FLOOD HAZARD ASSESSMENT OF EXTREME FLOOD EVENT OVER PATNA, INDIA: A FLOOD-PRONE ZONE

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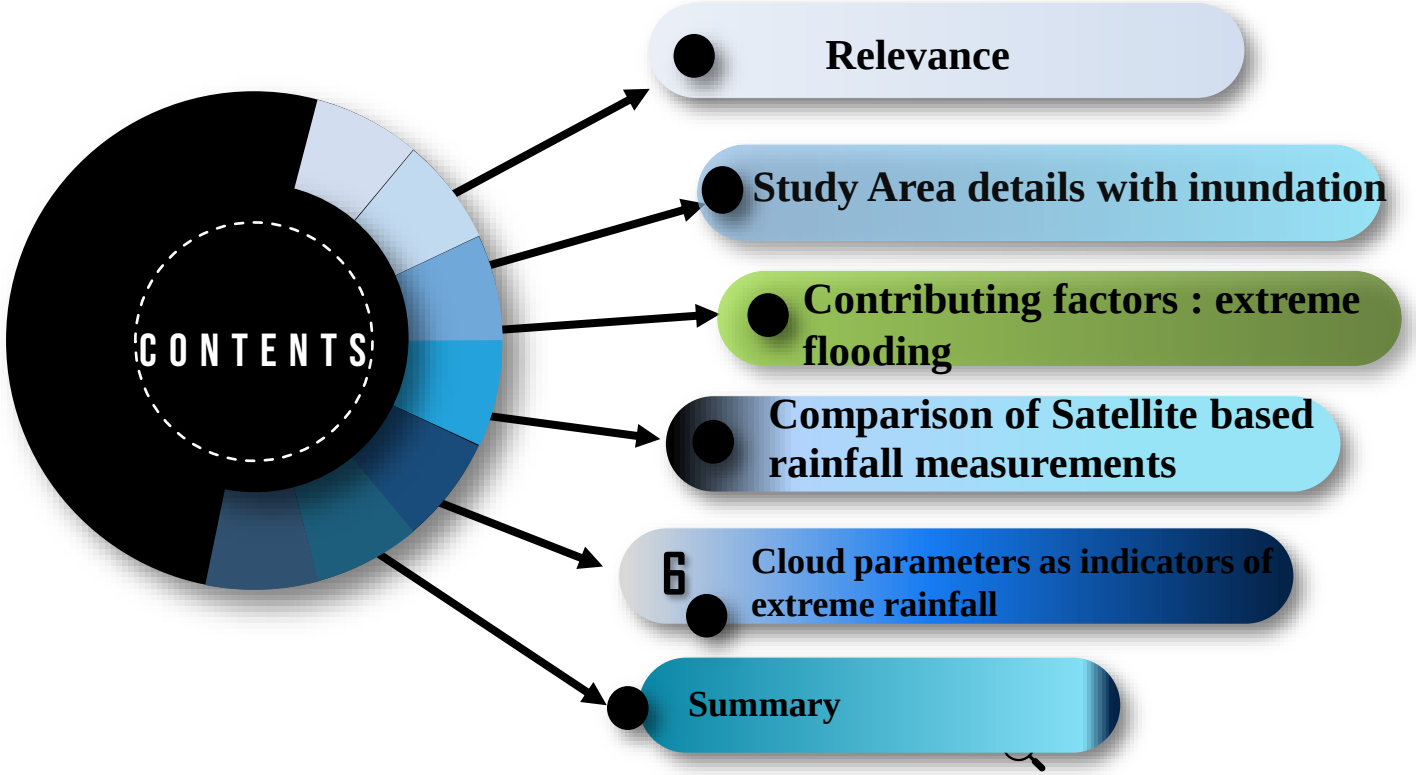
CONTENTS
Relevance
Study Area details with inundation
Contributing factors : extreme flooding
Comparison of Satellite based rainfall measurements
6
Cloud parameters as indicators of extreme rainfall
Summary

RELEVANCE

- It is well known fact that flooding is a natural disaster and a big societal problem. Many studies have been conducted to assess disastrous impacts of flood in different regions including Patna but behavior of extreme rainfall is less explored in context of Patna.

- understanding the behavior of extreme rainfall along with its quantification is very much required for the benefit of the society.

- Patna, the capital district of Bihar is one such district in India which is very much prone to flood and any extreme rainfall event makes the situation disastrous.

- Hence, the purpose of the present work is to **evaluate the ability of satellite derived cloud parameters to detect the extreme rainfall.**

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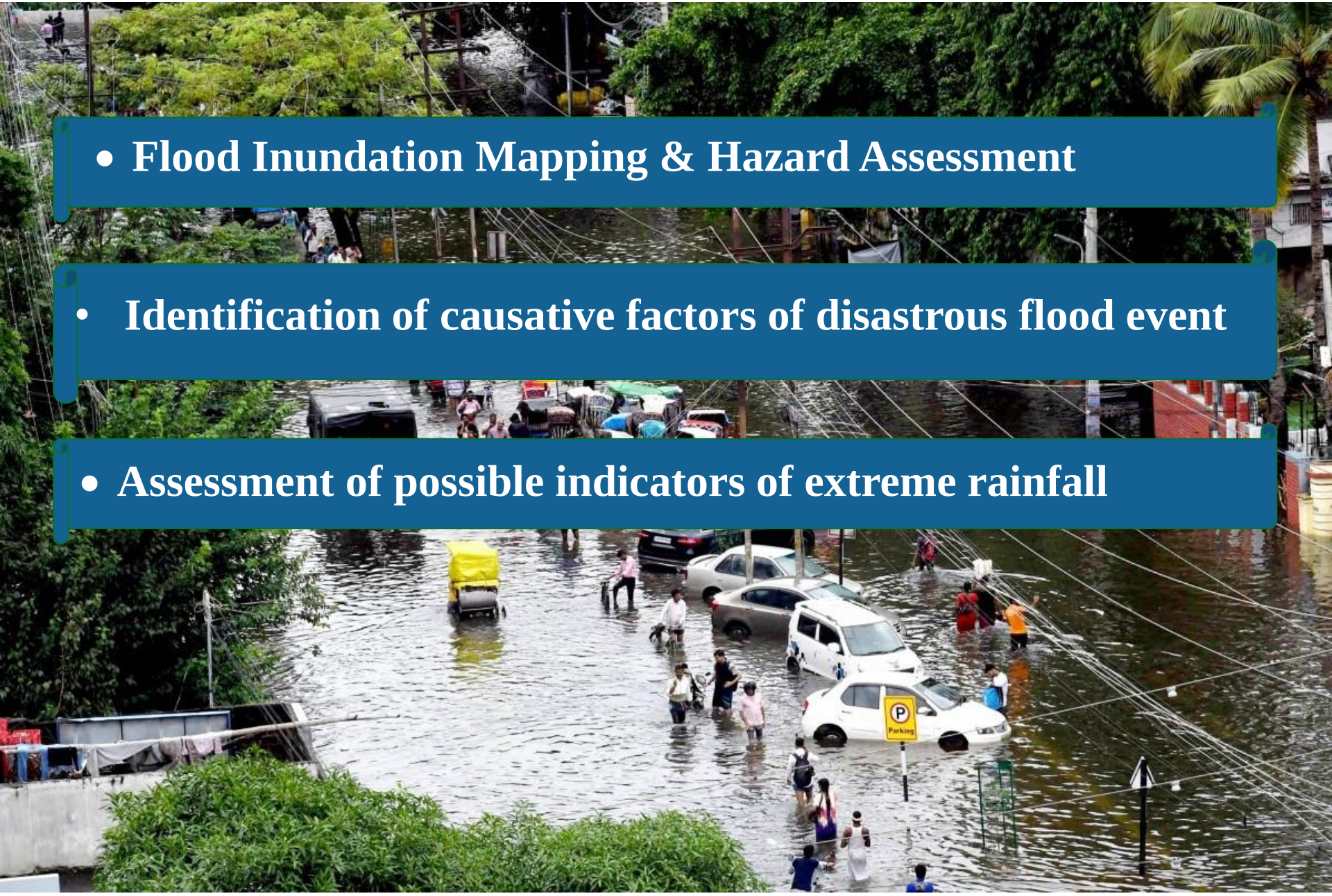
Objectives

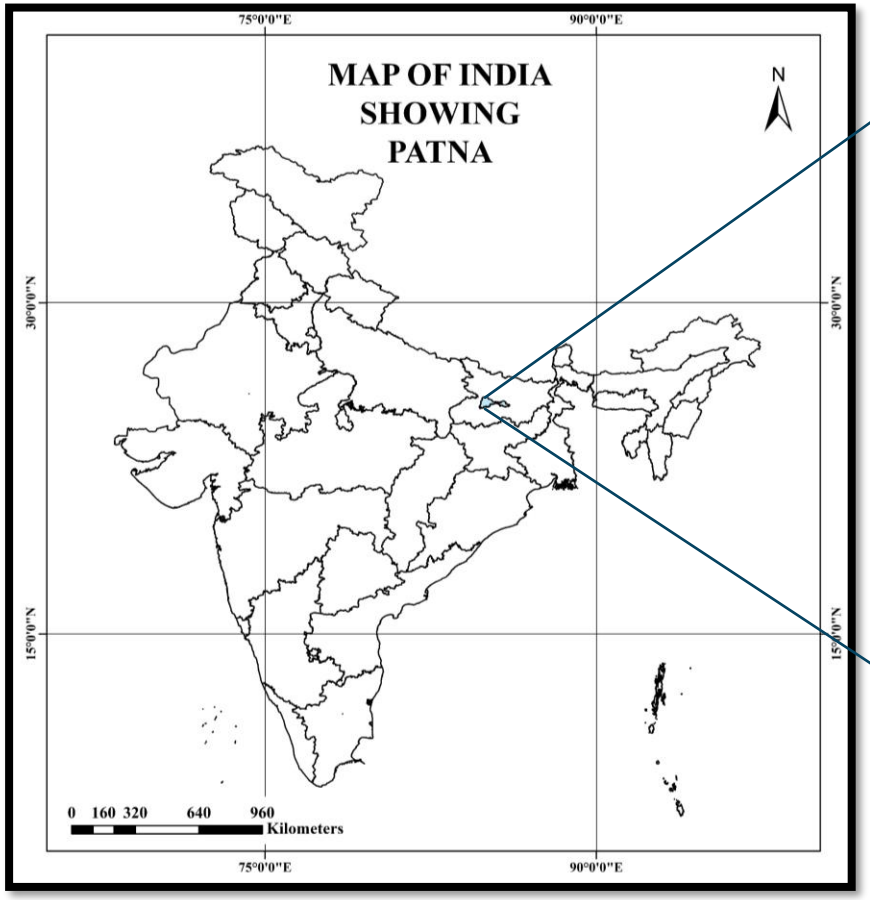


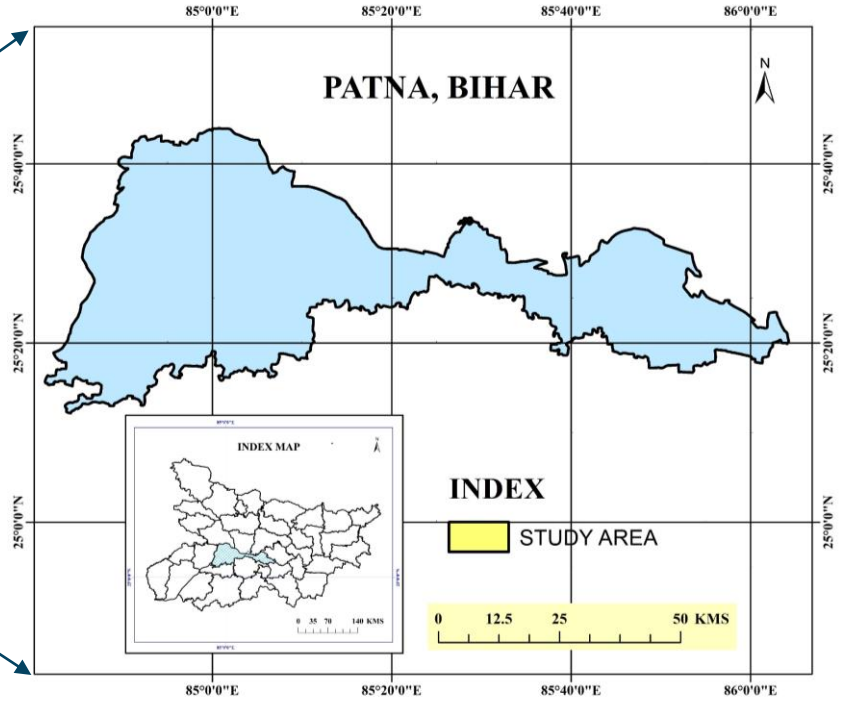
- Flood Inundation Mapping & Hazard Assessment
- Identification of causative factors of disastrous flood event
- Assessment of possible indicators of extreme rainfall

STUDY AREA DETAILS

Climate zone: **Composite**

Geographical area(GIS): 3073.91SqKm



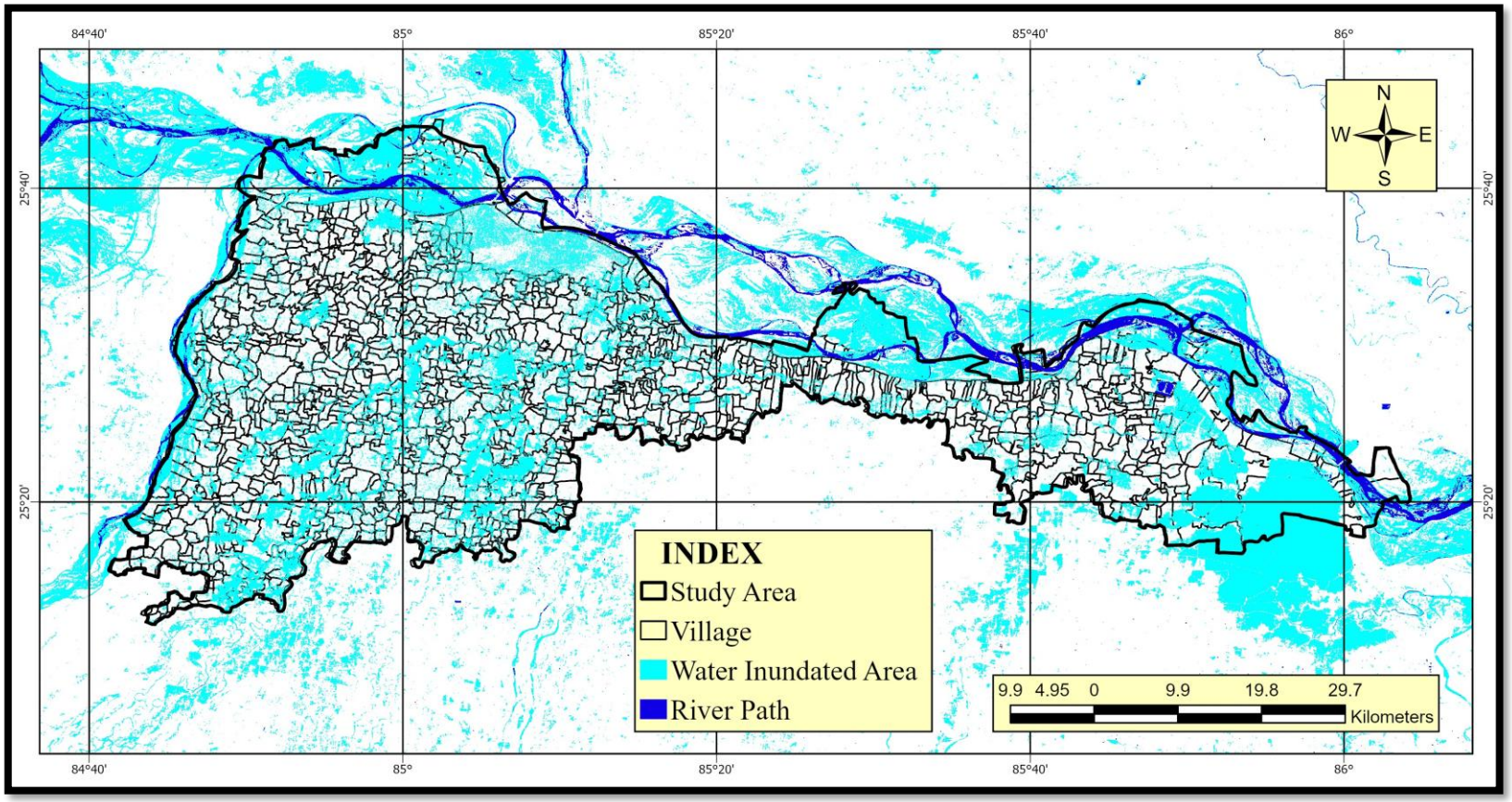


DATA USED

Data Type	Name of Sensor	Name of Satellite	Temporal Resolution	Spatial Resolution	Source (URL)
LULC (2018-2019)	Sentinel-2	Sentinel-2	Annual (2018-2019)	10 meters	ESRI Sentinel-2 Land Cover
CHIRPS Daily Precipitation	CHIRPS	TRMM (Tropical Rainfall Measuring Mission)	Daily (27th-29th Sep 2019)	0.05 degrees	CHIRPS Data on Earthdata
GPM Surface Precipitation	GPM (Global Precipitation Measurement)	GPM Core Observatory and partner satellites	Daily (27th-29th Sep 2019)	0.1 degrees (daily)	CLIM Data
Soil Surface Moisture	The "Combined" product results from a blend based on both scatterometer and radiometer soil moisture products	large set of satellite sensors	!0 Day interval	0.25° x 0.25°	Copernicus Climate Change Service (C3S)

Data type	Name	Source (URL)
Ground data	Rain-gauge data	Central Water Commision (CWC)
	Disaster Management Department, Govt. of Bihar	http://disastermgmt.bih.nic.in/
Satellite data	Sentinel-2	https://sentinel.esa.int/web/sentinel/home
	INSAT 3D HEM	https://www.mosdac.gov.in
	ERA5	https://cds.climate.copernicus.eu/
	CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data)	https://www.chc.ucsb.edu/data/chirps
	Cloud Top Temperature	https://nrsc.gov.in https://www.mosdac.gov.in
	INSAT 3DIMR	

FLOOD INUNDATION(September,2019)



Inundated Area in Patna (September 2019 Flood) extracted from Pre flood and post flood Sentinel-1 Satellite images and water mask extracted from NDWI derived from Sentinel-2 optical image

Flood Condition Near Gandhi Maidan, Kankar Bag area, Patna (1 October 2019)

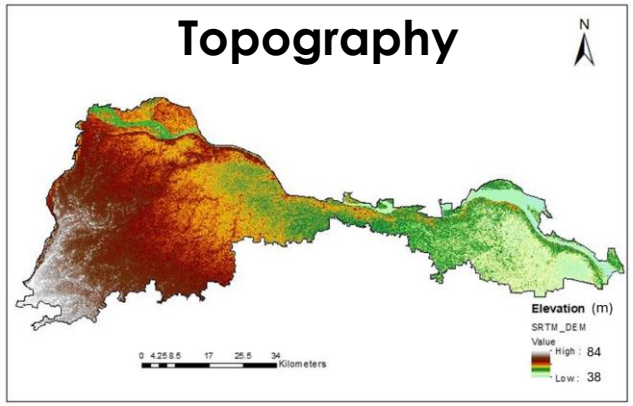

Vehicles navigating through flooded streets


Pedestrians wading through water


Flooded roads and disrupted daily life in Kankarbag

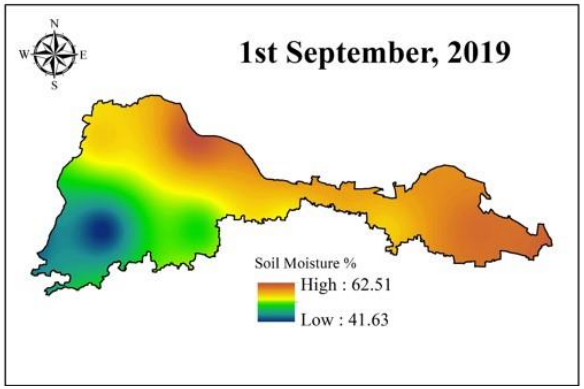
- Rainfall: **371.85**mm over 4 days (27th to 30th September 2019)
- **Residents Affected** : 58,38,465,
- **Submerged** :0.24 lakh hectares of agricultural land, and caused extensive property damage. Water entered 80% of the houses in the capital City of Patna and about 30% of total area of Patna District.
- The slum areas of Rajendra Nagar area, Ramakrishna Nagar, Kankarbagh, boring road, Nala Road, Gandhi Maidan are among the worst-affected localities in Patna

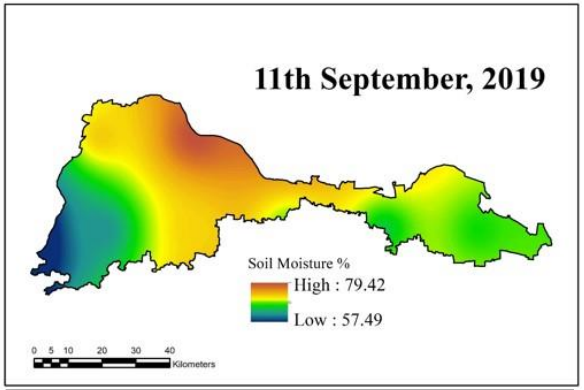
Contributing factors towards extreme flooding

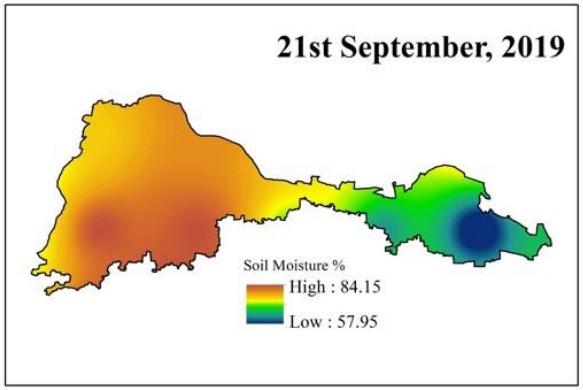


- Ganga at Patna Gandhighat was at 49.42m (danger 48.6m).
- The Sone river at Maner, Patna district, stood at 52.34m (danger 52m)

Saturated Soil(10 days soil moisture product 2-5 cm depth)



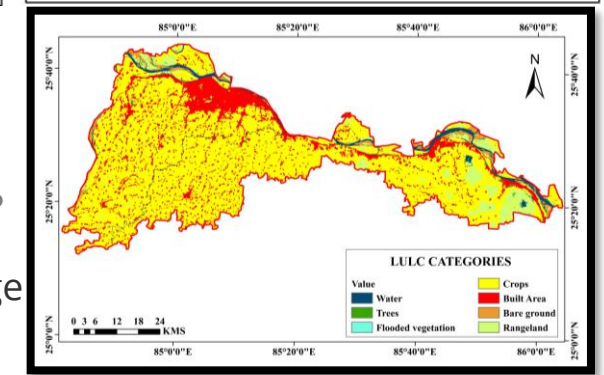




Satellite-based soil moisture climate data record production

Horizontal reso 0.25° x 0.25°

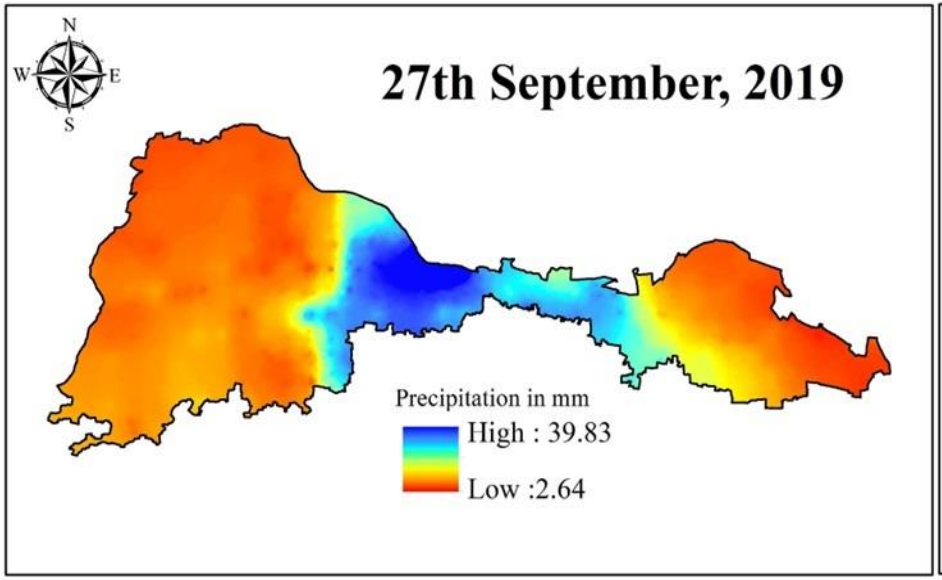
(Source: Copernicus Climate Change Service (C3S)

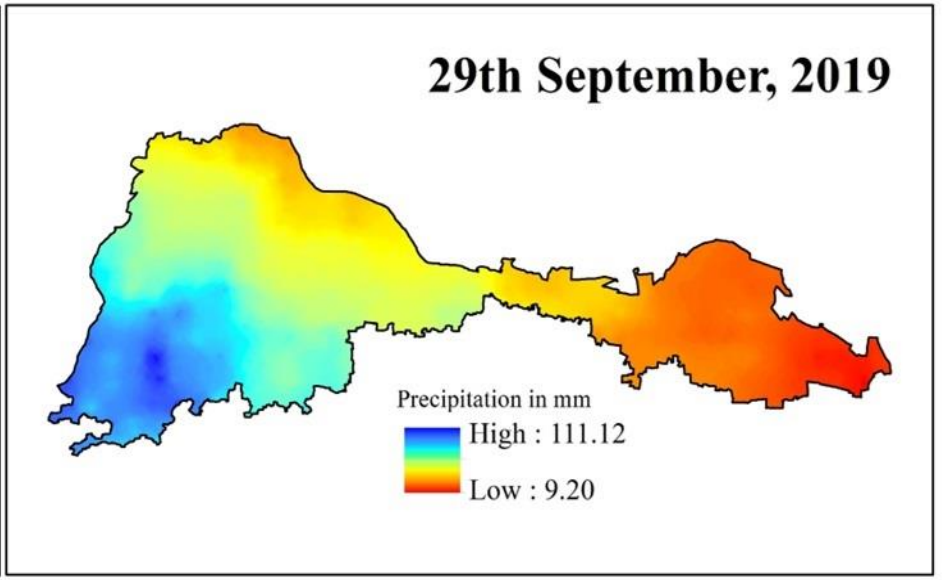


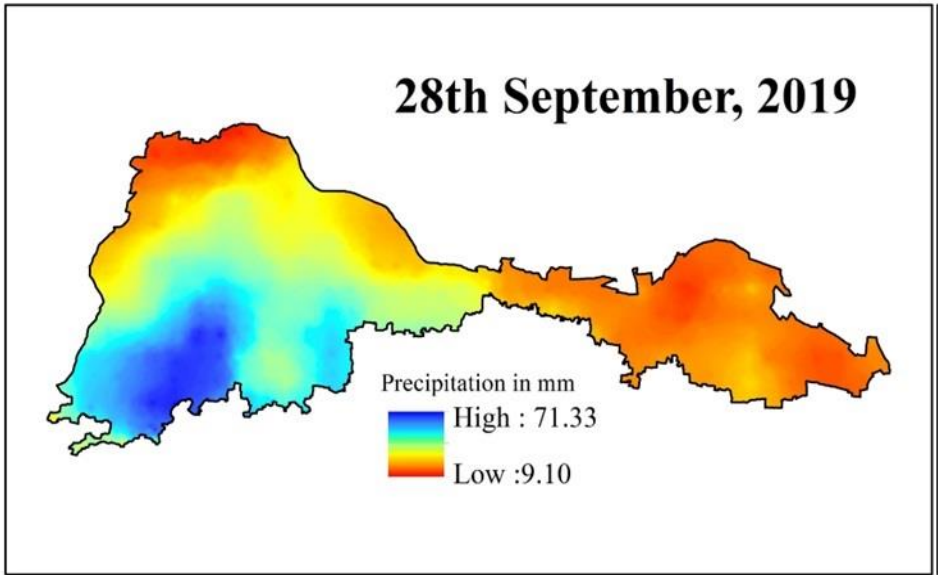
Land Use Land Cover (LULC) for Patna(2018-2019)

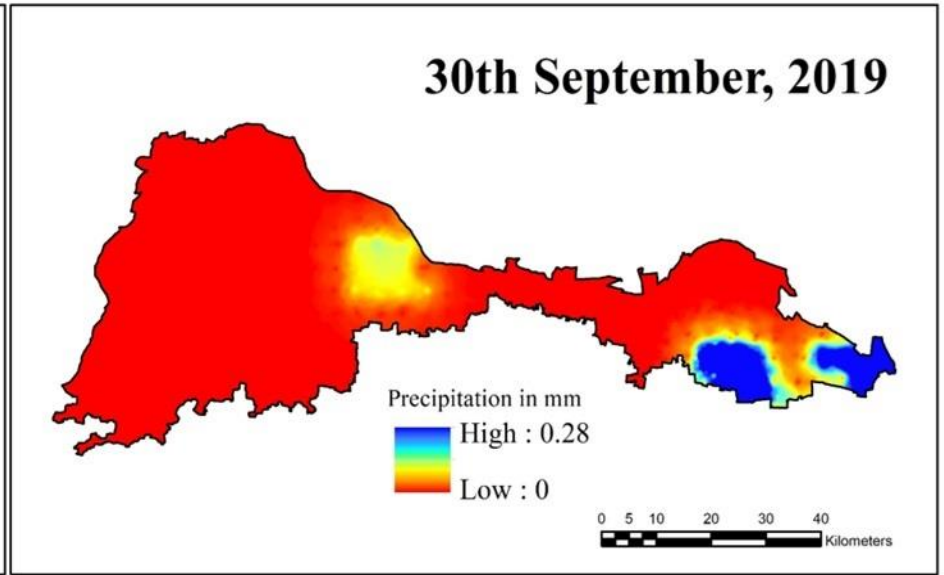
Major Contributing factors: Extreme rainfall

Daily Precipitation: INSAT 3D HEM

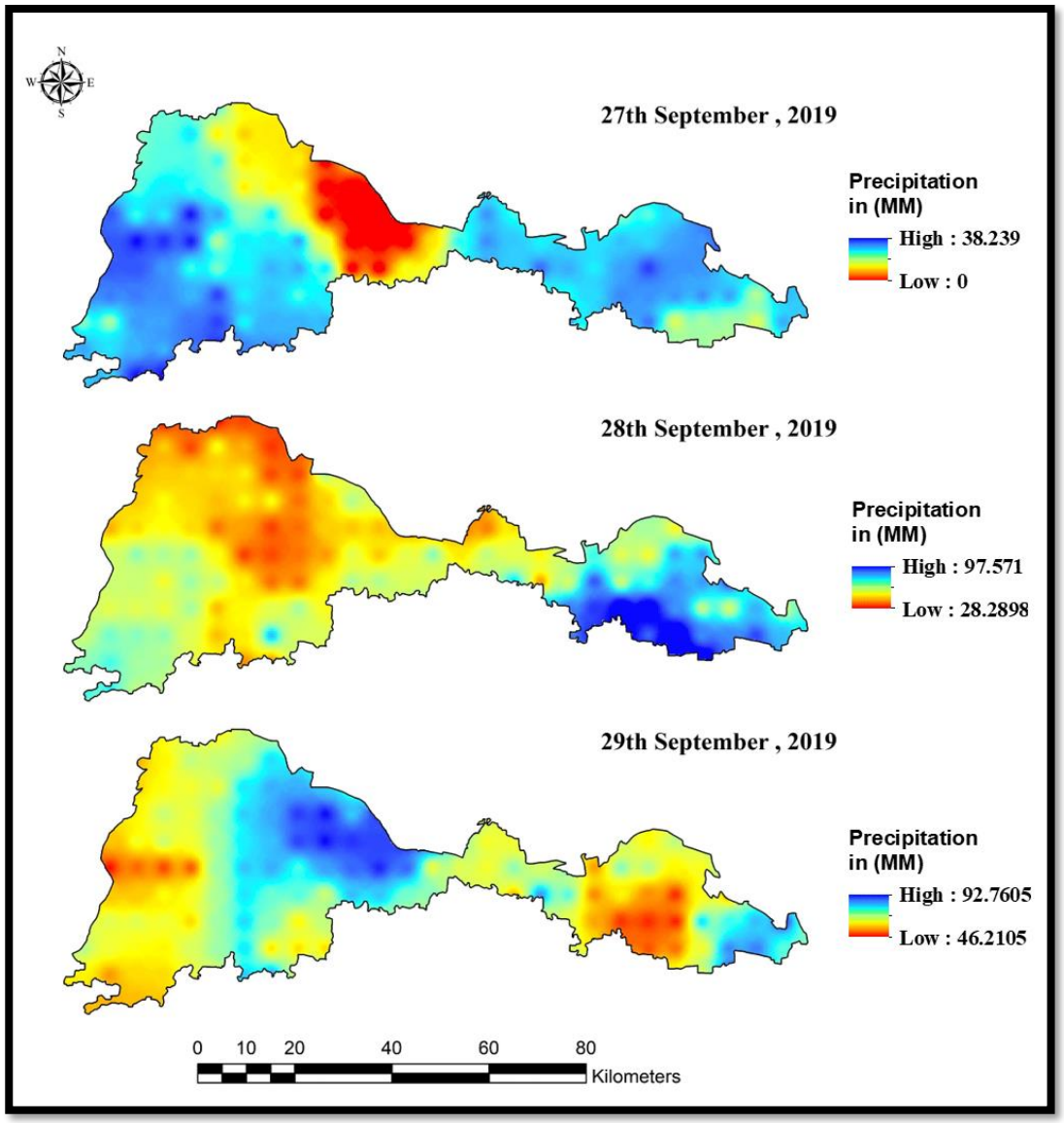


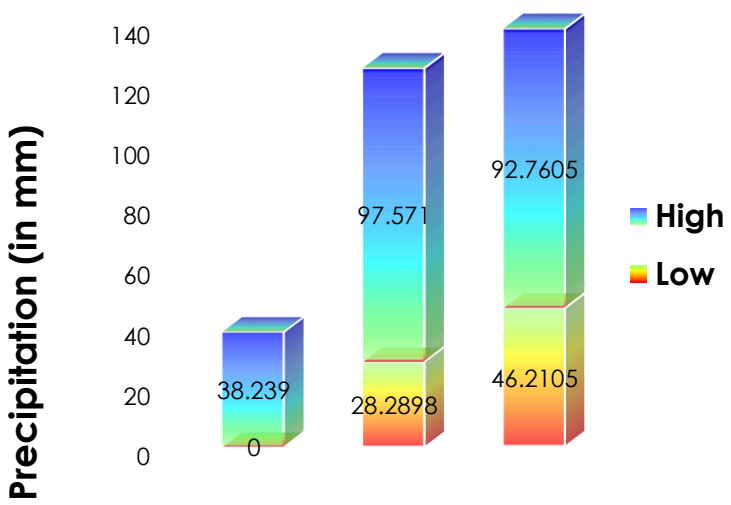




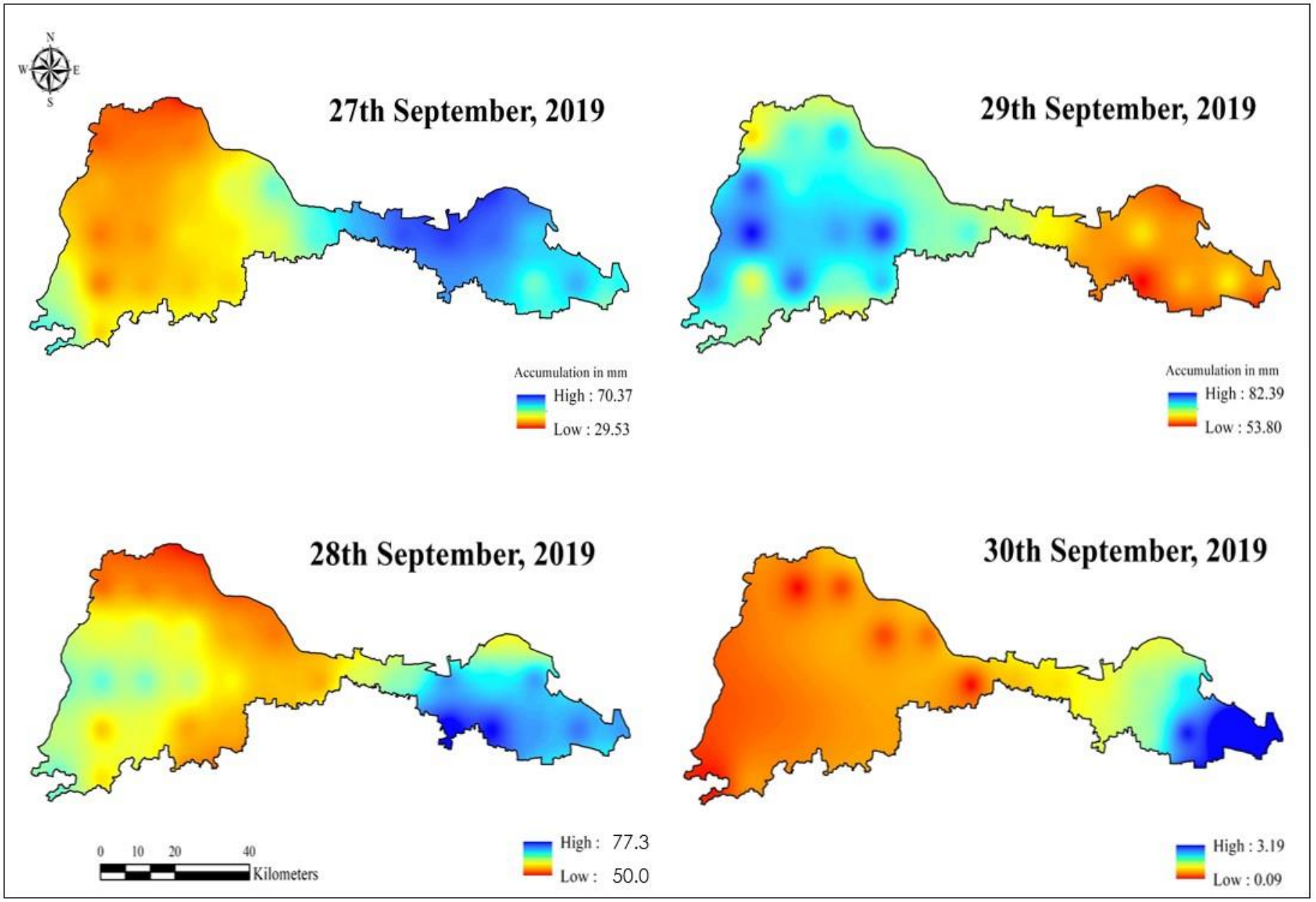


CHIRPS Daily Precipitation Analysis for Patna - 27-29 September, 2019

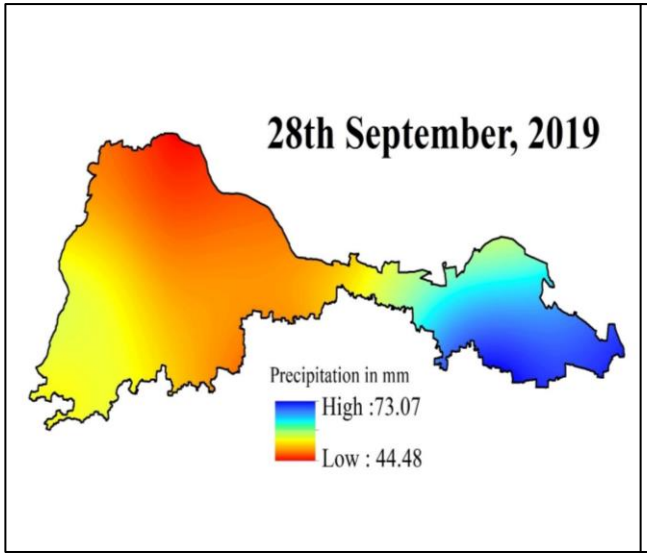


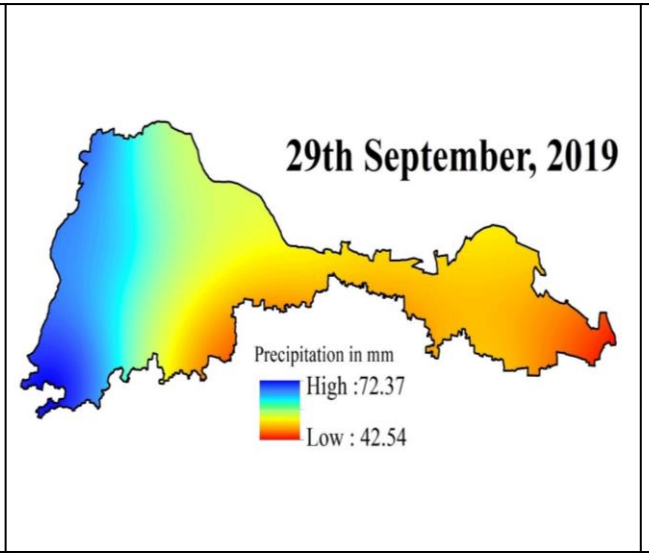


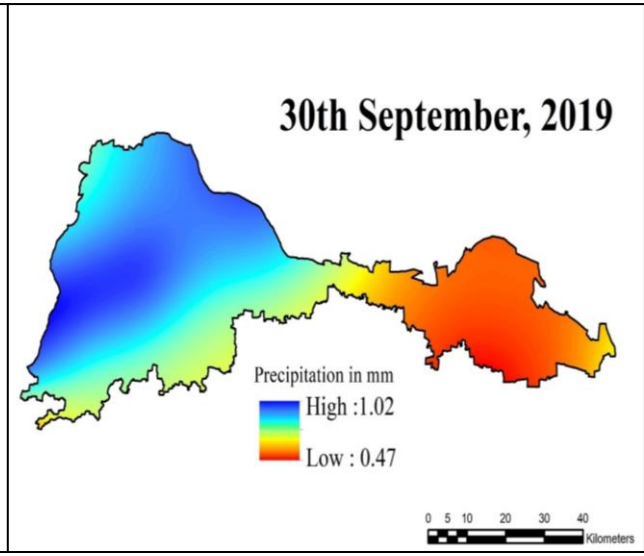
GPM Daily Precipitation Accumulation



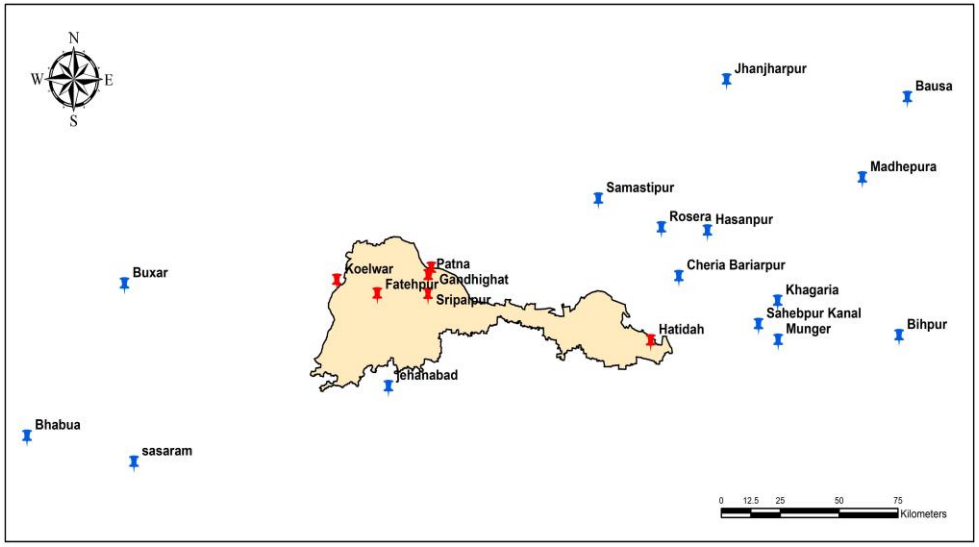
GPCP Daily Precipitation Accumulation

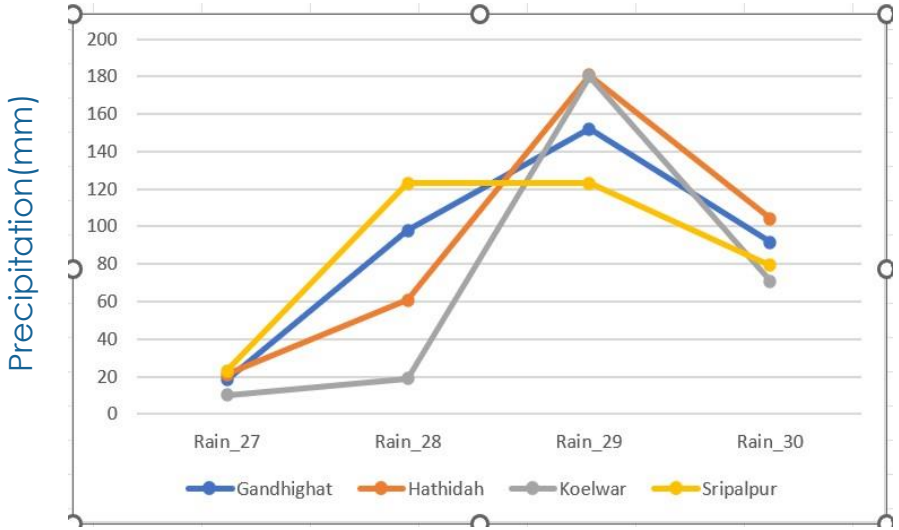




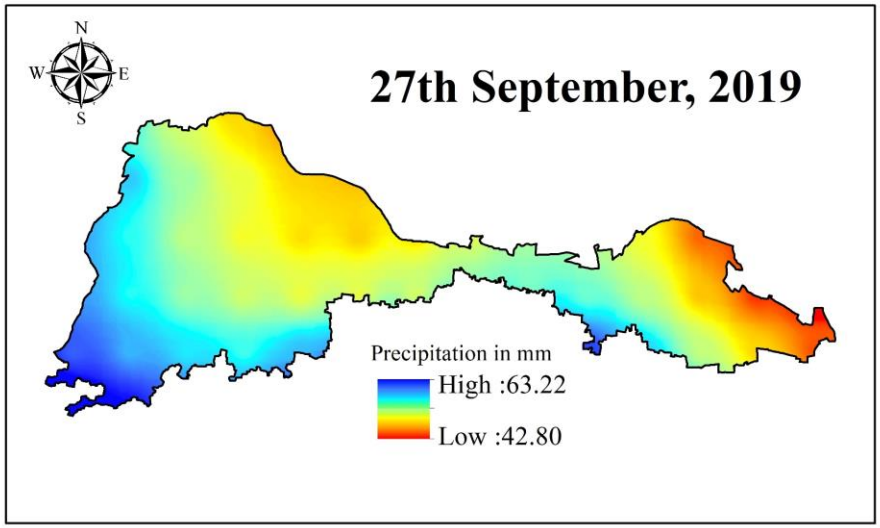


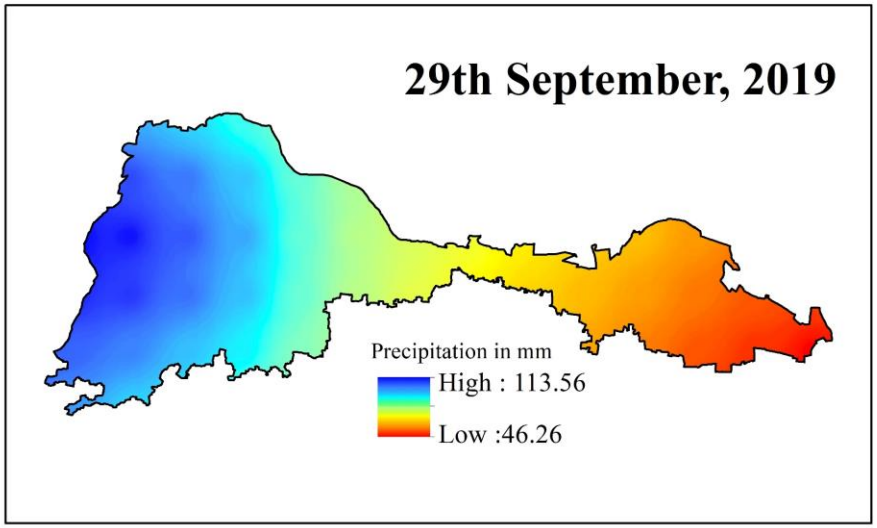
Location of CWC and other points

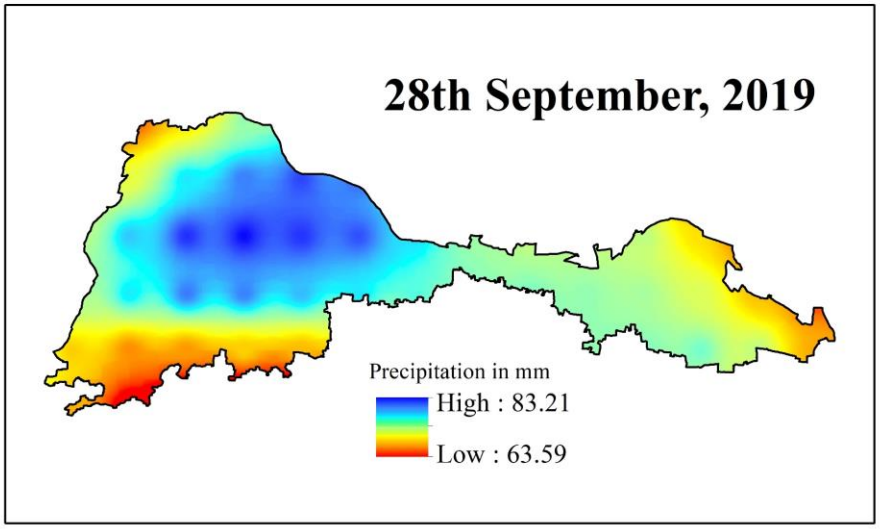


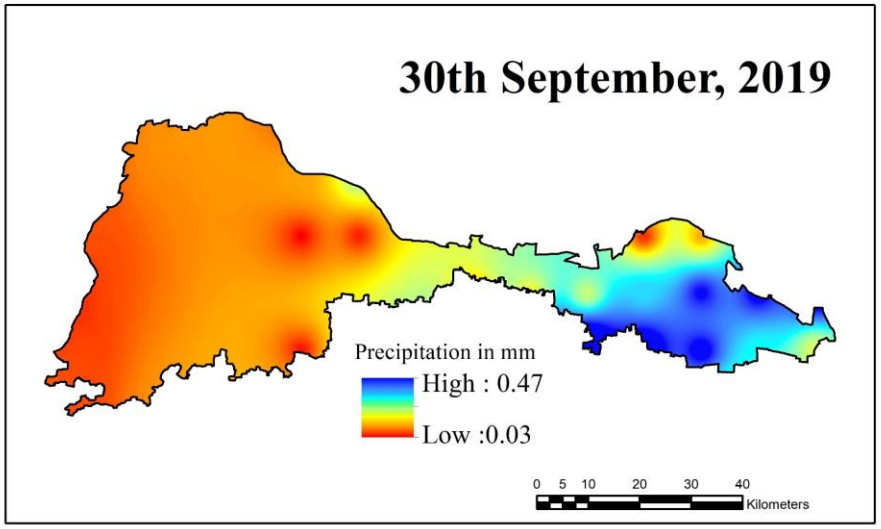


IMR

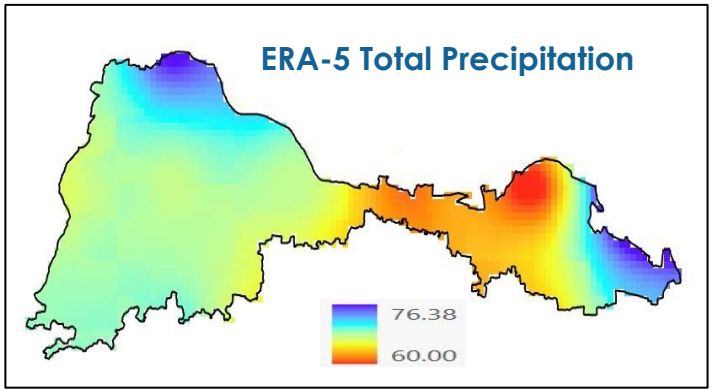

N
W
E
S
27th September, 2019
Precipitation in mm
High :63.22
Low :42.80

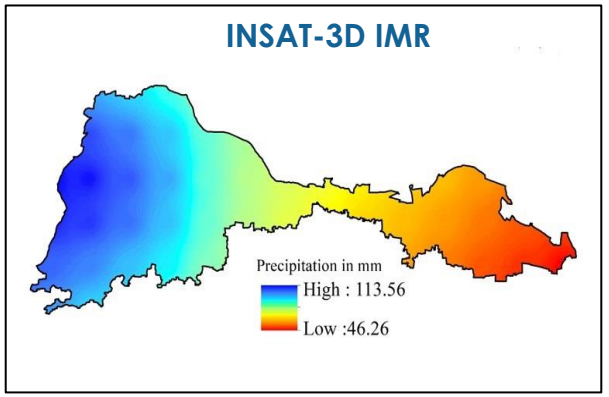

29th September, 2019
Precipitation in mm
High : 113.56
Low :46.26

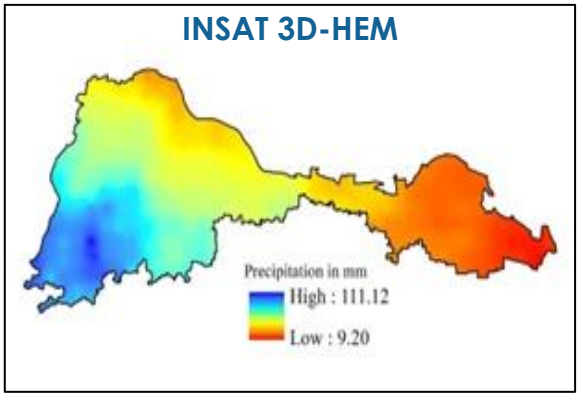

28th September, 2019
Precipitation in mm
High : 83.21
Low : 63.59

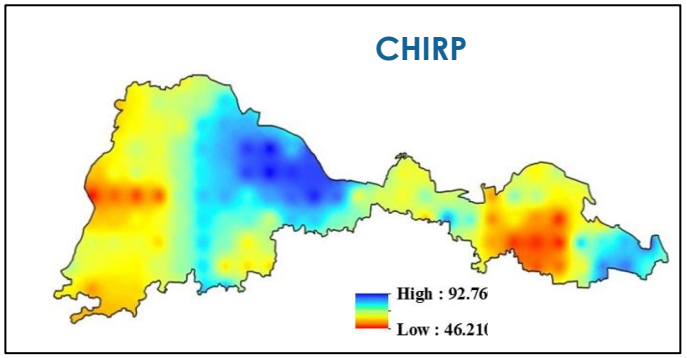

30th September, 2019
Precipitation in mm
High : 0.47
Low :0.03
0 5 10 20 30 40
Kilometers

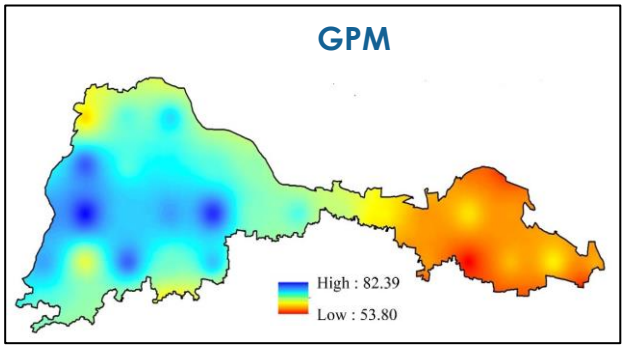
Comparison of satellite derived rainfall measurement (29 Sep,2019)

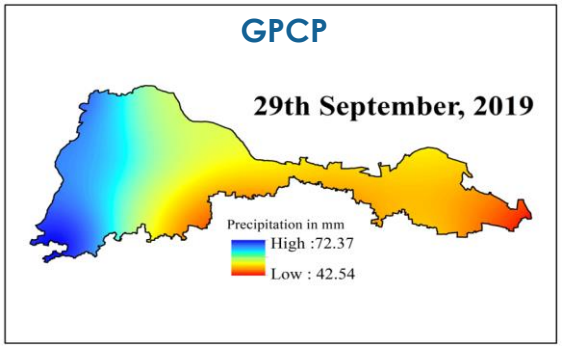


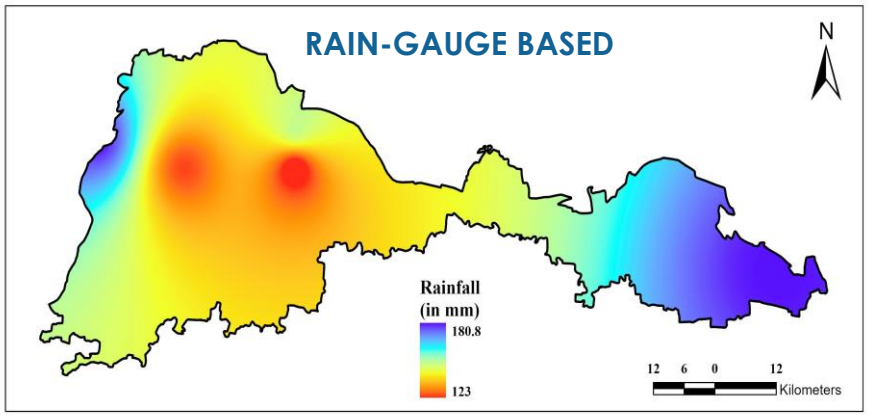


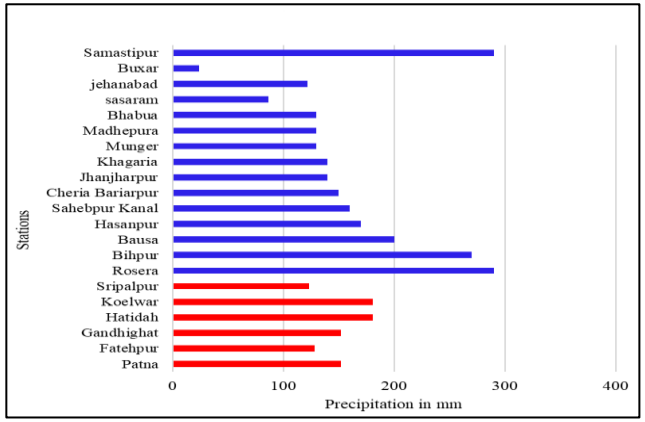




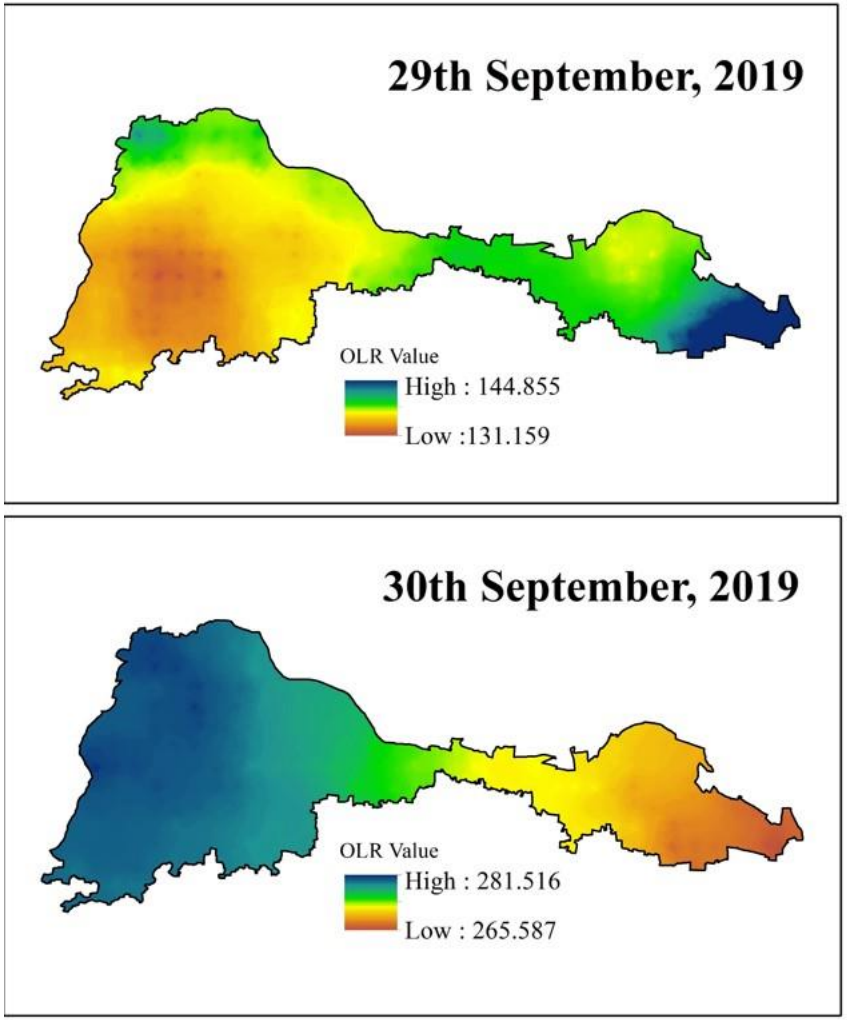




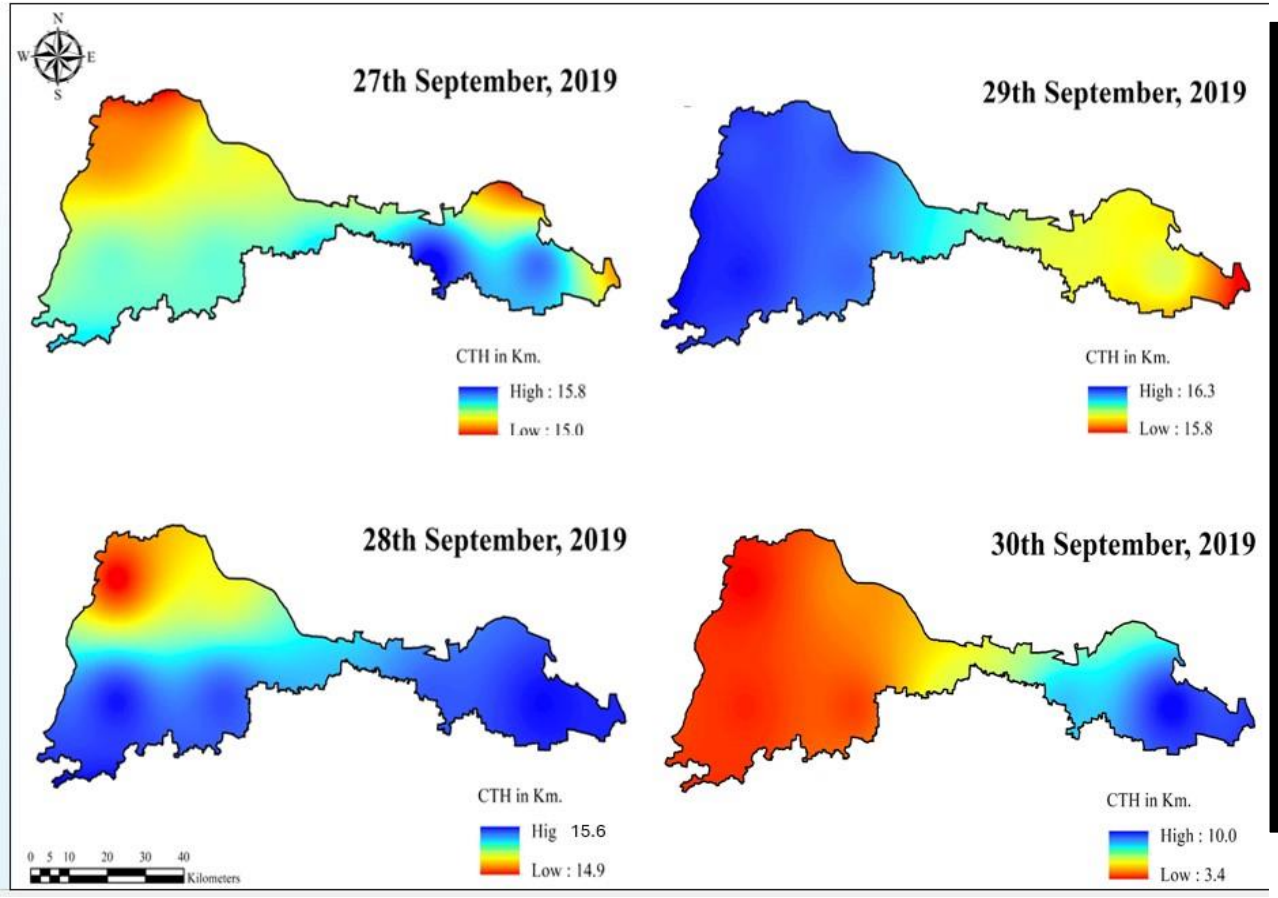


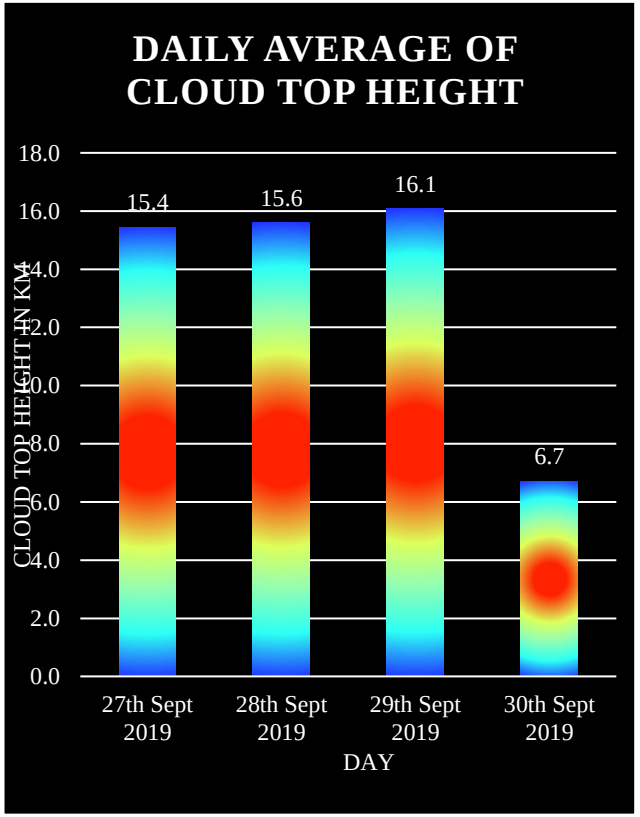


Cloud parameters as indicators of Extreme rainfall (OLR)

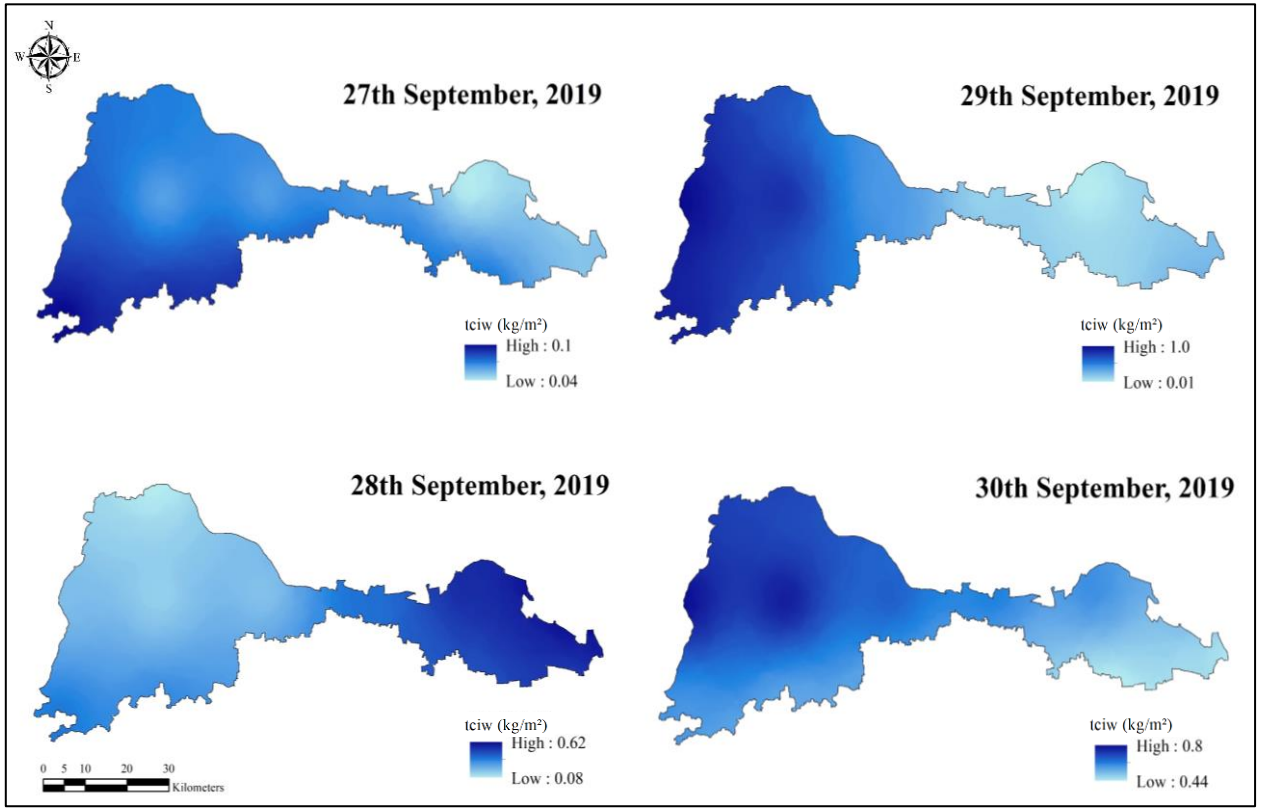


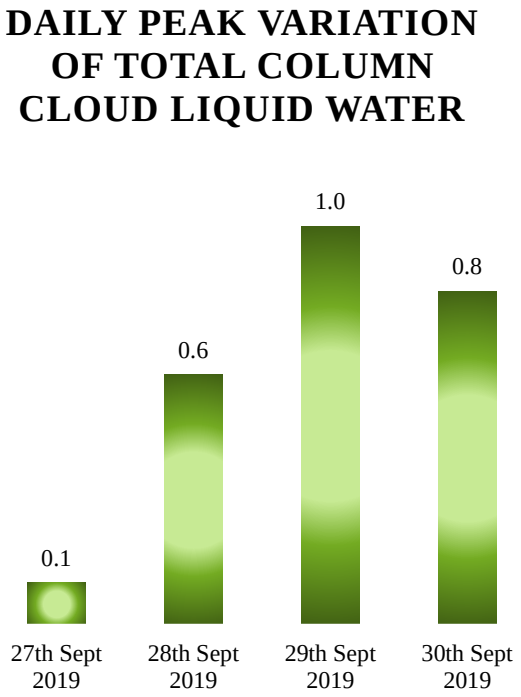
CLOUD TOP HEIGHT

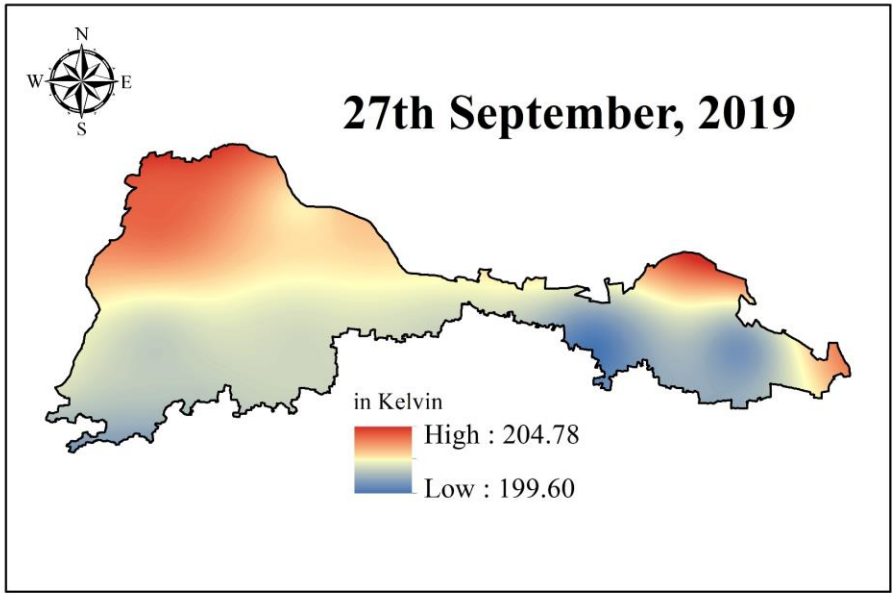


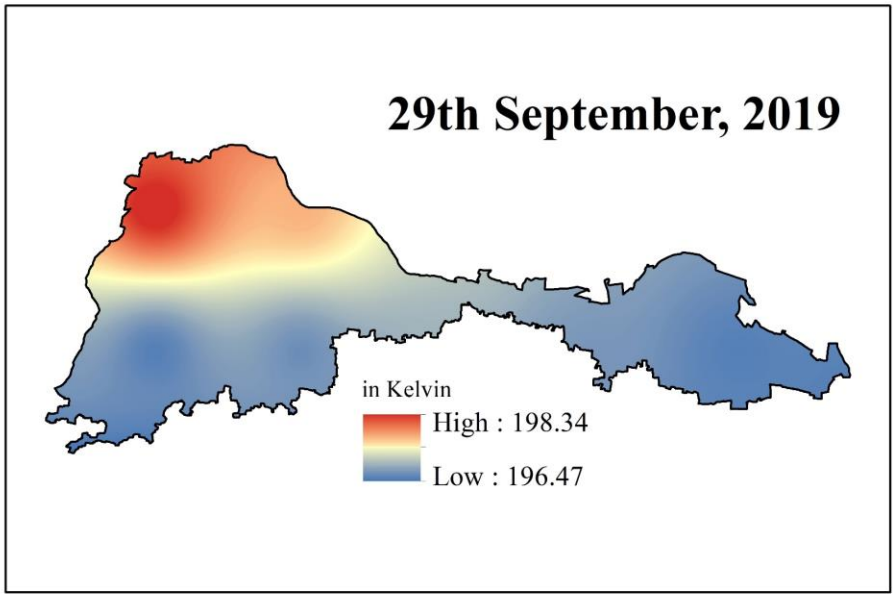


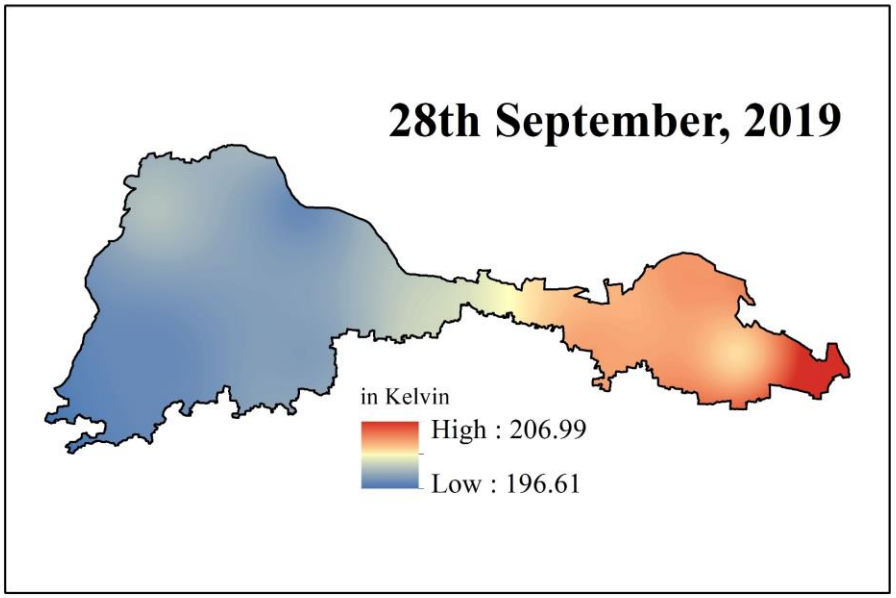
Total Column Cloud Liquid Water (kg/m^2)

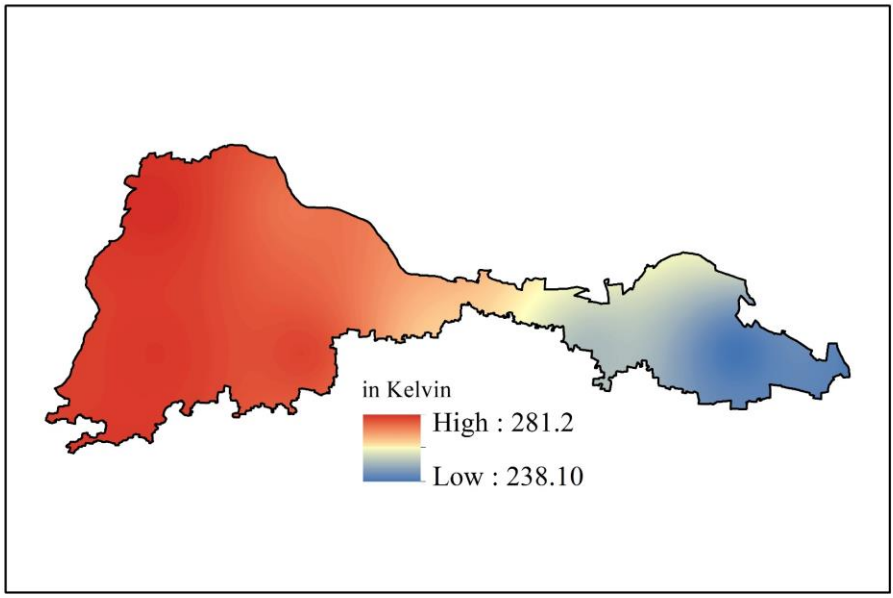










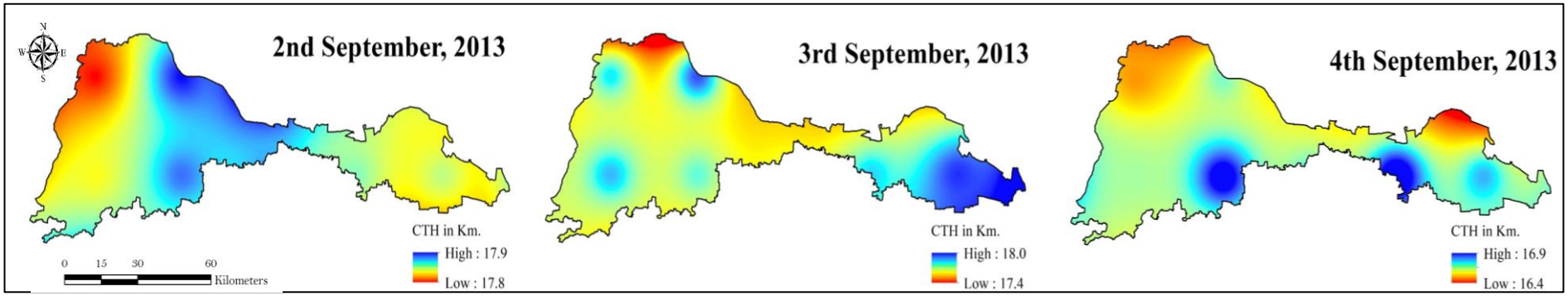


CLOUD TOP TEMPERATURE

Cloud Top Height

September, 2013

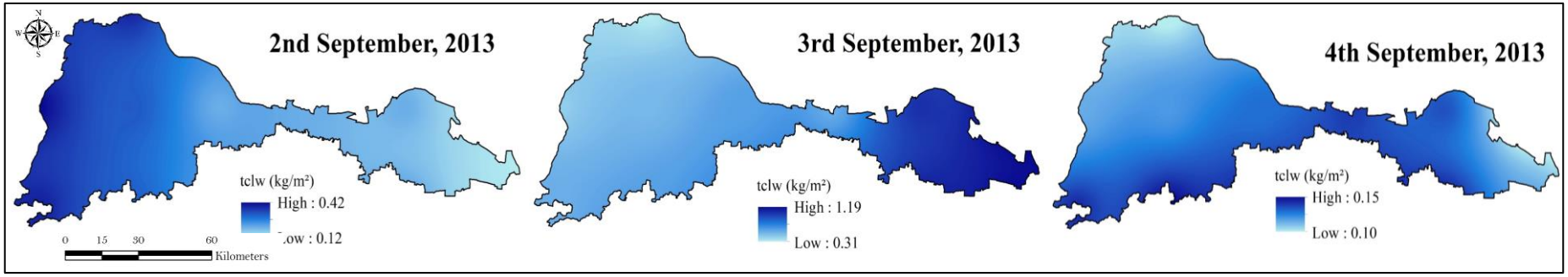
[Diurnal variation]



Total Column Cloud Liquid Water (kg/m^2)

September, 2013

[Diurnal variation]



Summary

- Extreme rainfall is natural phenomena, one can not stop it. We can't change the topography as well.
- Hence , the corrective measures will be removal of construction from river catchment.
- Timely desiltation of river bed.
- There are few cloud parameters which indicates extreme rainfall and careful monitoring of theses parameters in real time can lead to finding better probability of extreme rainfall.
- Enhanced accuracy of cloud products derived from satellite can be used for the assimilation of NWP modelling for better forecast.

Acknowledgement

- I deeply acknowledge the financial support by Sponsors,9th GEWEX Open Science Conference and George Mason University, USA for its processing.

- Further, I would like to acknowledge the contribution of Dr.Divya Prakash for preparations map layouts
- I also acknowdge CWC for providing ground data

Thank you