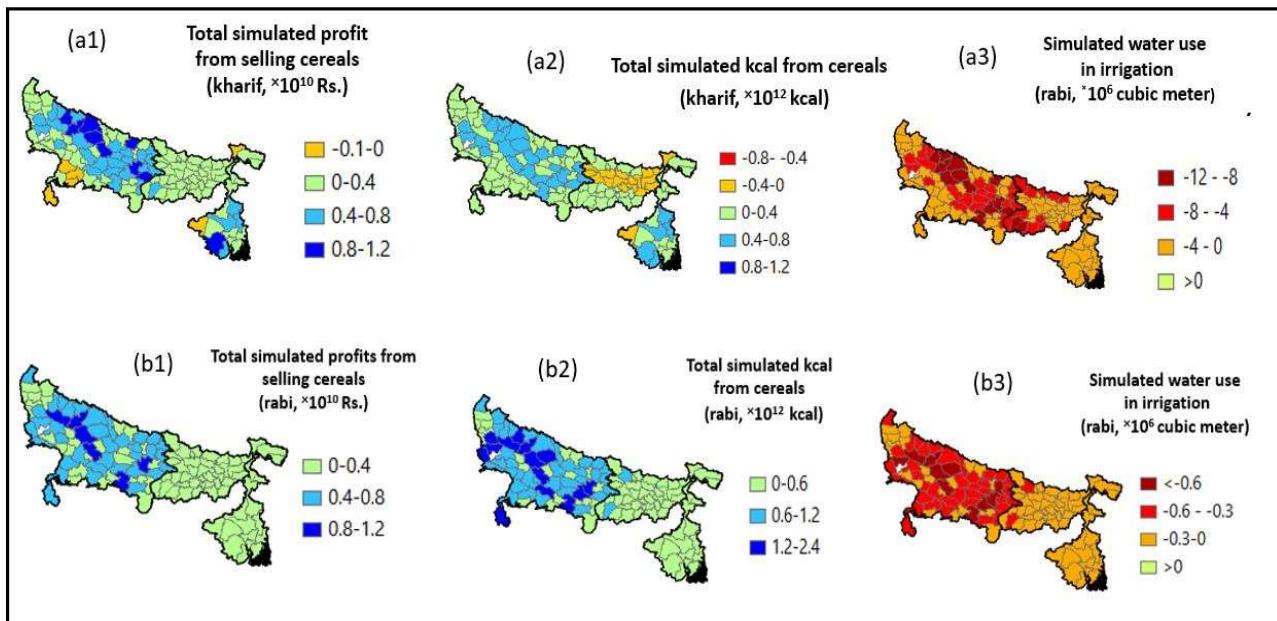
No change in total crop area for cereals

Proposed Changes in cereal crop areas



Chakraborti et al.
(2023), Nature
Water

Benefits and co-benefits



Nutrition co-benefits:

With replacement scenario:

46% increase in protein

353% increase in iron

82% increase in zinc

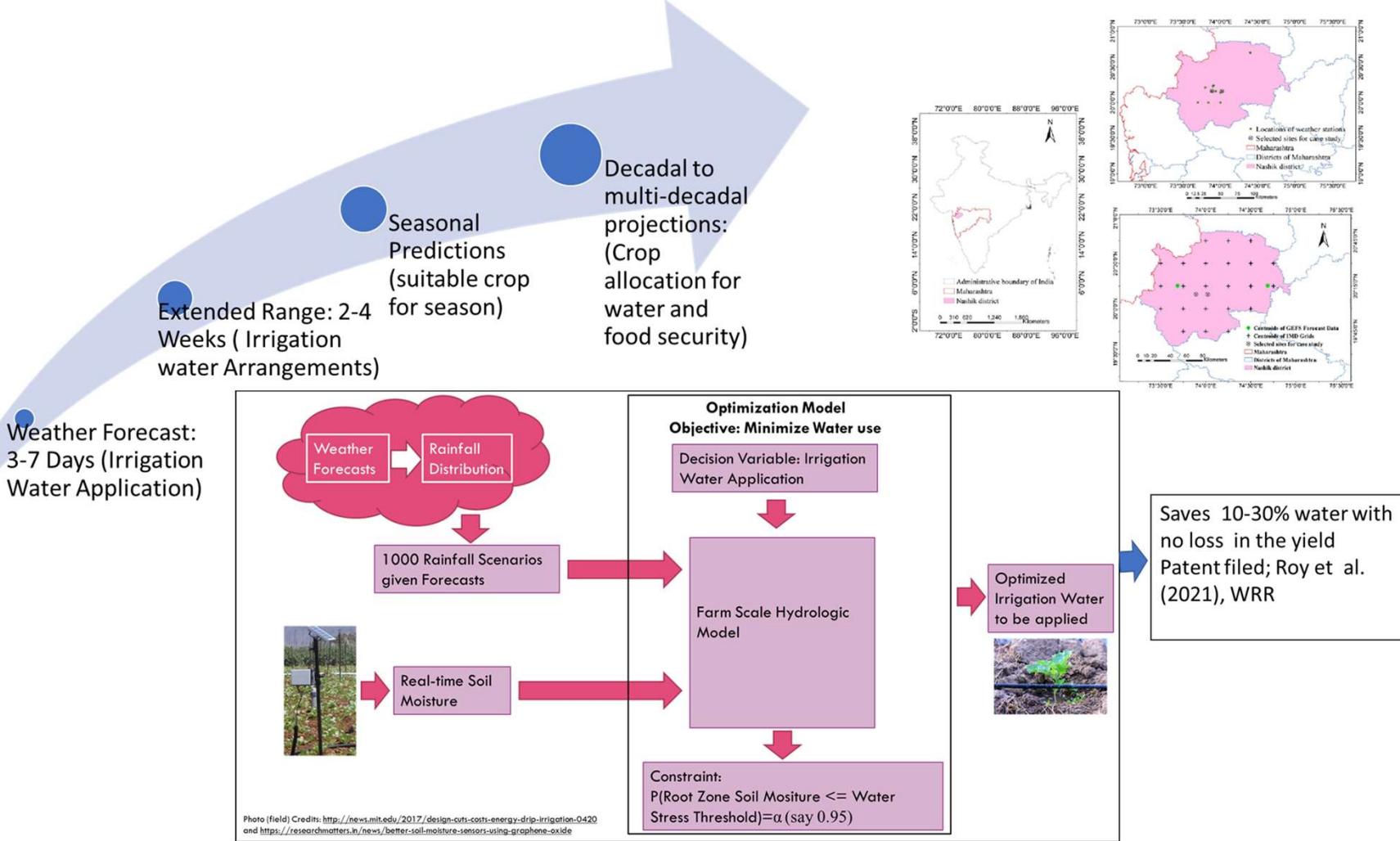
Challenges:

Creating demand

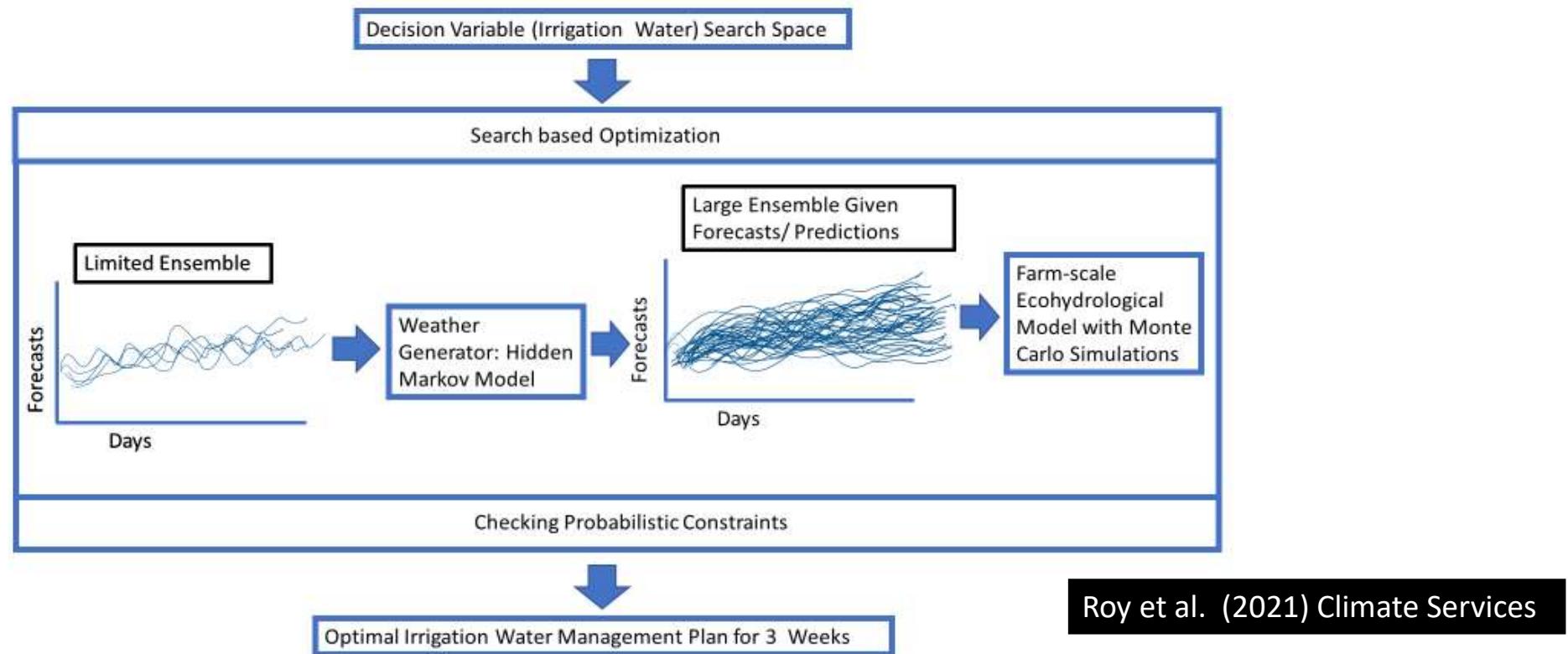
Convincing farmers

Chakraborti et al. (2023),
Nature Water

Weather Generators add Value!



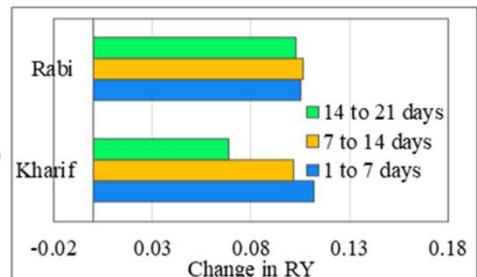
Extended Range: Irrigation Water Arrangements 2 Weeks in Advance



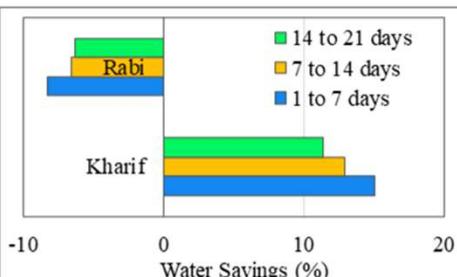
Water Savings and Maintaining RY

Site 1

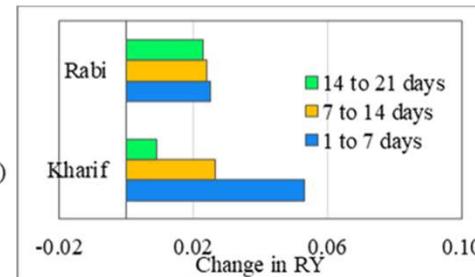
$$\alpha = 0.95$$



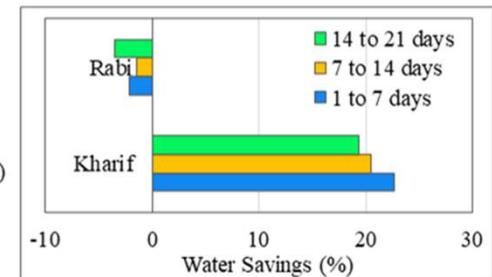
(b)



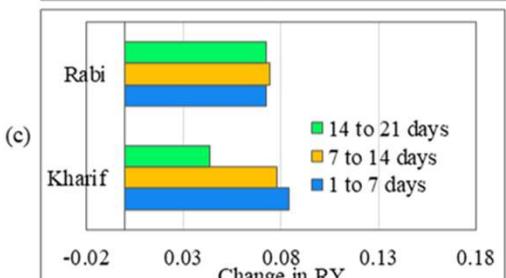
(e)



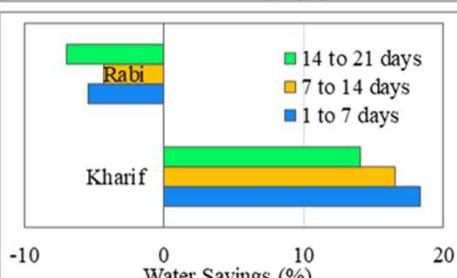
$$\alpha = 0.75$$



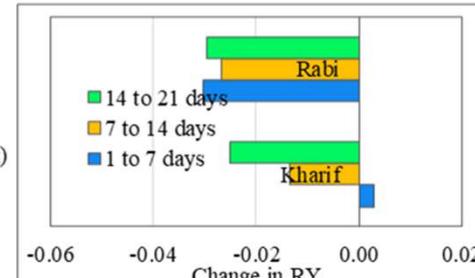
(f)



(d)



(g)



$$\alpha = 0.5$$

$$\alpha = 0.85$$

Changes in RY (a, c, e and g) and savings in irrigation water use (b, d, f and h) w.r.t. the farmer's method of irrigation scheduling, using the proposed framework with extended range forecast for $(t+1)^{th}$ to $(t+7)^{th}$ day, $(t+8)^{th}$ to $(t+14)^{th}$ day and $(t+15)^{th}$ to $(t+21)^{th}$ day.

α : 0.95 in (a) and (b), 0.85 in (c) and (d), 0.75 in (e) and (f), 0.5 in (g) and (h).

Challenges with Upscaling and Affordability

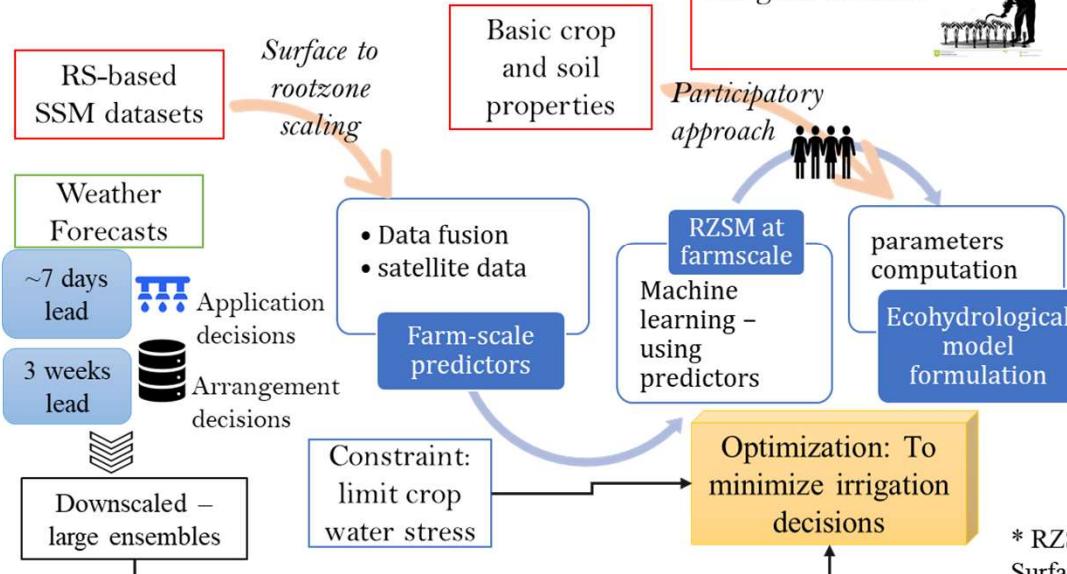
How to enhance farmscale irrigation water management with Remote Sensing and Weather Forecast at different lead times?

Background and Motivation:

- Need for generic exhaustive irrigation scheduling framework
- Suitability for arid regions – advance arrangement planning along with application decisions
- Optimized water use



Adopted Approach

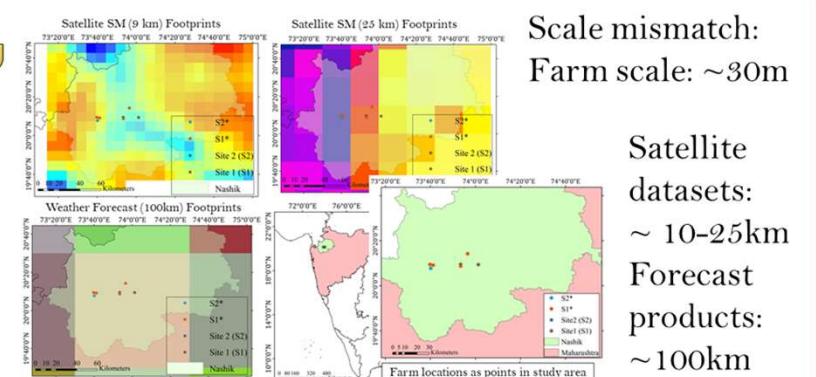


Drawbacks:

Existing methods for irrigation decisions – using in-situ RZSM data from sensors.



Unrealistic to install expensive sensors for marginal farmers.



Key Outcomes:

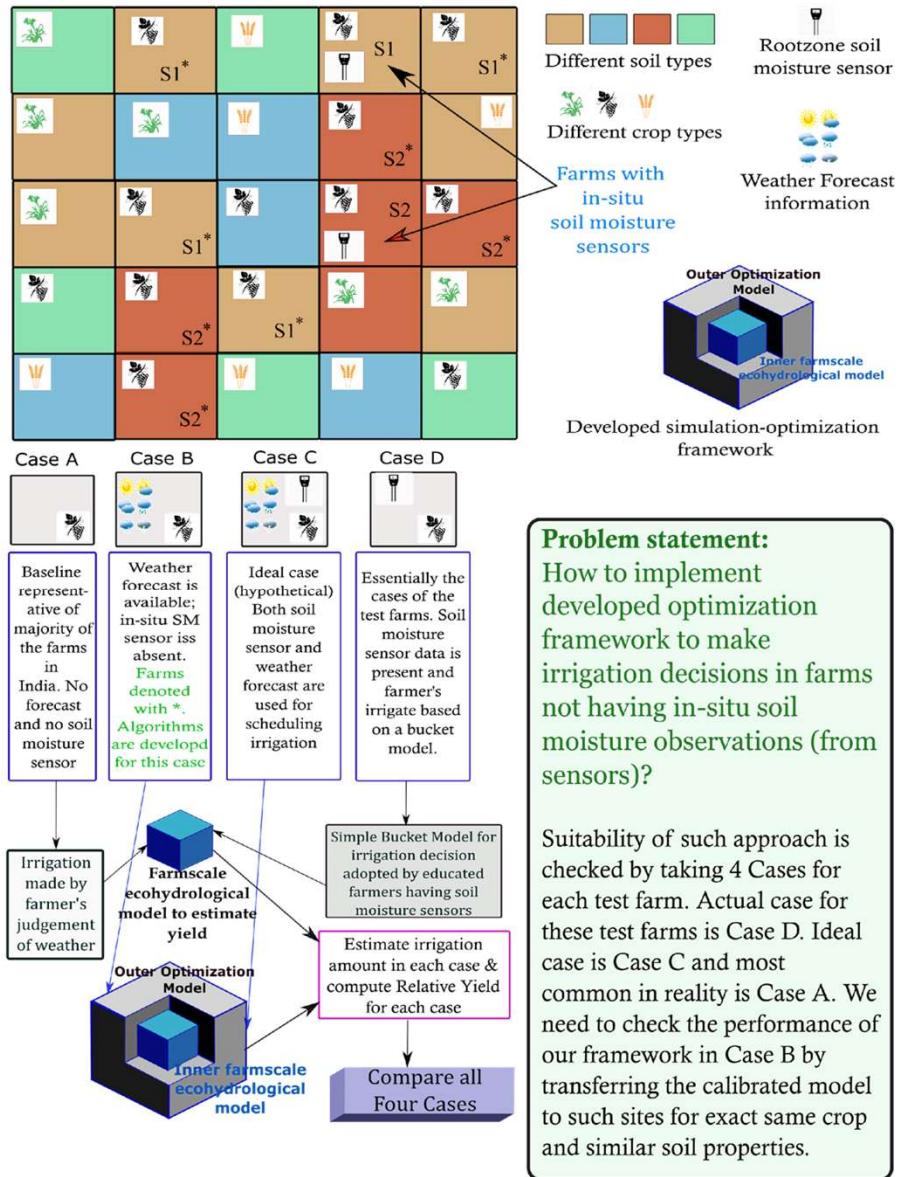
- A ready-set-go strategy for irrigation scheduling – simultaneous water “Arrangement” and “Application” decisions
- Minimize data requirement – Use of RS based datasets along with weather forecast
- Optimization of irrigation water use
- Provision of suitable in-farm storage – from surplus/deficit of arrangement/applications

* RZSM: Rootzone Soil Moisture, SSM: Surface Soil Moisture, RS: Remote Sensing



PRECISION FARMING

Implementation in Test Sites



Deriving irrigation water needs at S1* and S2*, using the calibrated model for S1 and S2, based on satellite information and forecast (Case B)

Case A:

- No soil moisture in-situ measurements
- Farmers apply irrigation based on their judgement on the climatic conditions of the last 1 day to 1 week.

Case B:

- No in-situ soil moisture measurements
- Weather forecasts are used
- Generated RZSM was used to parameterize the ecohydrological model

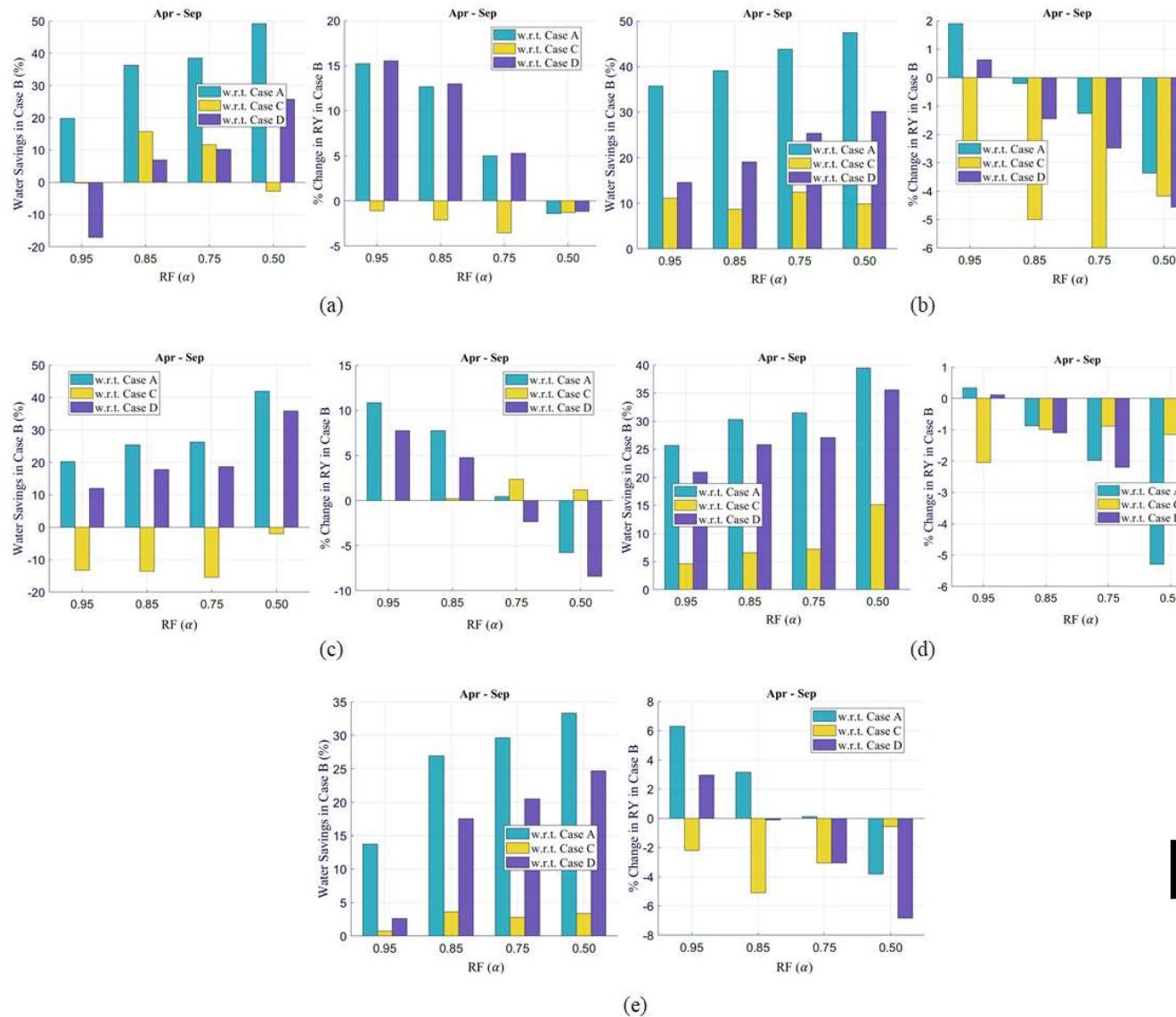
Case C:

- Accurate soil moisture measurements from sensor
- Weather forecasts are also used to make irrigation decisions

Case D:

- Access to in-situ soil moisture sensors
- No access to weather forecast information
- Farmers apply irrigation when soil moisture goes below a threshold

Implementation in Test Sites



Water Savings and Change in RY achieved for Case B with respect to the other Cases for (a) Site 6, (b) Site 11, (c) Site 14, (d) Site 15 and (e) Site 21, with varied RF. The plots are for the Kharif season from 15th Apr – 9th Oct 2021

Roy et al. (2023) STOTEN

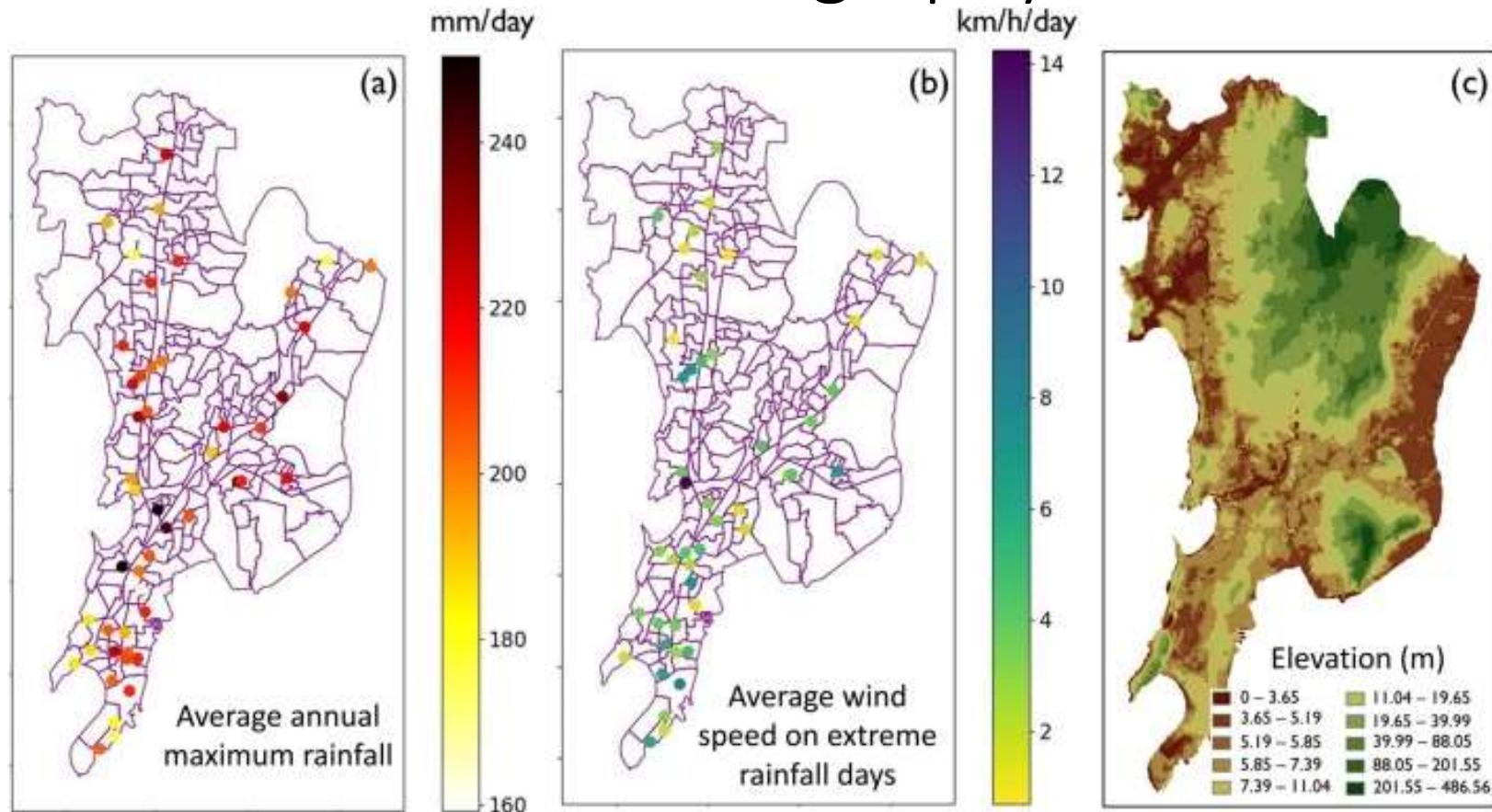
Climate Services Example: Mumbai Flood Monitoring and Forecasting

- Forecasting Rainfall from 15 minutes to 3 days using Statistical and Machine Learning Methods
- Real-time monitoring of floods by the citizen (crowdsourcing) for the citizen (available to all)
- Forecasting of Floods
- Designing Decision tools to improve resilience
- Generating flood risk map

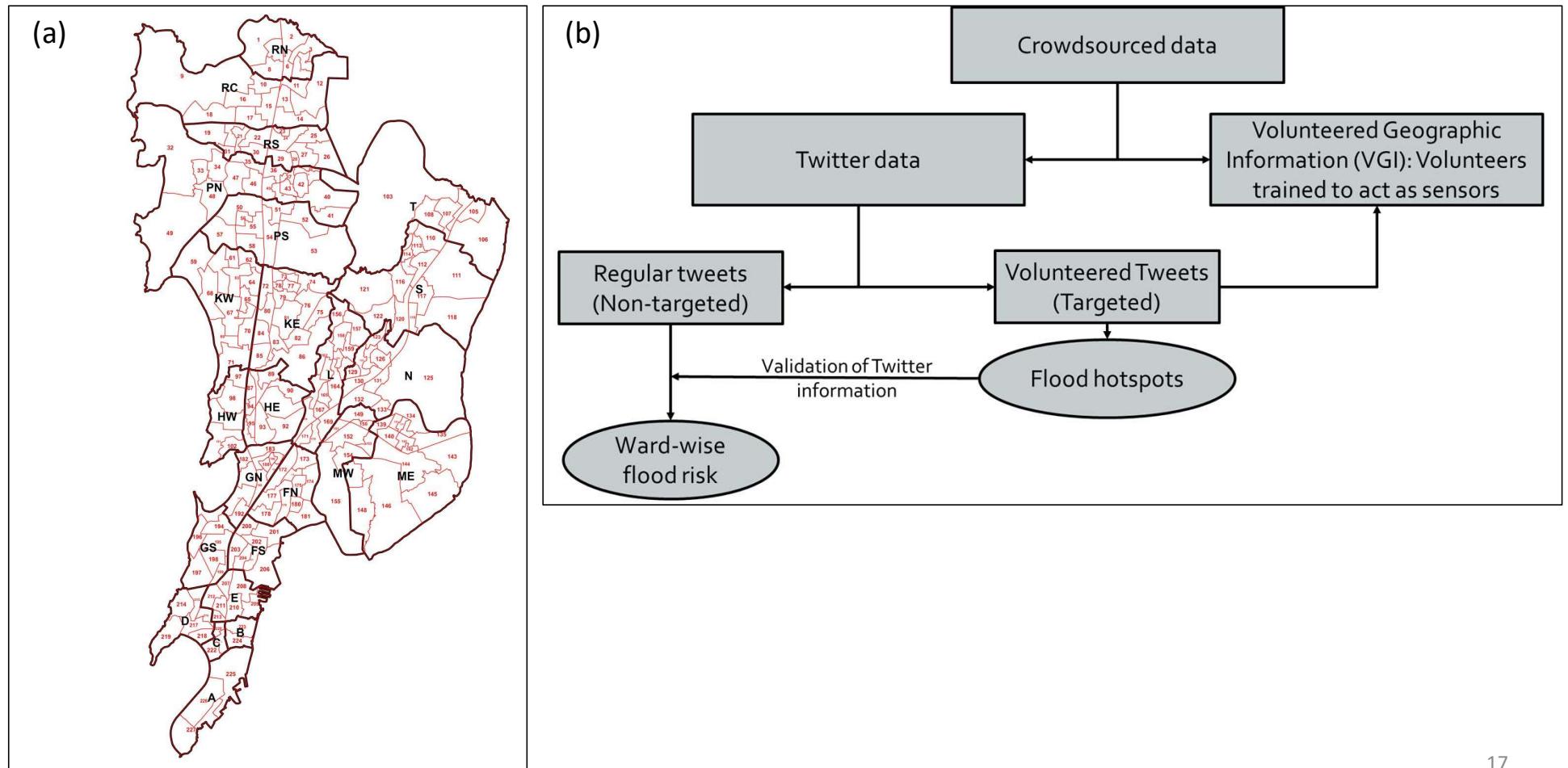


- Mumbai: Coastal City Receiving very high rainfall
- Very high spatial variability
 - 26th June 2005: Santacruz received 900 mm in 24 hours, while Colaba received just 84 mm
- A combination of high and low elevation area
- Almost fully concreted surface

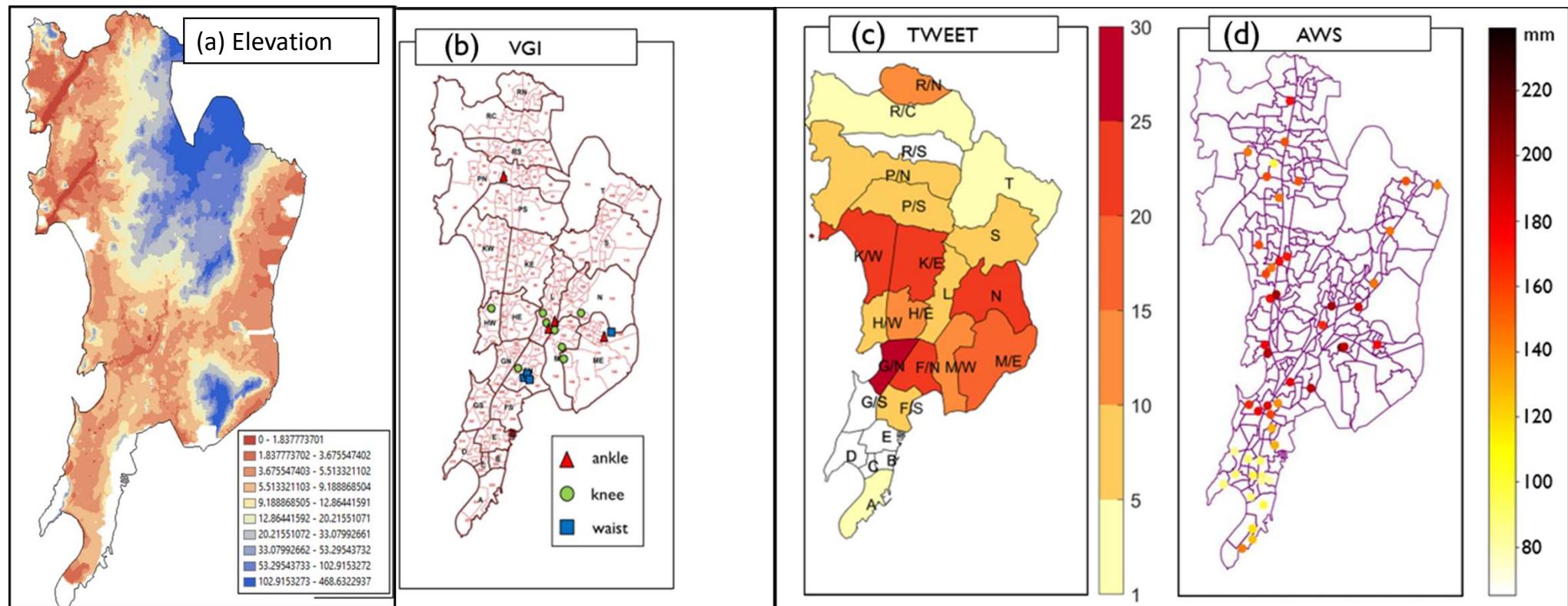
Rainfall Pattern and Orography



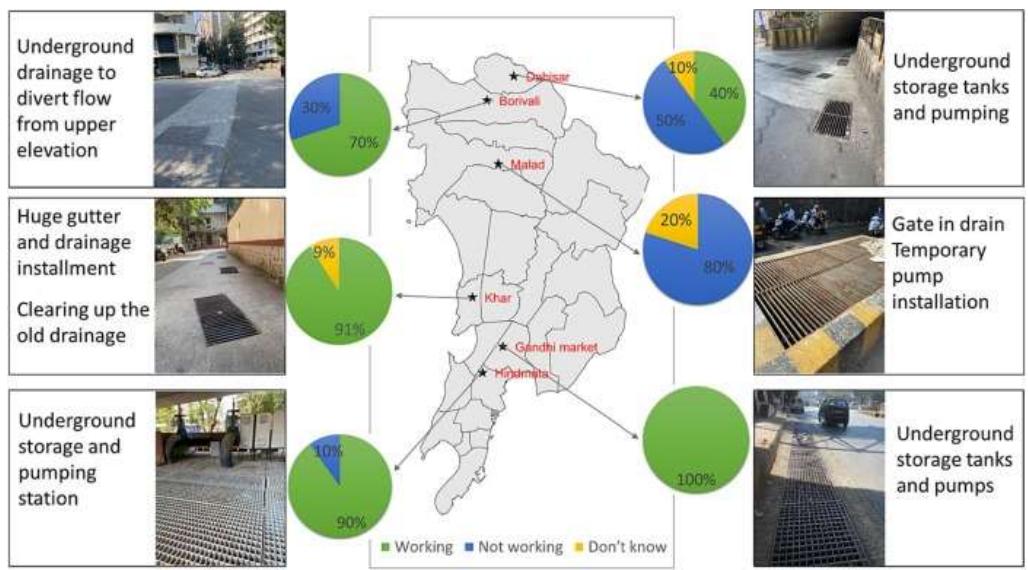
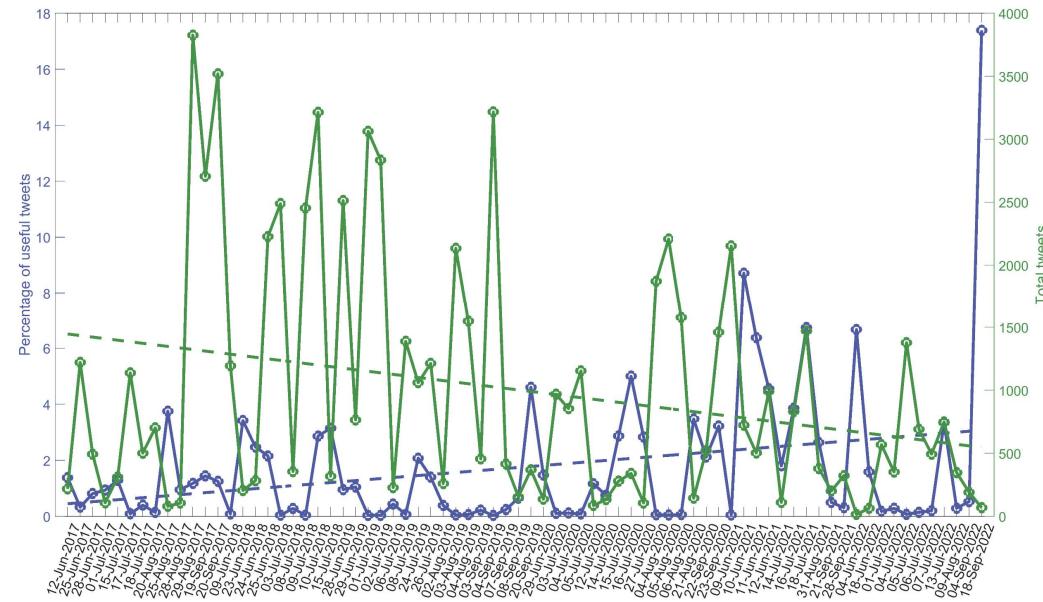
Monitoring: Crowdsourcing Flood Data



Results for July 05, 2022

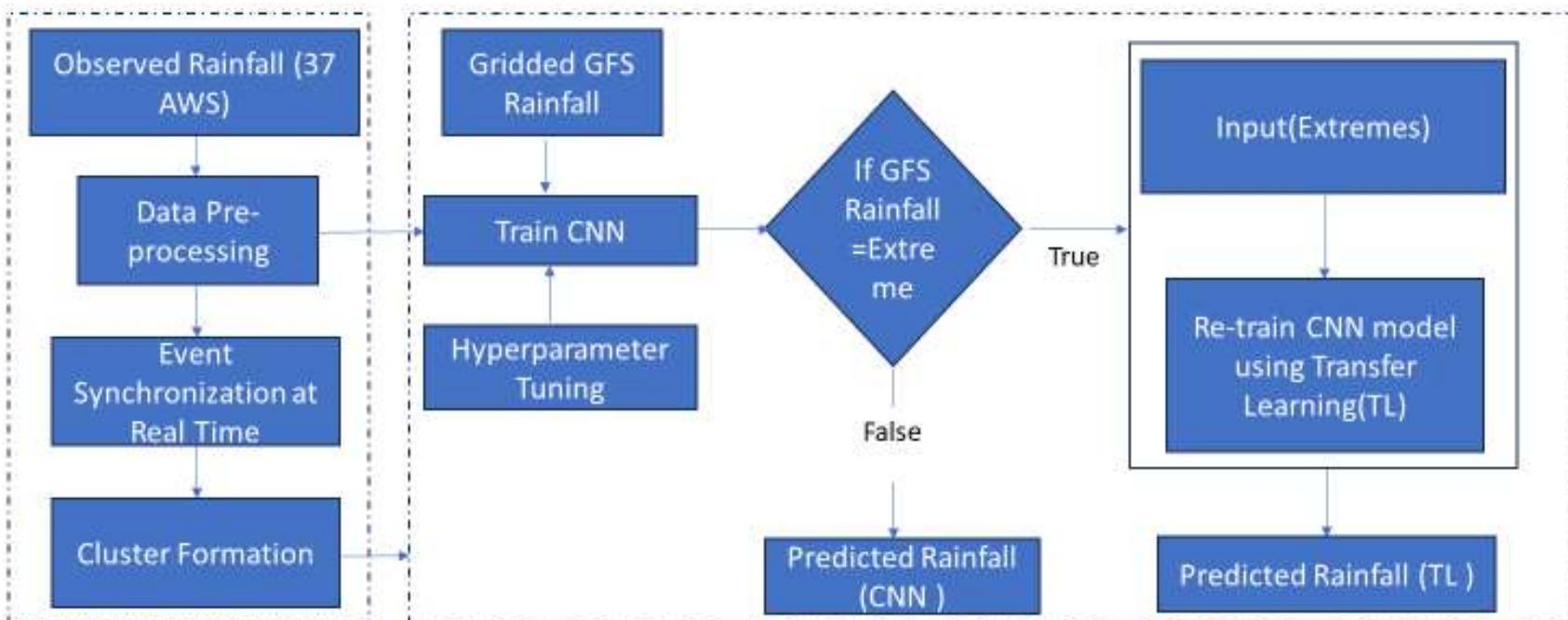


Scenario Improving

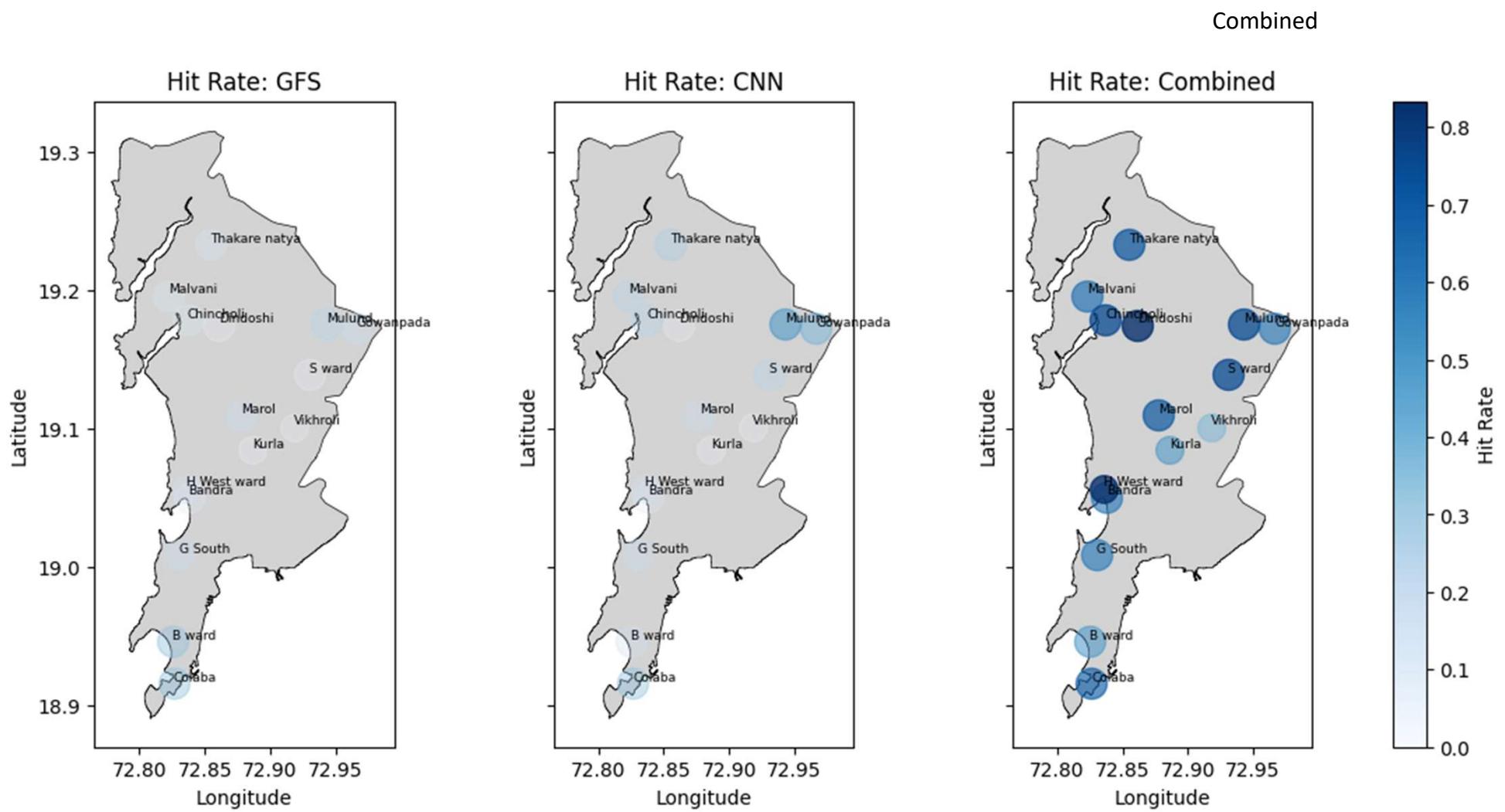


Algorithms for Daily Forecasts

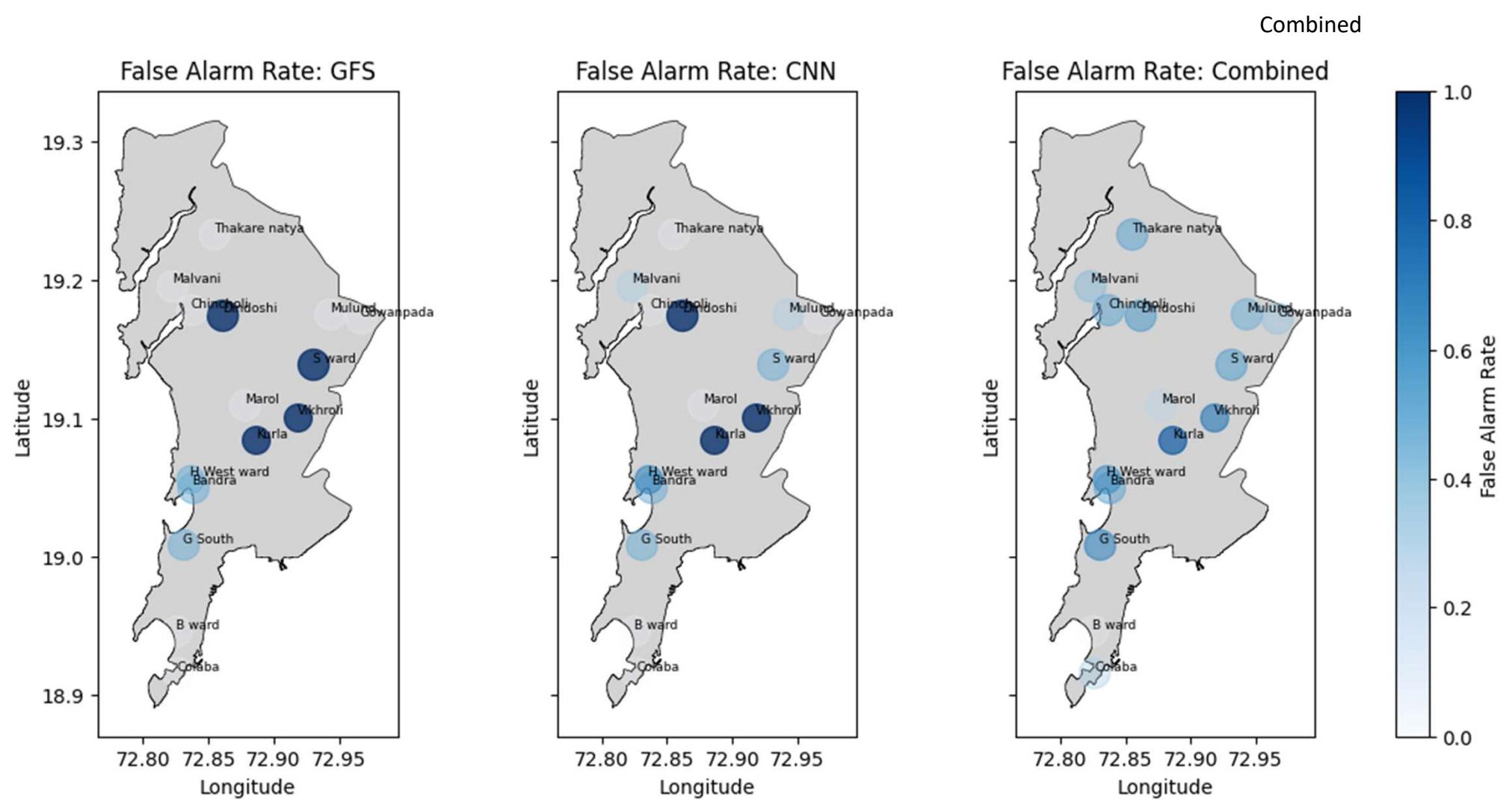
Overall Methodology:



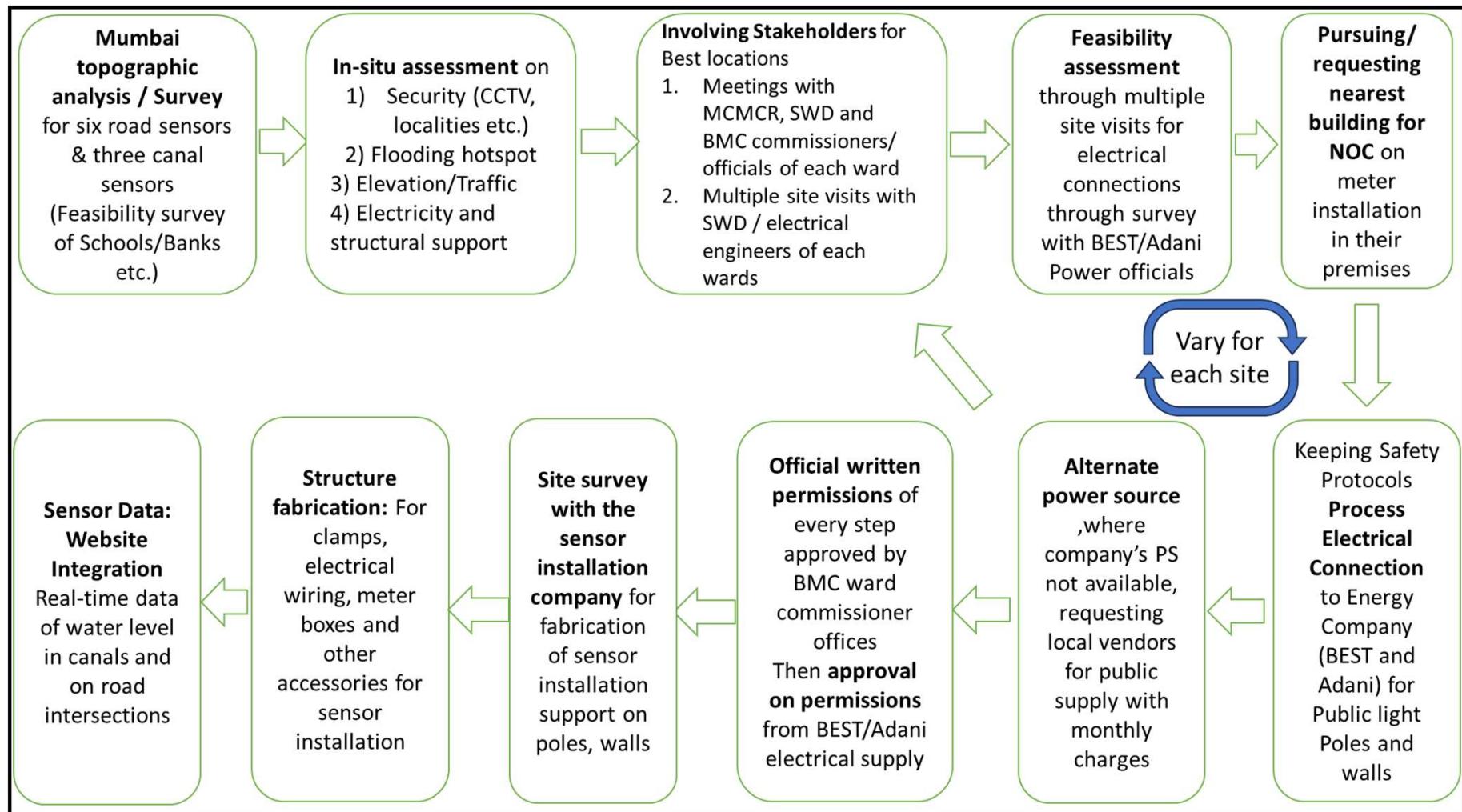
Hit Rate for 95th Percentile Monsoon Rainfall



False Alarm for 95th Percentile Monsoon Rainfall



Sensor Installation



Sensors

Canal Water level Monitoring Sensors

Vakola Nalla at Mumbai University



Mithi River at 8MLD Sewage Treatment Plant, Powai



Andheri Subway Nalla

Water level Monitoring Sensors at Roads/Intersections



RA Kidwai Road Wadala



Near Gurukripa Restaurant Sion

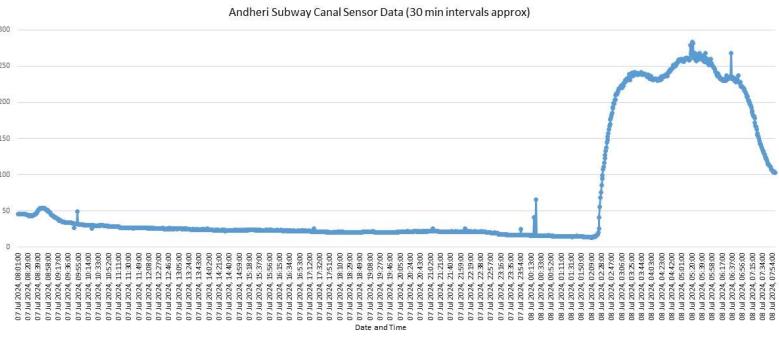
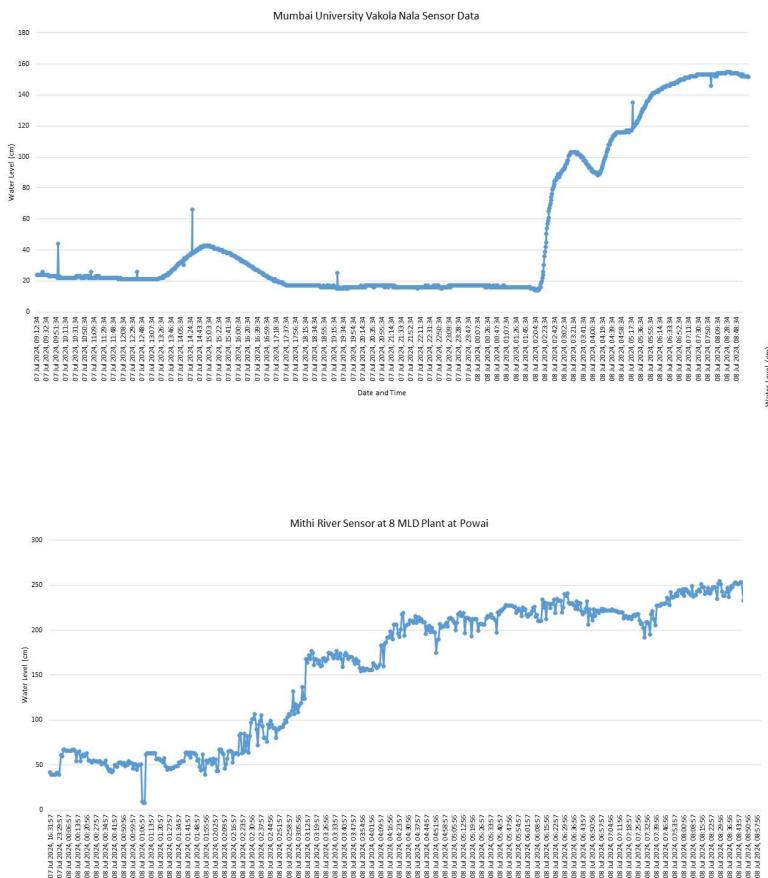
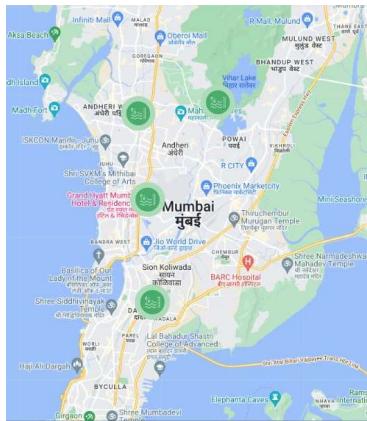
Newly installed meters from Adani/BEST



Locations



Water-level during extremes



MUMBAI FLOOD APP



<https://www.mumbaiflood.in/>

Download now!

**MUMBAI
FLOOD
APP**
Experimental



Hourly rainfall data from all MCGM AWS.
3-day rainfall forecasts (experimental).
Water-level monitoring sensors.
Rainfall Twitter feed.
Rainfall local train stations data.

The promotional image displays the Mumbai Flood App's user interface. On the left, a desktop screen shows a detailed map of Mumbai with numerous yellow dots indicating rainfall monitoring stations. To the right of the map is a large orange button with the text "REPORT FLOOD IN YOUR AREA" and a right-pointing arrow. Below the desktop screen is a smartphone displaying a similar map with red dots, representing more advanced or experimental monitoring. At the bottom of the smartphone screen, there is a small text box with the text "Click to Report flood in your area". The background of the entire promotional image features a faint silhouette of the Mumbai city skyline against a cloudy sky.

by Climate Studies, IIT Bombay

REPORT FLOOD IN YOUR AREA

Our Website

mumbaiflood.in

Support for KDL-40... The 15 Most Beautiful... ESRL : PSD : PSD/Cli... THERMO EXAMPLE... Countries where Co... Google Calendar - F... Buy Seafood Online... COVID-19 Tracker | I... Download Course... All Bookmarks

MUMBAI FLOOD EXPERIMENT

Home Rail Tweet About

Rainfall Waterlevel Reported Flood

Andheri

Current Time: Jul 20, 11:03:58 PM

Report Flood in your Area!

Observed Hourly Rainfall (data from MCGM)

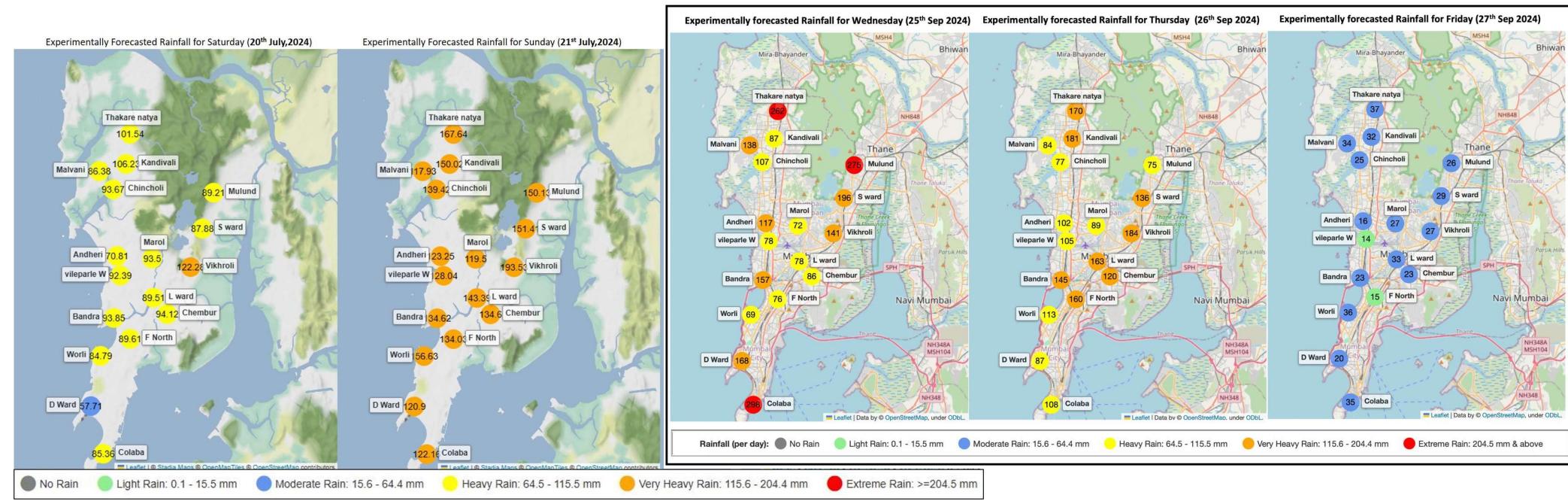
Daily Rainfall Forecast

Past Forecasted Rainfall (1-day lead) for this season

Rainfall Forecast (Sunday, July 21, 2024)

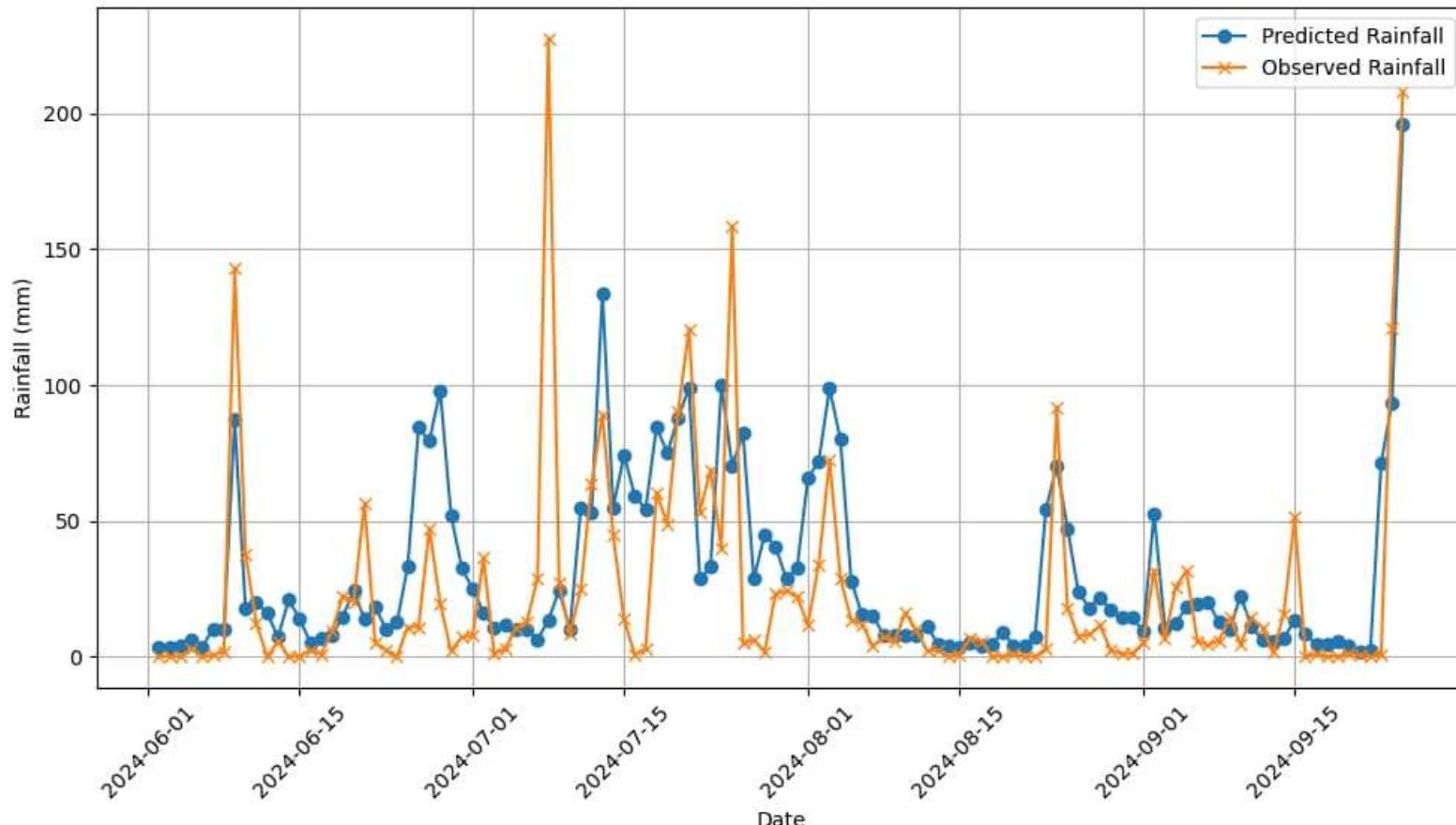
- No Rain (0 mm)
- Light Rainfall (0.1 - 15.5 mm)
- Moderate Rainfall (15.6 - 64.4 mm)
- Heavy Rainfall (64.5 - 115.5 mm)
- Very Heavy Rainfall (115.6 - 204.4 mm)
- Extremely Heavy Rainfall (>=204.5 mm)

Hyperlocal Rainfall Forecasting (Experimental)



MUMBAI FLOOD APP accurately forecasted most of the extreme rainfall events during Monsoon 2024.

Time Series of Predicted and Observed Values



Comparison shown here for S-Ward, Mumbai.

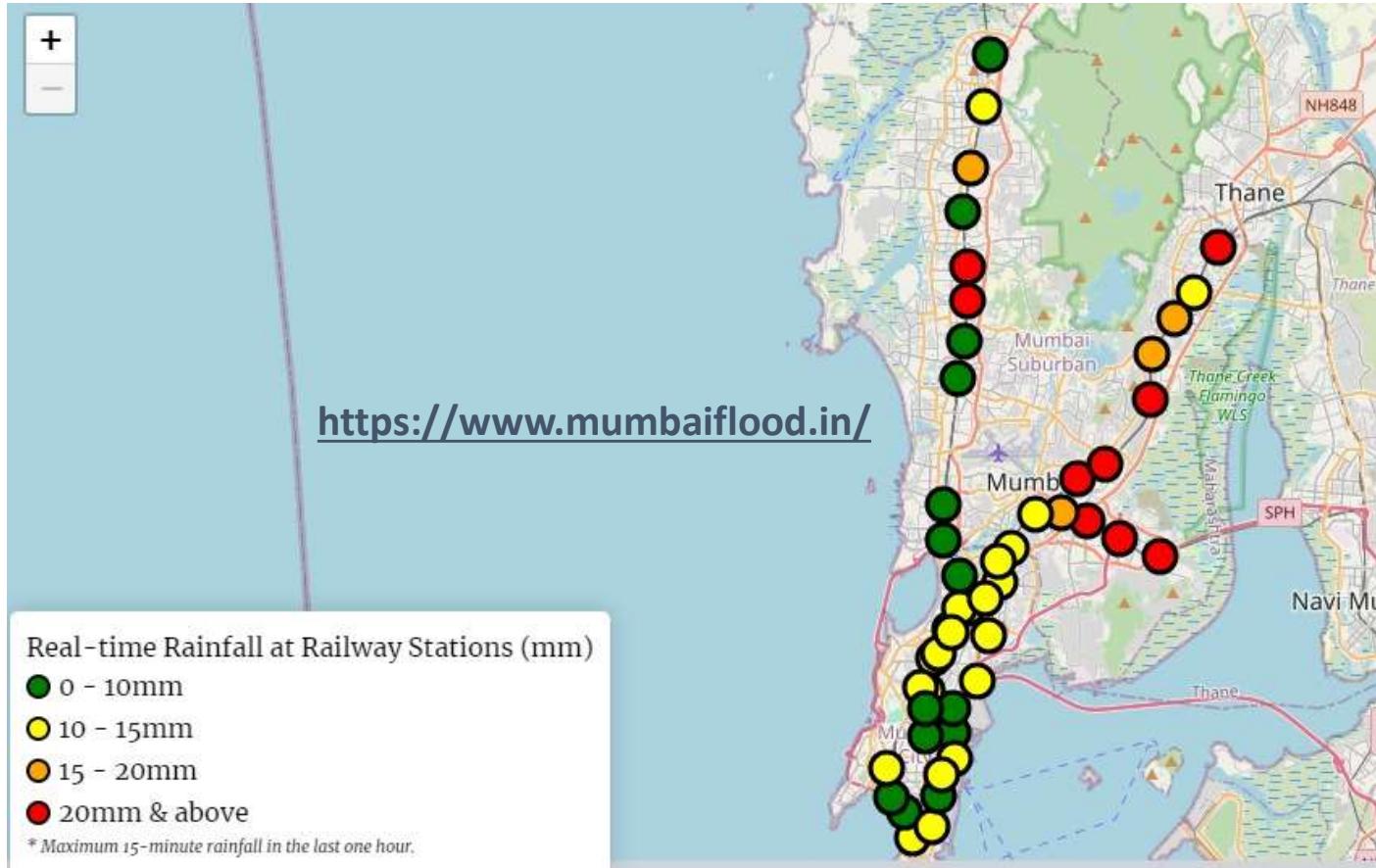
Mumbai extreme rainfall events in 2024:

9th June,
8th July,
18th July,
20th July,
21st July,
25th July,
25th Sept

MUMBAI FLOOD APP correctly forecasted all the extremes at 1 day lead, except one. 25th July 2024 extreme rainfall event was also forecasted by us at 2/3 days lead.

Hyperlocal Rainfall Forecasting (Experimental)

Real-time Rainfall at local rail stations (in mm in 15-minute interval)



MUMBAI FLOOD APP can alert you if there is a possibility of waterlogging at various railway tracks across Mumbai during extreme rainfall events.

On **extreme rainfall event day, 25th Sept' 24**, 20 mm rain crossed in just 15 mins and red alerts are visible at **Goregaon, Ram Mandir, Mulund, Vikhroli, Ghatkopar, Vidyavihar, Chembur, Govandi and Mankhurd.**

MUMBAI FLOOD APP | media coverage & public appreciation



IIT-Bombay Launches AI-Powered Platform for Real-Time Rainfall & Flood Forecasting in Mumbai

www.thebetterindia.com

@thebetterindia



Business Standard

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Home / India News / IIT-Bombay creates platform for real-time ...

IIT-Bombay creates platform for real-time Mumbai rainfall, flood forecast

The system uses IMD data from Colaba, Santacruz, Marine Lines, and over 60 automatic weather and rainfall stations across Mumbai and nearby areas



HOME MUMBAI NEWS FPJ SHORTS GAMES ENTERTAINMENT

Home > Mumbai > Mumbai's Flood Fears Dim With IIT-B's Hyperloc...

Mumbai's Flood Fears Dim With IIT-B's Hyperlocal Forecast App; Check Details And Features Here

Its crowdsourcing-approach enables citizens to report flooding in their areas by submitting water level information via the web portal or mobile app, which is then made available to the public in real-time.

RUCHA KANOLKAR | Updated: Thursday, July 18, 2024, 12:24 AM IST



Home Latest News Markets News Premium

IIT-Bombay develops app, website for near real-time forecasting of rainfall, flooding in Mumbai

The information on near real-time rainfall and waterlogging can be accessed through the web portal or mobile app. It will provide rainfall forecasts and flood updates.

Written By Riya R Alex

Published • 16 Jul 2024, 12:59 PM IST



IIT Bombay launches platforms for rainfall and flood monitoring in Mumbai

These tools allow Mumbai residents to plan their daily activities more effectively during the monsoon season by giving them up to date information about the weather.

Pratiksha Tripathi - September 26, 2024

Parth @Parth_GPT Follow Back

The new experimental forecasts by @ClimateIITB are spot on!

Kudos to the team behind [mumbaiflood.in](#) for accurate hyperlocal updates.

We need these as global models grow more uncertain."

#MumbaiRains



6:17 pm · 21 Jul 24 · 3,380 Views

3 Reposts 1 Quote 16 Likes

rajesh @Rg197923 Follow

Replying to @subimal_ghosh @ClimateIITB and 9 others

Sure your efforts on this are appreciated, most of the predictions you have given are bang on except I think last week when everyone was predicting 140+mm which never happened due to changes in weather

11:39 am · 07 Jul 24 · 79 Views

1 Retpost

Subimal Ghosh @subimal_gh... · 26 Sept 2024 · 07 Jul 2024

Replying to @Rg197923 @ClimateIITB and 9 others

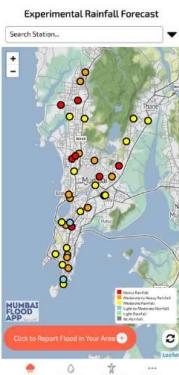
Thank you. I think all models have limitations. Some will do good for one event while others are for another..it's important to develop strategies to learn from data and different models with different limitations for a better forecast.

0 2 53 0 0

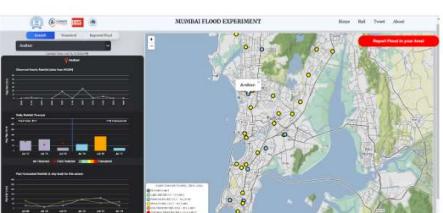
MUMBAI FLOOD APP (Team)

Logos of sponsors: IDP in CLIMATE STUDIES IIT BOMBAY, HDFC ERGO, heitt, and MDMCR.

MUMBAI FLOOD APP *Experimental*



www.mumbaiflood.in





Thank you