

Satellite Based Analysis – Flood Mapping & Monitoring in Uttar Pradesh -2022



Flood Mapping & Risk Assessment Division (FMRAD)
Disaster Management Support Group (DMSG)
National Remote Sensing Centre (NRSC)
Indian Space Research Organisation (ISRO)
Department of Space, Government of India
Balanagar, Hyderabad, Telangana -500037, India

November 2022



nrsc

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| 15. | Abstract: Heavy rainfall and heavy runoff during October 2022 in the Ganga River basin has hit Uttar Pradesh State and affected several districts in many locations along Rapti, & Ghagra river reaches. NRSC has initiated to acquire the satellite data and map & monitor the flood inundation starting from 9 th August to 25 th October 2022 for providing near real time flood inundation maps to the State and Central Disaster Management Support organizations. Summary of study is provided in this report. | | | |

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1. Introduction

Uttar Pradesh experienced severe floods during August – October 2022 due to unprecedented and intense rains. Major floods have occurred in Ganga River Basin along the Rapti & Ghagra river reaches due to heavy rainfall and runoff during Aug – October 2022. It has affected several districts in Uttar Pradesh, which left scores of population homeless and caused hundreds of fatalities, and washed away homes.

NRSC has initiated to acquire the satellite data and carried out rapid flood mapping and monitoring on daily basis starting from 9th August to 25th October 2022 for providing near real time flood inundation maps to the State and Central Disaster Management Support organizations. Summary of study is provided in this report. The major affected districts are Balarampur, Siddharth Nagar, Gorakpur, etc..

The report describes the summary of the study carried out on rapid flood mapping and monitoring using multi-sensor satellite data across the flood duration period.

2. Identification of Areas prone to be affected due to flood Inundation

Water level data of major river systems and their tributaries at various gauge stations is collected from CWC on daily basis towards the water levels of various rivers and their tributaries. NRSC has continuously monitored the raise / fall of water levels at CWC gauge stations which are above danger levels, rainfall pattern, predicted runoff scenarios on a daily basis, and planned for acquisition of satellite data during the flood duration to support the Disaster Management Support organizations as part of Indian Research Space Research Organisation (ISRO)'s Disaster Management Support Programme (DMSP).

3. Rainfall Pattern & Analysis

India Meteorological Department (IMD) Provides Rainfall Information as point data which is converted into the spatial gridded data. The floods have occurred during four times (1) 9-15th Aug 2022, (2) 15-23th Sep 2022, (3) 27th – 20th Sep 2022, and (4) 5-15th October 2022. Accordingly, Cumulative rainfall information were prepared for the flood affected regions of Uttar Pradesh using IMD gridded rainfall data for the following periods: 15th Aug- 7th Sep , 2022, 10th Sep – 27th Sep , 2022, 5th Oct – 15th Oct, 2022 is depicted through the figures 1(a), 1(b), 1(c)

It was observed that, Rainfall grids across Uttar Pradesh show that, rainfall is in the range of 50-100mm 15th Aug- 7th Sep, 2022 and is in the range of 250-300mm in majority of grids , further , rainfall is in the range of 300-350 in the regions along the Rapti river and several districts were flooded during 15th Aug- 7th Sep, 2022 .

It was observed that, Rainfall grids across Uttar Pradesh show that, 10th Sep- 27th Sep, rainfall is in the range of 350-400mm 2022 in the majority of grids , along the Rapti river and several districts were flooded during this period.

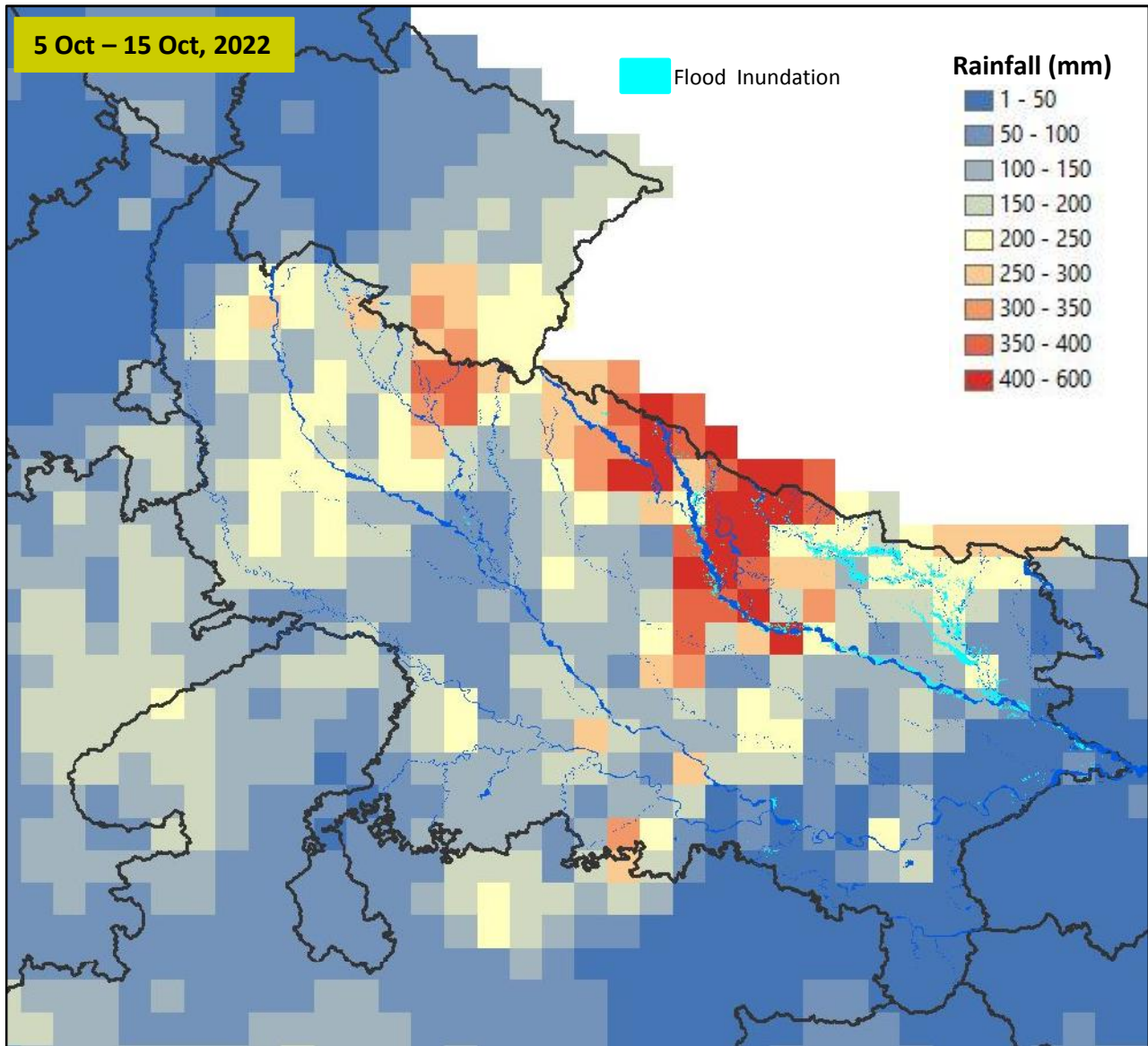


Figure. 1 - Gridded IMD Rainfall During 5th Oct to 15th Oct,2022

(Source: IMD)

4. Monitoring of River Water Levels at Gauge stations

Central Water Commission (CWC) measures water levels at various gauge stations and provide the information to NRSC. This will help to understand the warning and danger levels across the river (s) reaches. Figure.2 indicates location of gauge points where in alerts are provided . Major flood inundation is observed in the Rapti , Ghagra River reaches in Ganga Basin areas of Uttar Pradesh.

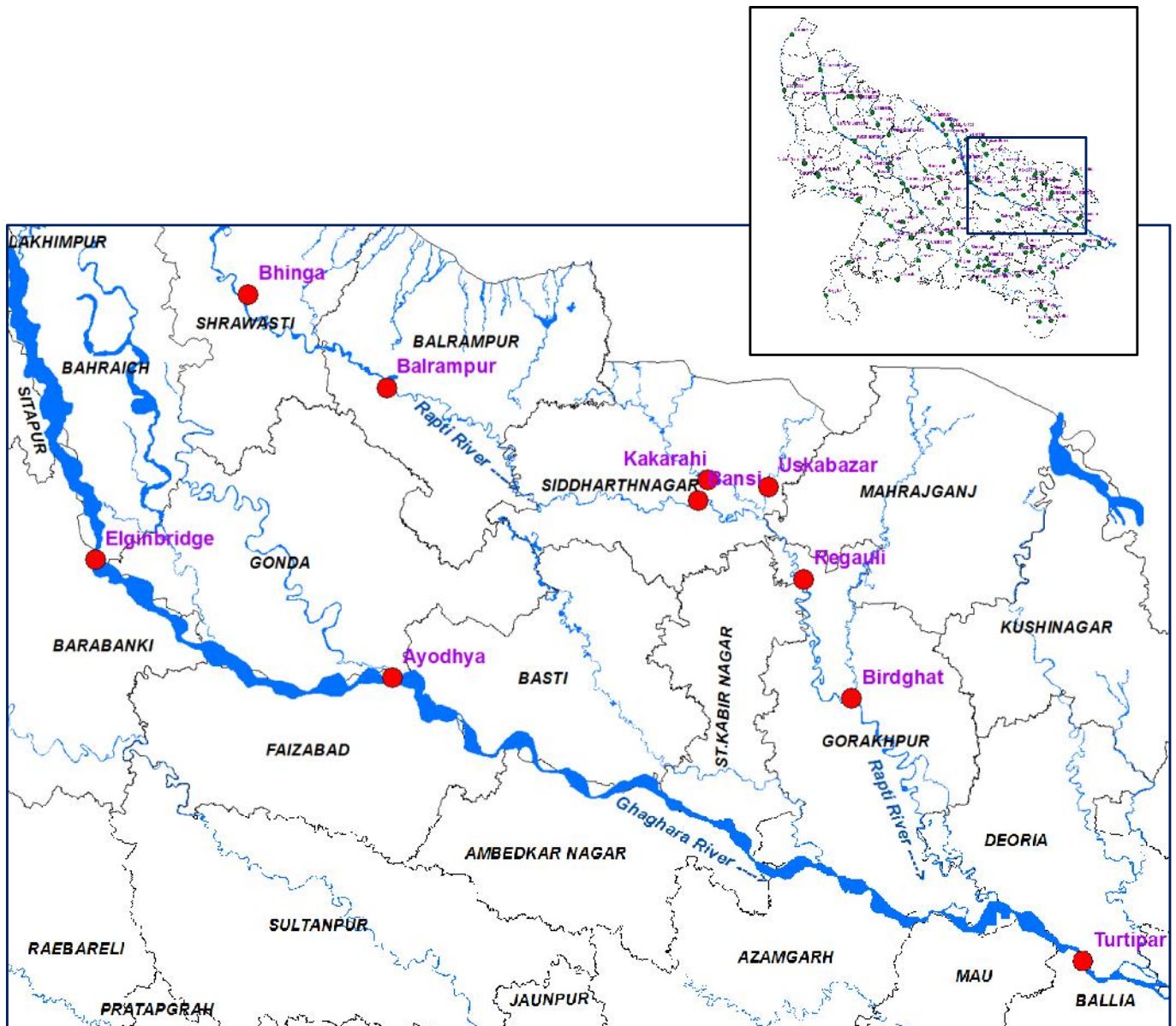


Figure. 2. Location of CWC Gauge Stations along Godavari river
(Source: CWC)

Dynamics of river water levels observed by CWC during the events of reaching the Danger levels and above are depicted in Figures 3

Figure 3(a) below indicate that the Water level has reached above Danger Level (119.5m) on 18th September 22 and is raised to 120.51m on 7th Oct,2022 to 9th Oct,2022 flowing above HFL and continued to flow above danger level at Bhinga gauge station till 11th October 2022. (Source: CWC)

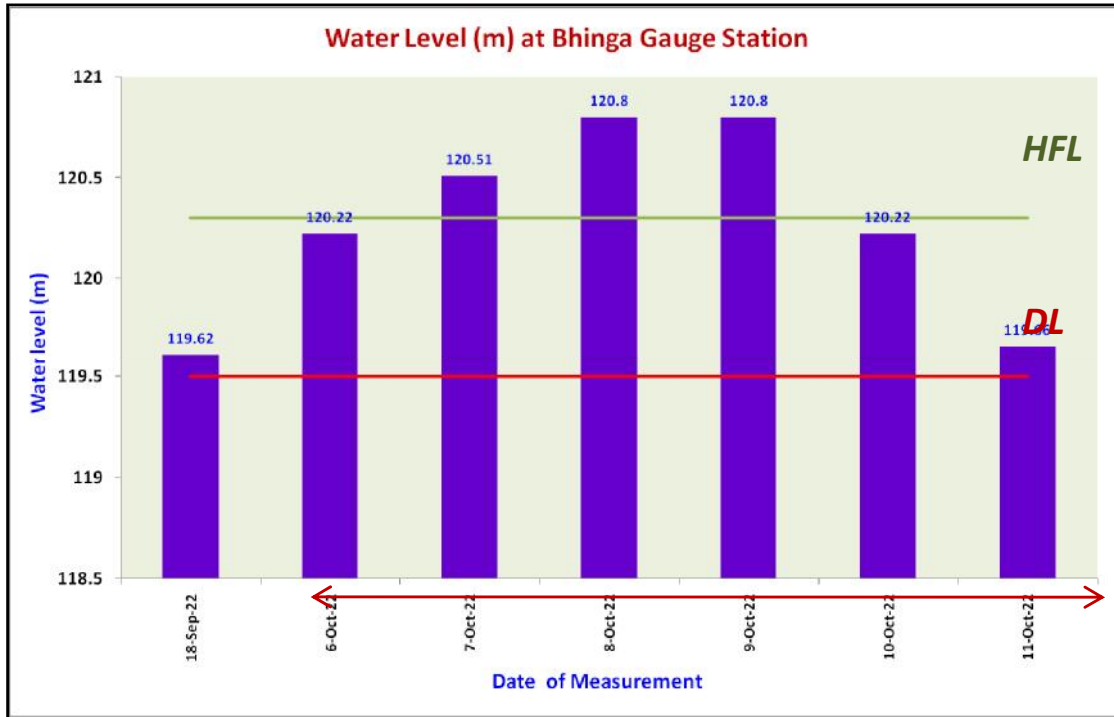


Figure 3(b) below indicate that the Water level has reached above Danger Level (104.6m) on 19th September 22 and is raised to 106.7m on 10th October,2022 and continued beyond danger level at Balrampur gauge station till 14th October 2022. (Source: CWC)

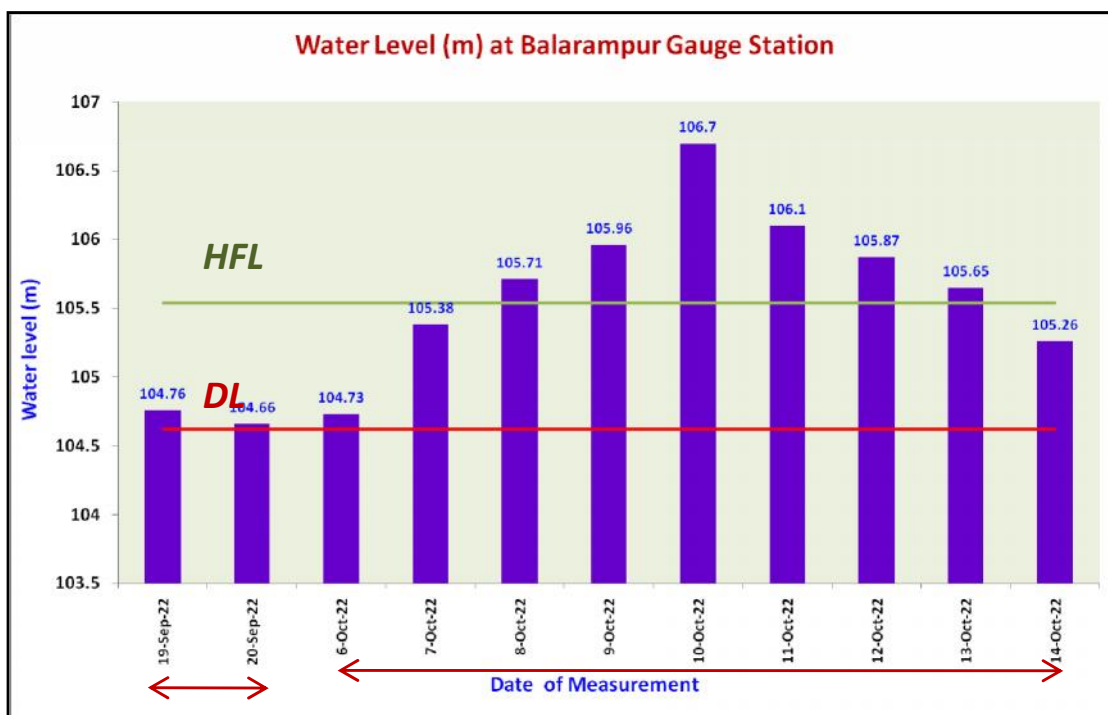


Figure (3c) below indicate that the Water level has reached above Danger Level (84.9m) on 10th October 22 and is raised to 86.26m till 16th October 2022 and is continued beyond danger level at Bansi guage station till 22nd October 2022. (Source: CWC)

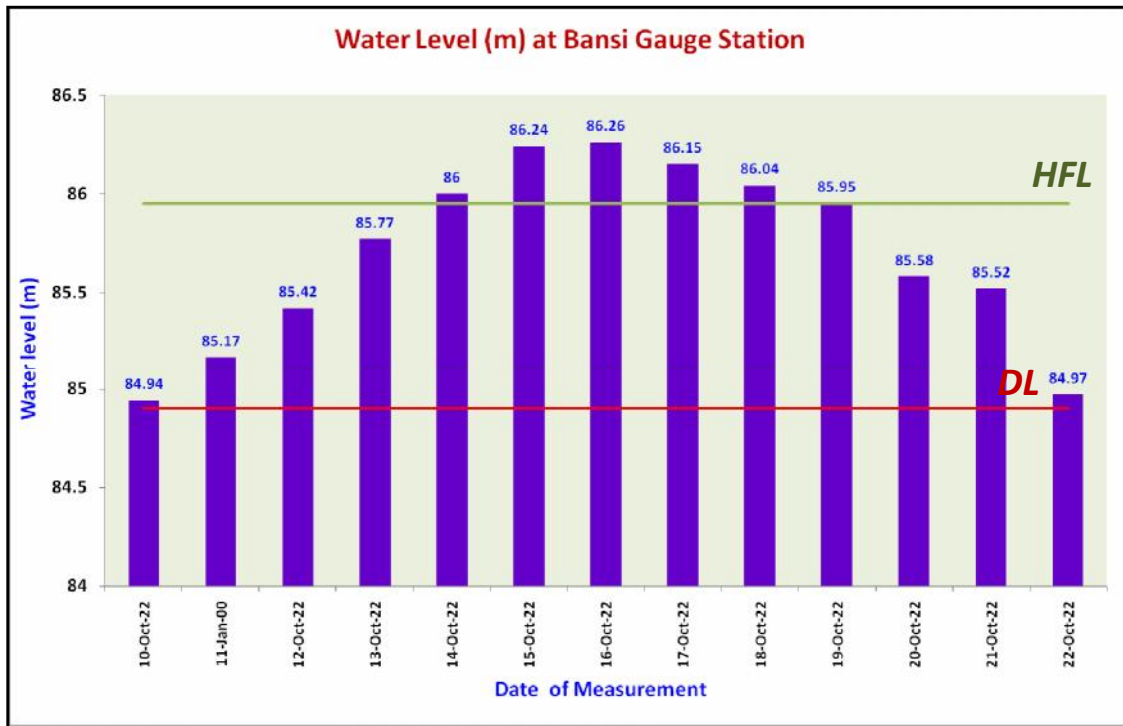


Figure 3(d) below indicate that the Water level has reached above Danger Level (83.6m) on 13th October 22 and is raised to 83.76m till 19th October 2022 and is continued beyond danger level at Uskabazar guage station till 20th October 2022. (Source: CWC)

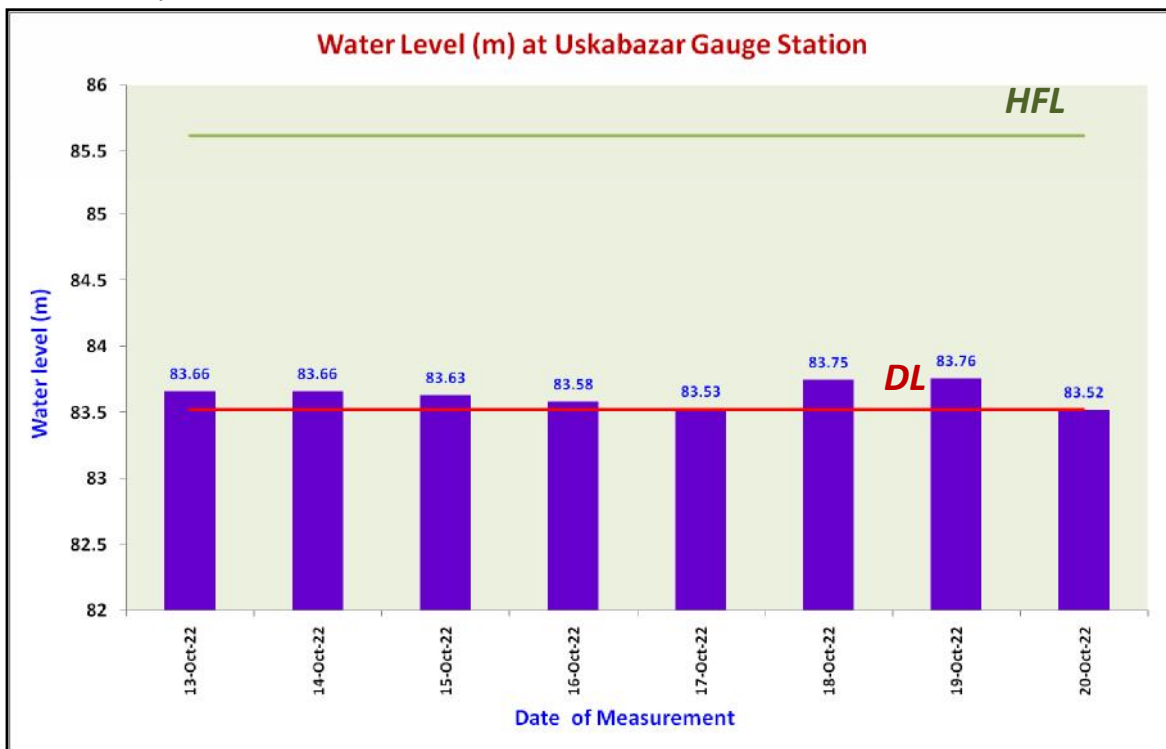


Figure 3(e) below indicate that the Water level has reached above Danger Level (86.21m) on 6th October 22 and is raised to 88.34m till 13th October 2022 and is continued beyond danger level at Kakrahi guage station till 23rd October 2022. (Source: CWC)

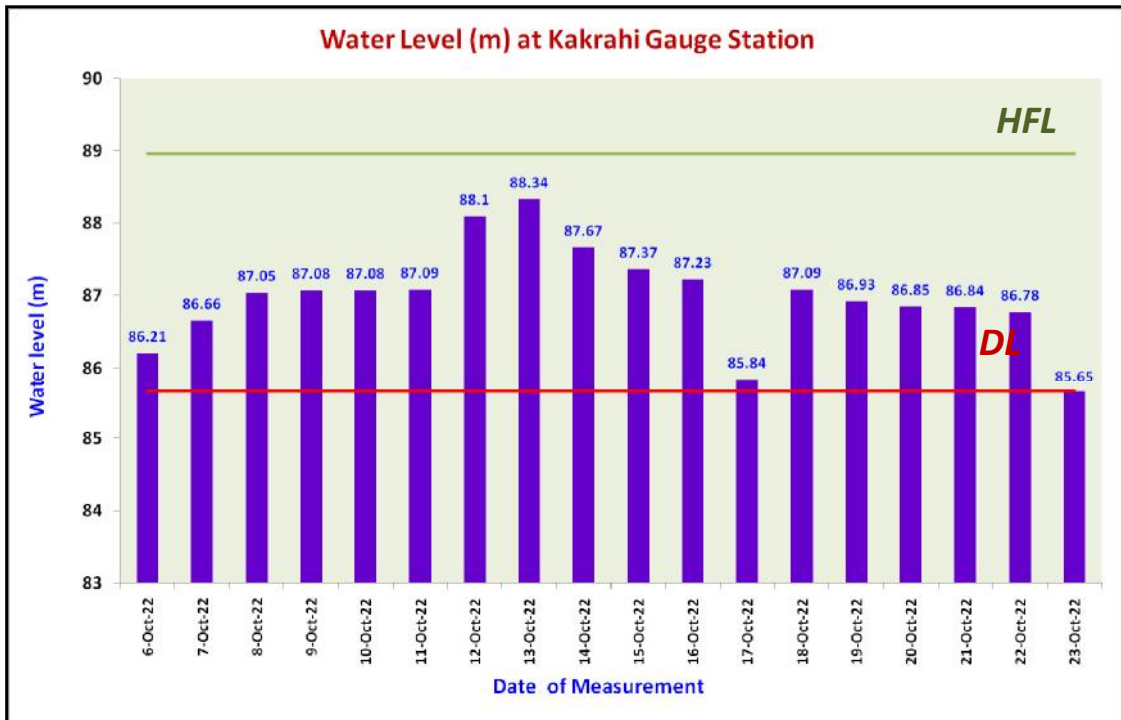


Figure 3(f) below indicate that the Water level has reached above Danger Level (80.3m) on 11th October 22 and is raised to 80.88m till 19th October 2022 and is continued beyond danger level at Regaugli guage station till 24th October 2022. (Source: CWC)

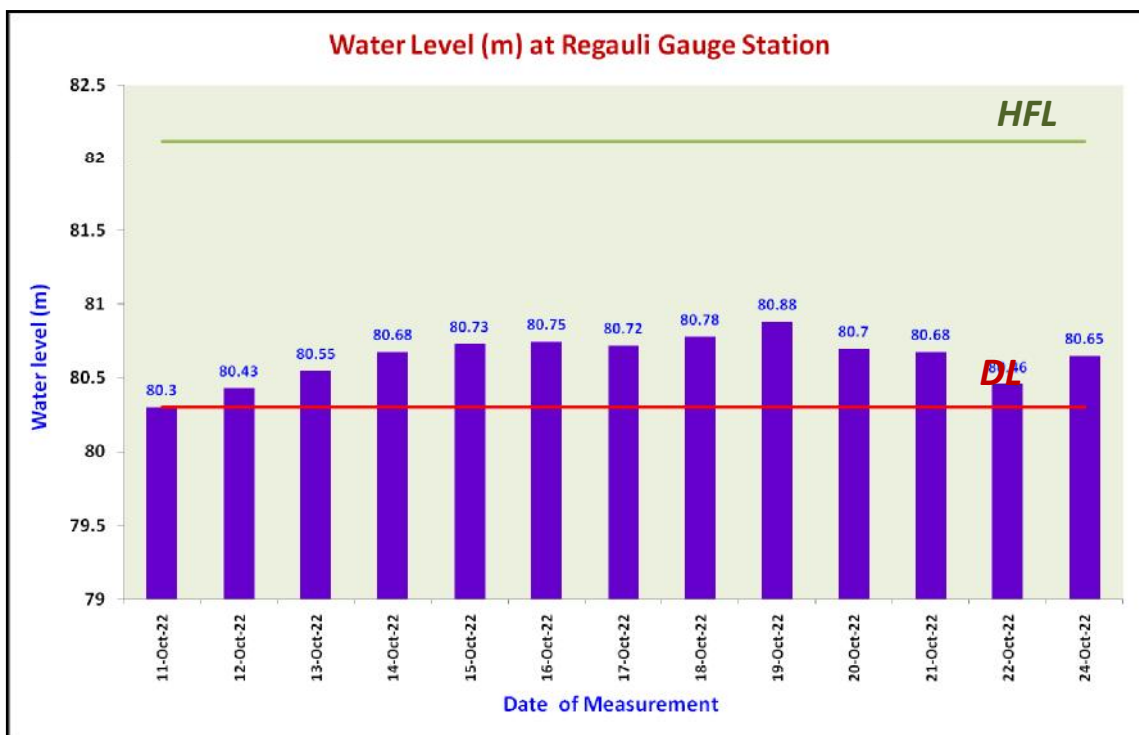


Figure 3(g) below indicate that the Water level has reached above Danger Level (75.21m) on 9th October 22 and is raised to 76.11m till 17th October 2022 and is continued beyond danger level at Bridghat guage station till 24th October 2022. (Source: CWC)

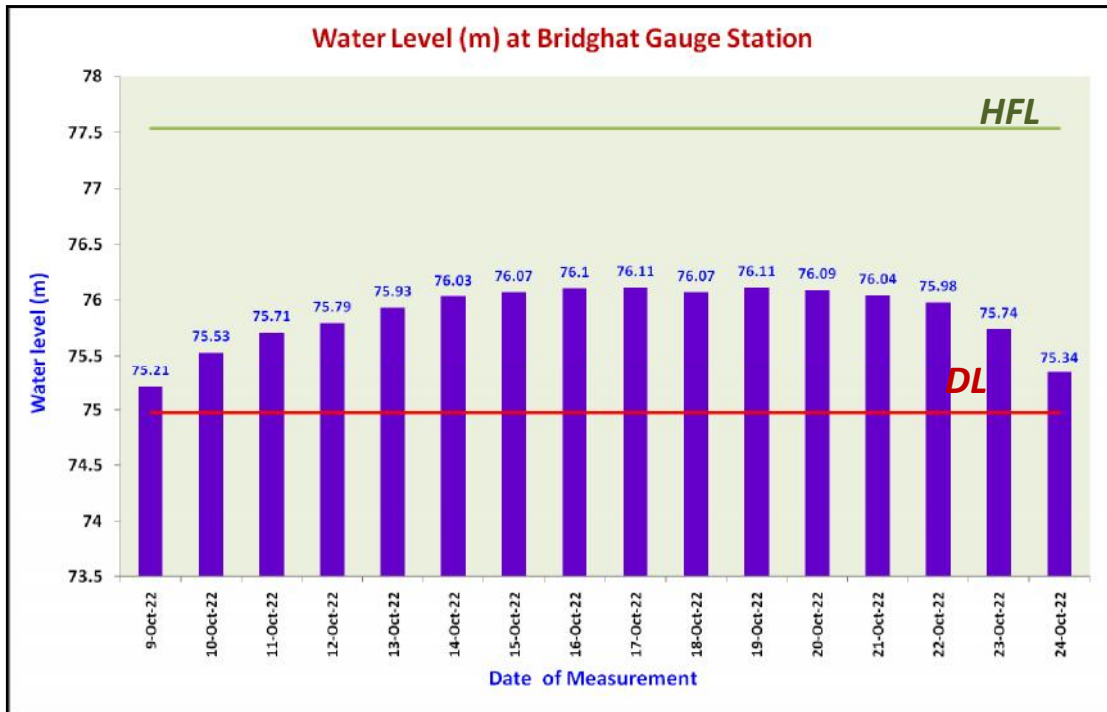


Figure 3(h) below indicate that the Water level has reached above Danger Level (69.02m) on 3rd August 22 and is raised to 65.68m till 15th October 2022 and is continued beyond danger level at Turtipar guage station till 30th September 2022. (Source: CWC)

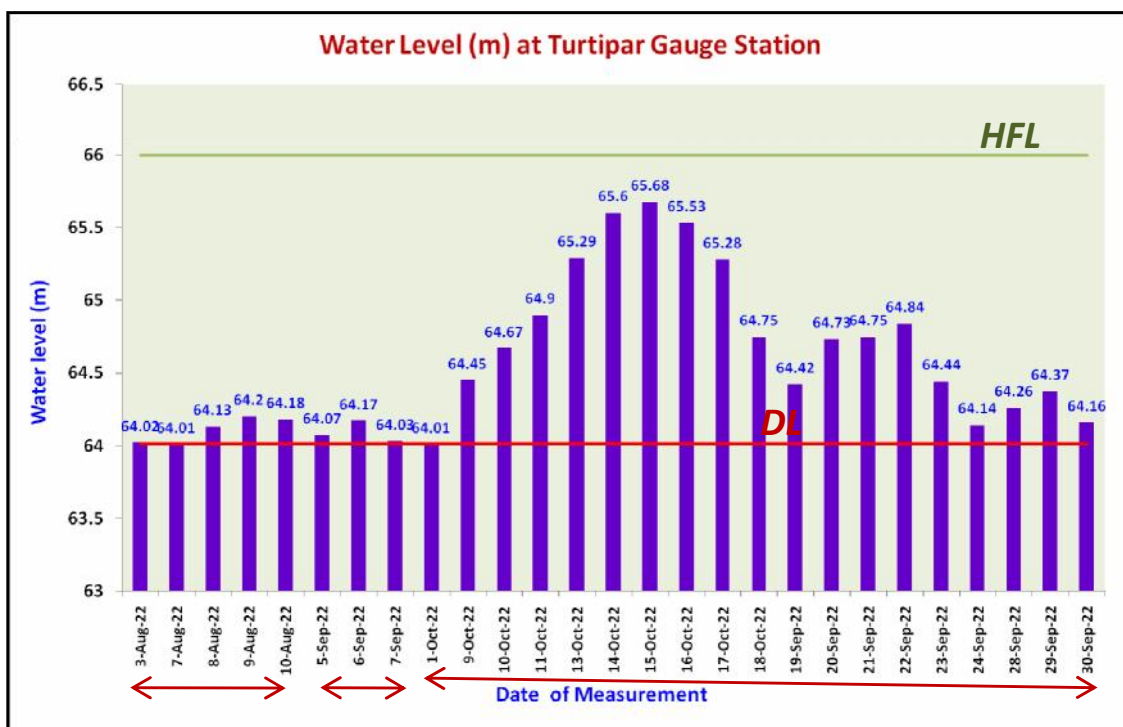


Figure (3i) below indicate that the Water level has reached above Danger Level (106.1m) on 6th August 22 and is raised to 107.27m till 11th October 2022 and is continued beyond danger level at Elginbridge guage station till 15th October 2022. (Source: CWC)

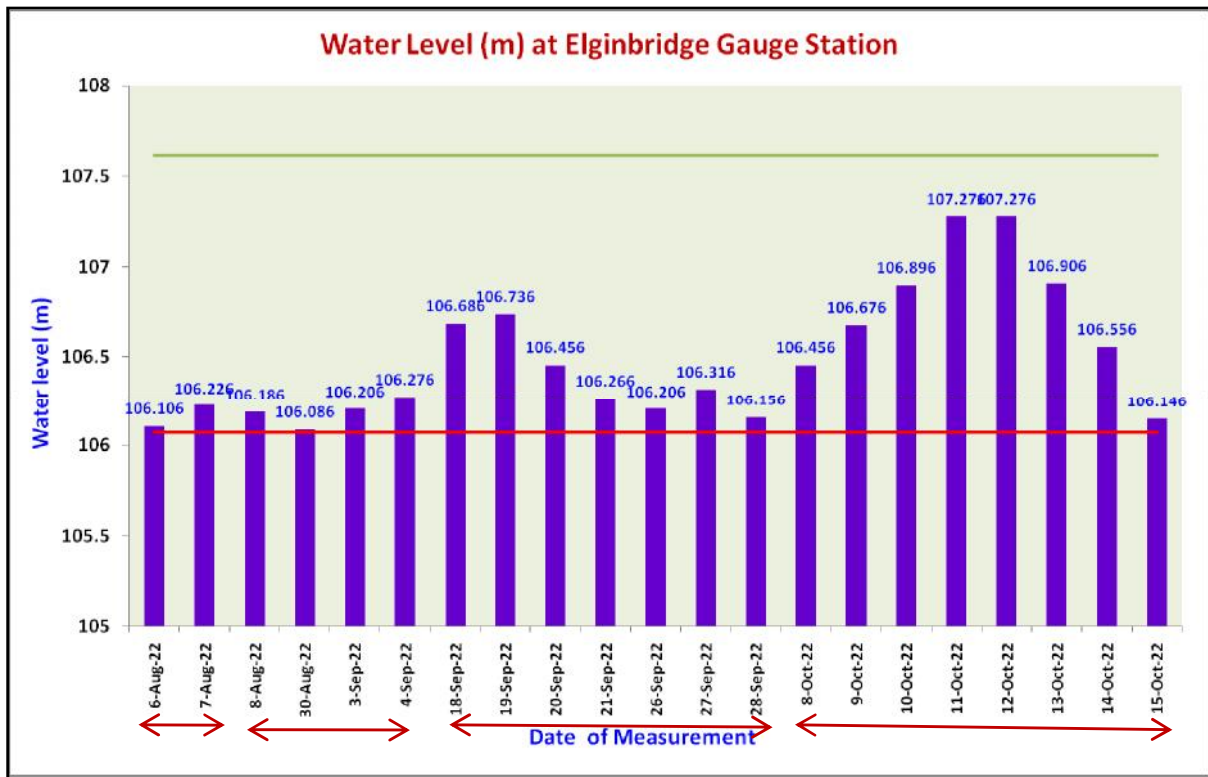
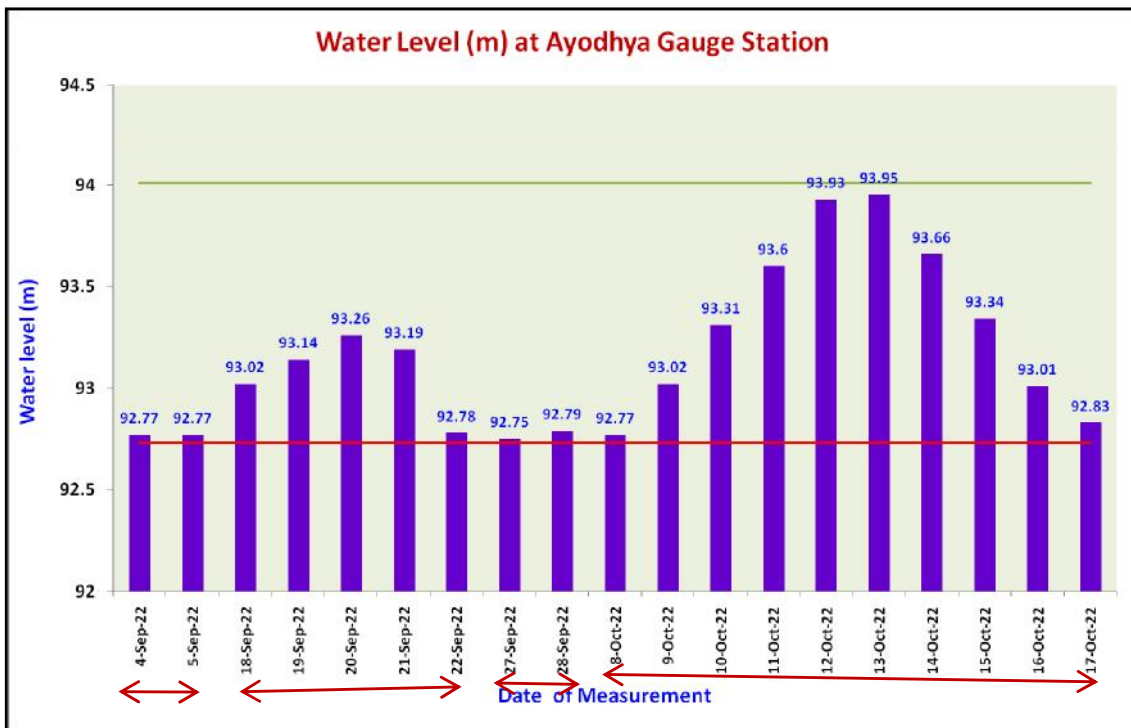


Figure 3(j) below indicate that the Water level has reached above Danger Level (92.77m) on 4th September 22 and is raised to 93.95m till 13th October 2022 and is continued beyond danger level at Ayodhya guage station till 17th October 2022. (Source: CWC)



5. Runoff Estimations in River Catchments and Flood Early Warning

5.1. Runoff Estimations

Runoff Maps (current and one day forecast) of the country is computed using slope corrected curve number grids of different Antecedent Moisture (AMC) conditions. All India Curve Number (CN) grid is prepared using 1:250000 scale Landuse / Landcover (LULC), Soil Map from NBSS&LUP, and 30m CARTO Digital Elevation Model (DEM). Model computes 5 day Antecedent Moisture condition (AMC) condition based on GPM/IMD-GPM Merged/ GEFS (used in order, which is decided based on availability) rainfall source data. GPM/IMD-GPM Merged/GEFS rainfall data is used for current day runoff calculation and GEFS data is used for calculating one day forecast runoff in the country (previous day 8:30AM to current day 8:30 AM rainfall is considered as current day rainfall for example current date is 02-Jul-2022 then rainfall is used from 01-Jul-2022 08:30 AM to 02-Jul-2022 08:30 AM and runoff is calculated accordingly). The spatial surface runoff grids are computed for entire India as part of Disaster Watch report by Flood Modeling Division (FMD) is utilised for computation of overall runoff pattern across the country to assess flood situation. The runoff grids are computed and disseminated to know overall runoff pattern across the country to estimate the probability of forthcoming flood situation. These are calculated based on satellite based rainfall. National Database for Emergency Management (NDEM) Portal of NRSC/ISRO provides daily runoff at 3'x3' Grid on daily basis and also one day forecast is also provided. The source for the data captured in this report is www.ndem.nrsc.gov.in.

Continuous observations and analysis has been made on daily and cumulative runoff which could result into inflows into Rapti, Ghaghra and its tributaries.

Figure. 4 indicates the Cumulative runoff during 1st October to 22nd October, 2022 in Ghagara and Rapati river. Rainfall is varying from 61-151mm during this period.

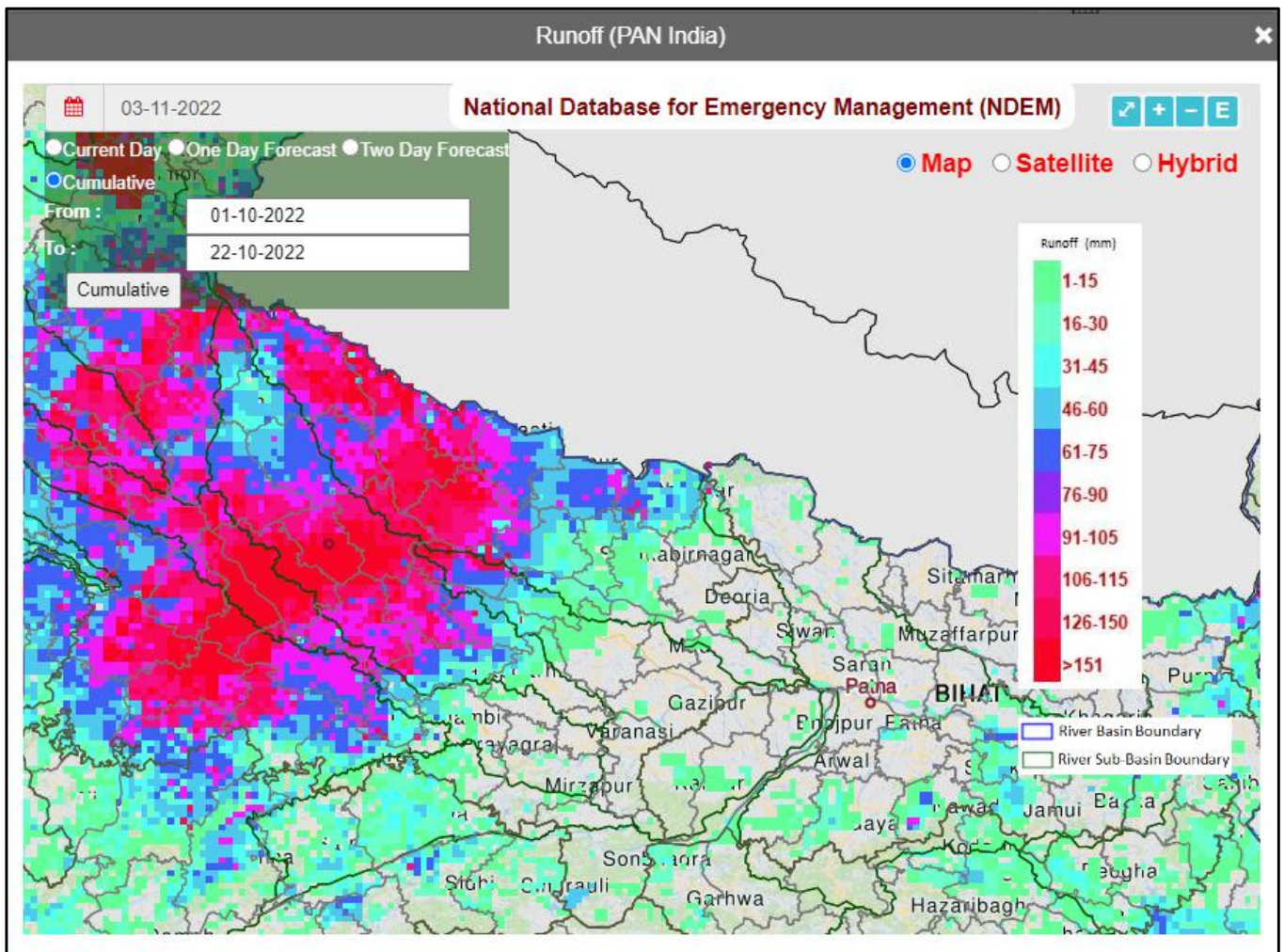


Figure -4 -Cumulative runoff during 1st October – 22nd Oct,2022

(Source: ndem.nrsc.gov.in)

6. Satellite data planning and acquisition

Satellite data acquisition plan has been made based on the indications of flood inundation understood through the rainfall and runoff information at grid levels and also water levels gauge stations. The available satellite data of optical and Microwave SAR sensors have been utilized to the best possible acquisitions from multiple satellites.

6.1. List of Satellite Data Utilized

List of satellite data utilized for the study is listed in Table.1. **Resourcesat-2/2A AWiFS, Sentinel-1A SAR, Sentinel-2B, Radarsat-2 SAR, ALOS-2 PALSAR, RISAT-1A SAR** satellite datasets were utilized for large area analytics at district level for generation of flood inundation maps and reporting to the Disaster Management support organizations in near real time. Timeline showing the generation and dissemination of flood inundation maps during Aug-Oct 2022 & vis-à-vis Water level at gauge station which one above Danger Level is showing below in Figure 5.

Table.1. List of satellite data used

| S No | Date | Satellite/Sensor | Major Flood Affected Districts (Covered in Satellite Data) |
|------|--|--|--|
| 1 | 09-August-2022 | SENTINEL-1A / SAR | Etah, Farrukhabad, Budaun |
| 2 | 10-August-2022 | Resourcesat-2 AWiFS | Barabanki, Farrukhabad, Sitapur, Gonda, Bahraich |
| 3 | 23-August-2022 | SENTINEL-1A SAR(1800 Hrs) | Ballia |
| 4 | 25-August-2022 | Radarsat-2 SAR (1800 Hrs) ALOS-2PALSAR (1100 Hrs) | Banda, Jalaun, Agra, Farrukhabad, Etawah, Fatehpur, Hamirpur, Kanpur dehat, Aurraiya, Kanpur Nagar |
| 5 | 28-August-2022 | RISAT-1A (0600 Hrs) | Banda, Prayagraj , Fatehpur |
| 6 | 28-August-2022 29-August-2022 29-August-2022 | Sentinel-1A SAR (1800Hrs) Sentinel-1A SAR (0600Hrs) RISAT-1A SAR (0600Hrs) | Prayagraj, Ghazipur, Mirzapur, Ballia, Jaunpur, Chitrakoot, Chandauli, Sultanpur |

| S No | Date | Satellite/Sensor | Major Flood Affected Districts (Covered in Satellite Data) |
|-------------|--|--|--|
| 7 | 29-August-2022 | RISAT-1A (1800 Hrs) | Ghazipur, Chandauli, Ballia |
| 8 | 31-August-2022 | Sentinel-1A SAR (1800Hrs) | Allahabad, Mirzapur, Varanasi, Chitrakoot, Chandauli, Banda, Bahraich, Ghazipur, Barabanki |
| 9 | 01-September-2022 | RISAT-1A SAR (1800 Hrs) | Allahabad, Mirzapur, Varanasi |
| 10 | 04-September-2022 | Sentinel-1A SAR (1800 Hrs) | Ballia, Ghazipur, Gorakhpur |
| 11 | 06-September-2022 | RISAT-1A SAR (0600 Hrs) | Mirzapur, Allahabad |
| 12 | 07-September-2022 | Sentinel-1A SAR (1800 Hrs) | Ballia, Gorakhpur, Ghazipur |
| 13 | 16-September-2022 17-September-2022 | Sentinel-1A SAR(1800 Hrs) Sentinel-1A SAR(0600 Hrs) | Gorakhpur, Deoria, Ballia |
| 14 | 18-September-2022 | RISAT-1A SAR (0600 Hrs) | Balrampur, Gorakhpur, Siddharthnagar, Ghazipur, St.Kabir Nagar, Mirzapur, Ballia |
| 15 | 20-September-2022 | Sentinel-2B | Bahraich, Barabanki, Lakhimpur, Sitapur, Shrawasti |
| 16 | 21-September-2022 22-September-2022 | Sentinel-1A SAR (1800Hrs) RISAT-1A SAR (0600Hrs) | Jalaun, Balrampur, Hamirpur, Gonda, Siddharthnagar, Faizabad, Bahraich, Barabanki |
| 17 | 23-September-2022 | ResourceSat-2A AWiFS | Ballia, Deoria, Gorakhpur, Mau |

| S No | Date | Satellite/Sensor | Major Flood Affected Districts (Covered in Satellite Data) |
|-------------|-----------------------------------|--|--|
| 18 | 23-September-2022 | RISAT-1A SAR (1800 Hrs) | Gonda, Barabanki |
| 19 | 25-September-2022 | RISAT-1A SAR (1800 Hrs) ResourceSat-2A AWiFS | Jalaun, Gorakhpur, Agra, Ballia |
| 20 | 26-September-2022 | Sentinel-1A SAR (1800Hrs) | Jalaun, Unnao, Budaun, Farrukhabad, Etah, Jhansi |
| 21 | 27-September-2022 | RISAT-1A SAR (1800 Hrs) | Gorakhpur, Balrampur Siddharthnagar, Mirzapur |
| 22 | 06-October-2022 | Sentinel-1A SAR (1800Hrs) | Shrawasti, Gorakpur, St.Kabir Nagar, Mahrajganj, Siddharthnagar, Balrampur |
| 23 | 9-October-2022 10-October-2022 | RISAT-1A SAR (1800 Hrs) RISAT-1A SAR (0600 Hrs) | Balrampur, Gorakpur, Siddharthnagar, St.Kabir Nagar, Mahrajganj, Azamgarh |
| 24 | 10-October-2022 | Sentinel-1A SAR (1800Hrs) | Balrampur, Gorakpur, Siddharthnagar, St.Kabir Nagar, Ballia, Deoria, Azamgarh |
| 25 | 11-October-2022 | Sentinel-1A SAR (1800Hrs) | Bahraich, Lakhimpur, Sitapur, Barabanki |
| 26 | 11-October-2022 | RISAT-1A SAR (1800 Hrs) | Gorakhpur, Siddharthnagar, Balrampur, St.Kabir nagar, Ballia |
| 27 | 13-October-2022 | Sentinel-1A SAR (1800Hrs) RISAT-1A SAR (1800Hrs) | Gorakhpur, Balrampur, Siddharthnagar,Gonda, St.Kabir nagar, Barabanki , Basti |

| S No | Date | Satellite/Sensor | Major Flood Affected Districts (Covered in Satellite Data) |
|------|-----------------|--|--|
| 28 | 14-October-2022 | IRS-Resourcesat-2A AWiFS (1030hrs) | Siddharthnagar, Gorakhpur, Balrampur, Gonda, Azamgarh, Deoria, St.Kabir nagar, Bahraich, Basti, Sitapur, Mau, Faizabad, Barabanki , Mahrajganj |
| 29 | 14-October-2022 | RISAT-1A (1800hrs) | Gorakhpur, Siddharthnagar, Balrampur, Ballia, St.Kabir nagar, Azamgarh, Deoria, Basti, Mau, Ambedkar Nagar, Mahrajganj |
| 30 | 15-October-2022 | Sentinel-1A (1800hrs) | Balrampur, Siddharthnagar, Gonda, Basti |
| 31 | 16-October-2022 | IRS-Resourcesat-2 AWiFS | Gorakhpur, Siddharthnagar, Deoria, Ballia, Sitapur, Balrampur, St. Kabir Nagar |
| 32 | 17-October-2022 | Sentinel-2B | Gorakhpur, Siddharthnagar, Deoria, St. Kabir Nagar |
| 33 | 19-October-2022 | RISAT-1A SAR (0600hrs) | Gorakhpur, Ballia, Deoria, Mau |
| 34 | 19-October-2022 | IRS-Resourcesat-2 AWiFS (1000hrs) | Gorakhpur, Siddharthnagar, Balrampur, Ballia, Deoria |
| 35 | 24-October-2022 | IRS-Resourcesat-2 AWiFS (1000hrs) | Gorakhpur, Siddharthnagar, St.Kabir nagar, Basti, Deoria |
| 36 | 26-October-2022 | IRS-Resourcesat-2 AWiFS | Gorakhpur, Siddharthnagar, St.Kabir nagar, Balrampur, Basti |

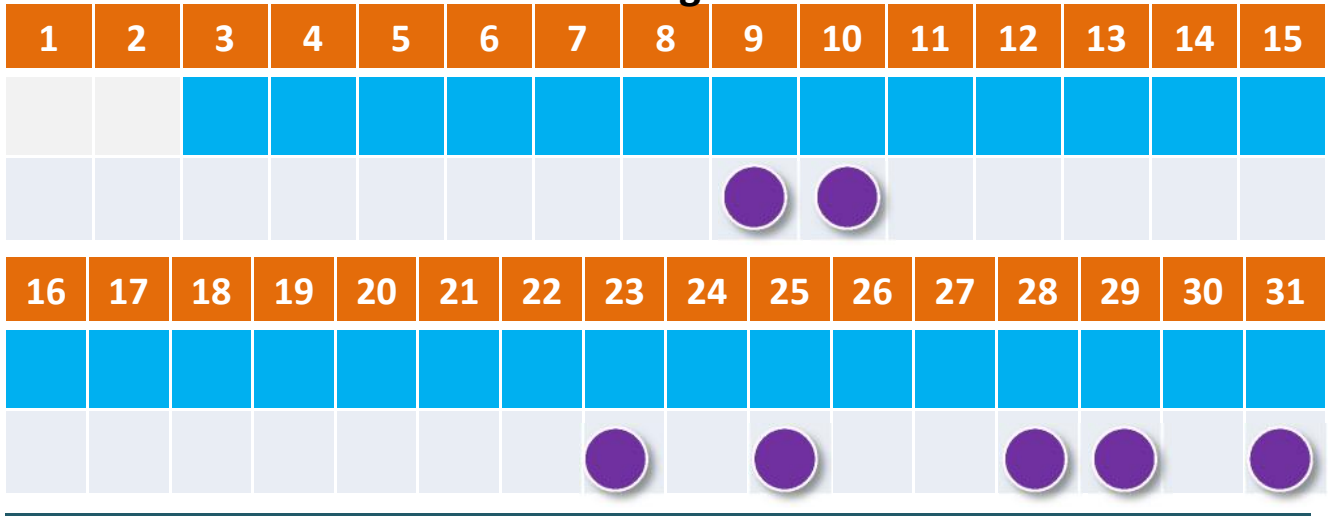


Date when River level is above danger level (DL) in any one of the rivers of Uttar Pradesh

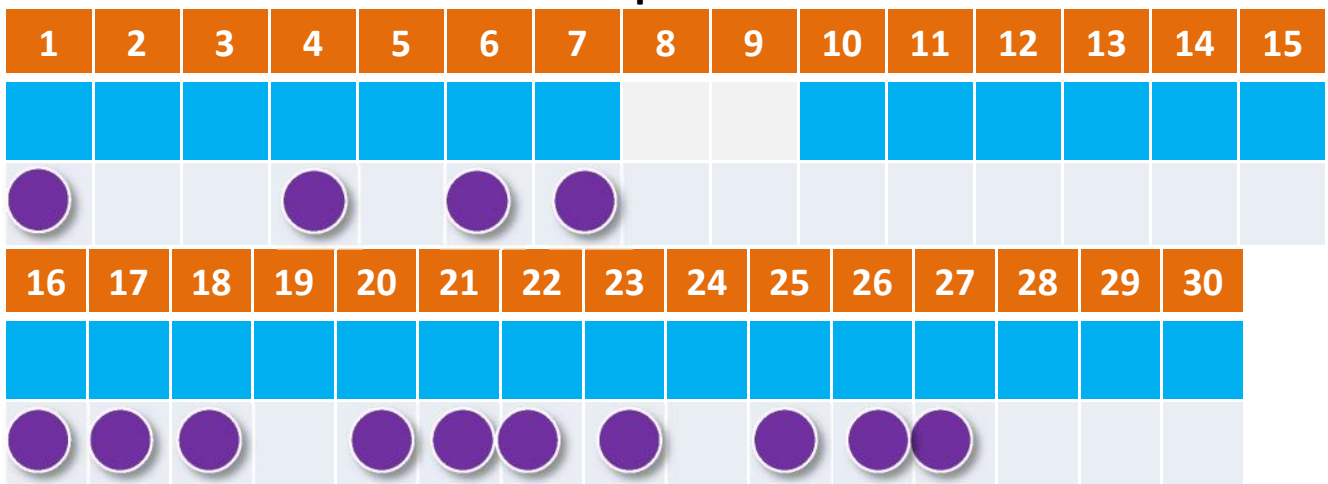


Map is generated Using multi-sensor satellite data and disseminated

August 2022



September 2022



October 2022

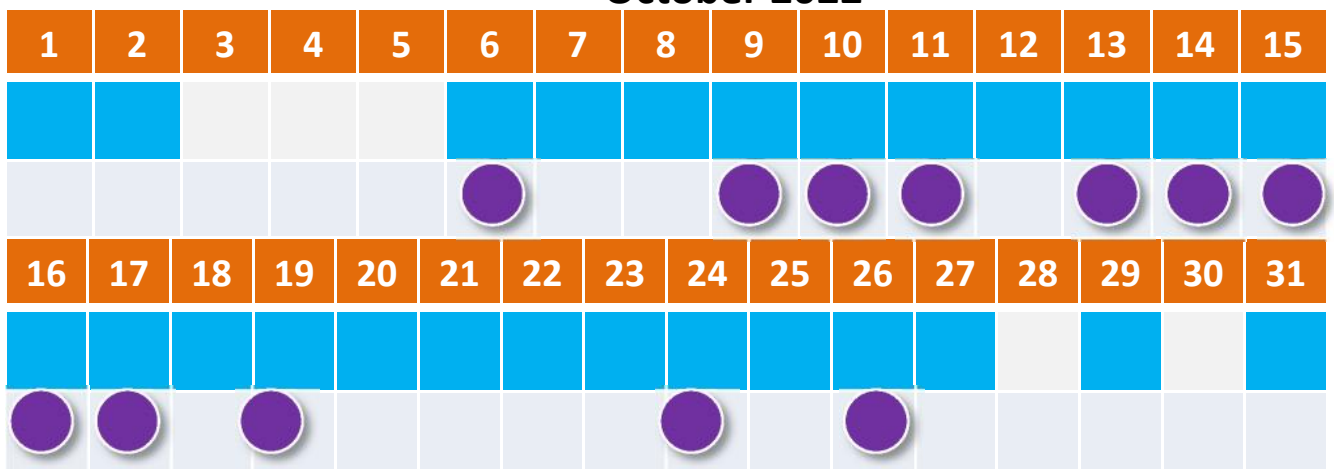


Figure .5 : Timeline showing the generation and dissemination of flood inundation maps during Aug-Oct 2022

7. Methodology Satellite based Flood Inundation Mapping & Monitoring

Role of space applications in supporting flood disaster management is important, if the information can be provided to disaster management support organizations in near real time. Satellite remote sensing data provides information on spatial flood extent on a continuous basis.

Satellite data can be used at regular intervals for updation of the flood condition on the ground in terms of flood progression, recedence and persistence.

The advantage of using radar data over the optical data is its ability to penetrate cloud cover and also data acquisition during day and night. Water surfaces are generally smooth at radar wavelengths and can be regarded as specular reflectors which yield small backscatter. The surrounding terrain is assumed to be rough at radar wavelengths which exhibits diffuse scattering with moderate backscatter. Hence, water is regarded as low intensity areas whereas the surrounding terrain corresponds to brighter intensities.

Thresholding is the traditional method of detecting flooding in open areas. Intensities below the threshold are regarded as flood or open water, whereas pixels with intensities above the threshold are regarded as dry land. The threshold will depend on the contrast between the land and water classes, and generally needs to be set for each SAR scene. The backscatter depends on the frequency, incidence angle, polarization and is sensitive to the ripples on the water surface induced by wind waves.

Before the onset of flood season, pre-flood satellite data over flood prone states are acquired and analysed. River banklines, permanent water bodies and active river channel are extracted using digitization tools. These datasets and layers will be used as master data sets for further analysis. Detailed steps are as follows. The raw satellite data during floods will be geometrically co-registered with the respective state masters for positional accuracy. These rectified data sets are considered as master data sets for that particular year. Classification is performed to extract water bodies from the image.

In case of optical data, unsupervised classification will be performed giving maximum number of classes and main active river channel, its tributaries and permanent water bodies are classified and converted into vector format. Enhancement techniques are used for increase contrast between the features in the image. On-screen digitization techniques are used for delineation of river banklines from the image in GIS environment and after post editing, the final layer is stored in vector format. In case of microwave data, back scattering image (Sigma nought) is generated and water bodies are extracted using variable threshold technique model. State mask, hill mask, hill shadow mask are applied on the extracted water layer. Further, stray water pixels are separated by grouping and removing them. Flow chart of methodology for pre-flood data preparation is shown in Figure 3 . Flow chart of methodology for flood delineation from satellite data is shown in Figure. 4

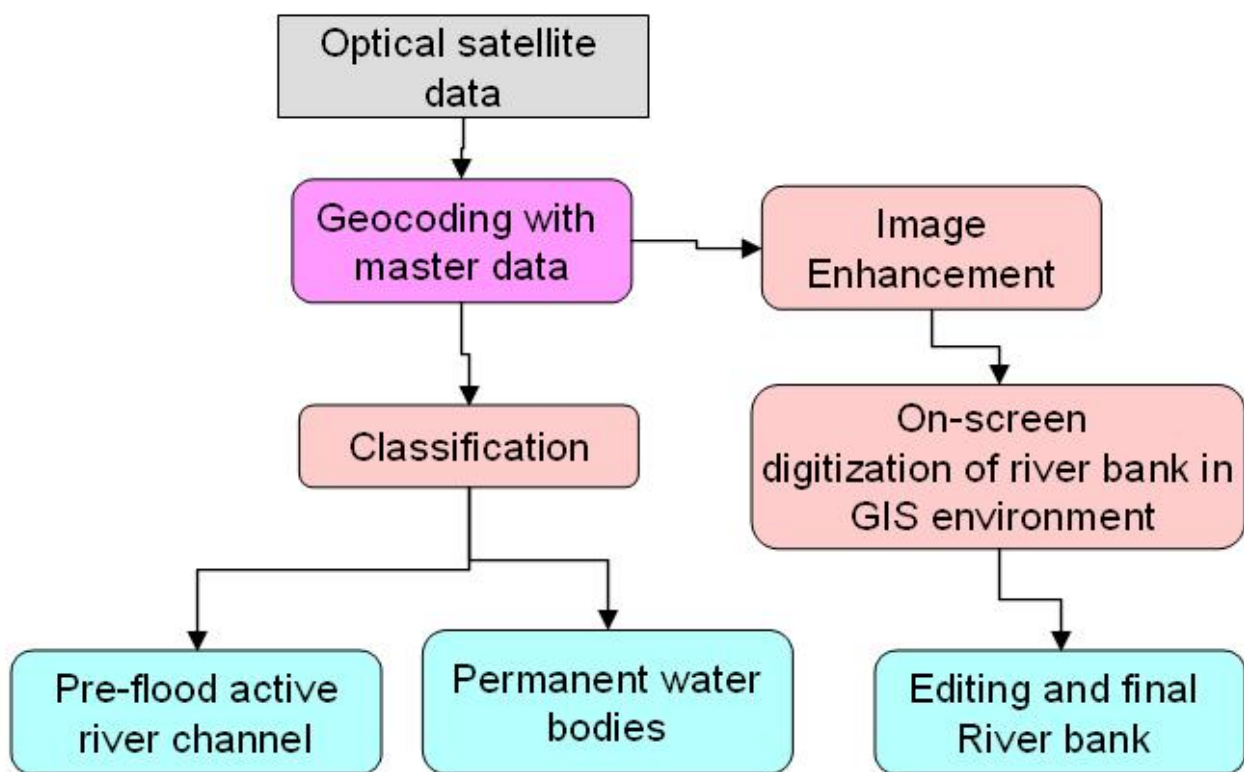


Figure.6. Methodology for Pre-flood data preparation

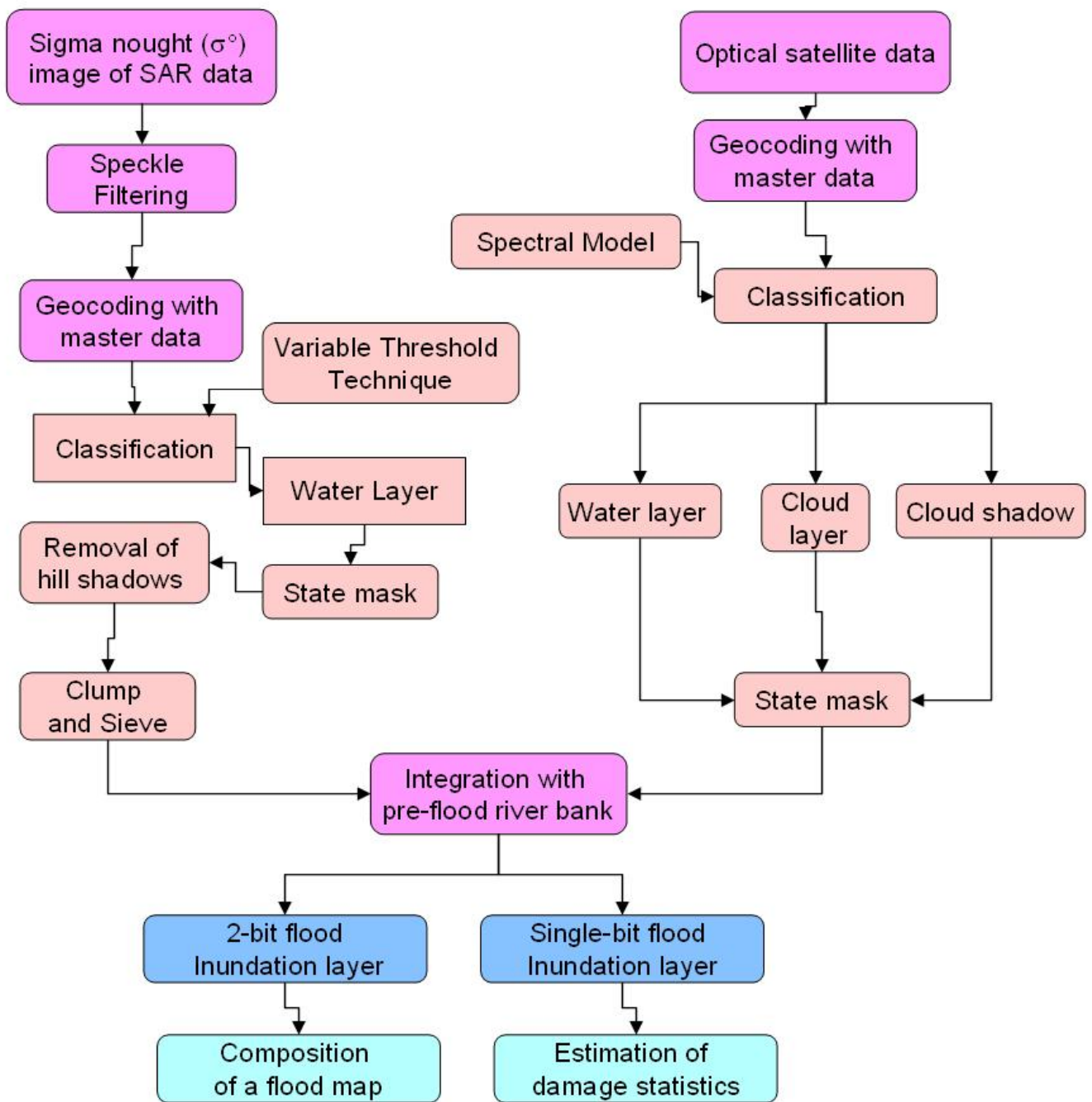


Figure.7. Methodology for flood mapping and monitoring

8. Flood Inundation Mapping and Monitoring

8.1. Analysis of Flood Inundation areas

36 Flood maps were prepared during 9th August 2022 to 26th October 2022 to disaster management support organizations for supporting flood disaster management. At the end of flood season after 26th October 2022, a cumulative Spatial flood inundation map is prepared and district wise flood inundation area statistics were estimated and in Table.2. It is estimated that, cumulative flood inundation area is >10000 ha in 20 districts, 5000-10000ha in 7 districts, 1000-5000ha in 16 districts and <1000 Ha in rest of the affected districts during 2022

Table.2. Cumulative Flood Inundation area statistics at district level in Uttar Pradesh State during August - October 2022

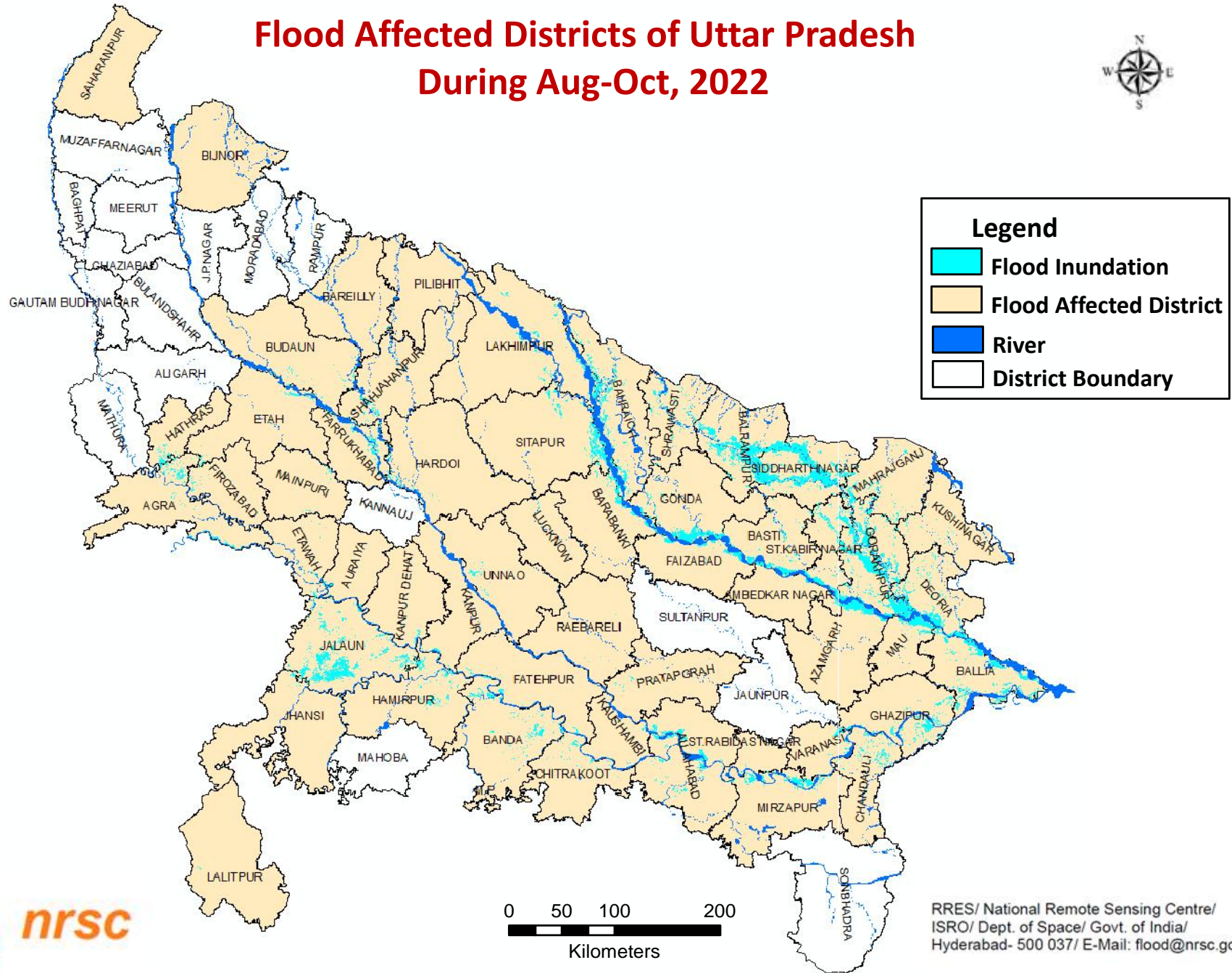
| S no | DISTRICT | Area (Ha) under Flood Inundation |
|------|-----------------|----------------------------------|
| 1 | GORAKHPUR | 78430 |
| 2 | SIDDHARTH NAGAR | 69183 |
| 3 | JALAUN | 53831 |
| 4 | BALRAMPUR | 52433 |
| 5 | BALLIA | 30982 |
| 6 | BAHRAICH | 27806 |
| 7 | DEORIA | 26681 |
| 8 | SITAPUR | 19806 |
| 9 | GONDA | 19312 |
| 10 | ST.KABIR NAGAR | 17845 |
| 11 | GHAZIPUR | 17563 |
| 12 | ALLAHABAD | 17299 |
| 13 | AZAMGARH | 13713 |
| 14 | MIRZAPUR | 13304 |
| 15 | BASTI | 13067 |
| 16 | BANDA | 12491 |
| 17 | BARABANKI | 11485 |
| 18 | LAKHIMPUR | 10916 |
| 19 | AGRA | 10799 |
| 20 | MAU | 10112 |
| 21 | HAMIRPUR | 9699 |
| 22 | FAIZABAD | 9612 |

| S no | DISTRICT | Area (Ha) under Flood Inundation |
|------|------------------|----------------------------------|
| 23 | MAHRAJGANJ | 9603 |
| 24 | CHANDAULI | 9476 |
| 25 | SHRAWASTI | 8294 |
| 26 | FARRUKHABAD | 8111 |
| 27 | SHAHJAHANPUR | 5313 |
| 28 | VARANASI | 4112 |
| 29 | AMBEDKAR NAGAR | 4074 |
| 30 | ETAH | 4035 |
| 31 | CHITRAKOOT | 4006 |
| 32 | HARDOI | 3753 |
| 33 | BUDAUN | 3510 |
| 34 | ETAWAH | 3324 |
| 35 | HATHRAS | 3174 |
| 36 | FATEHPUR | 3021 |
| 37 | KUSHINAGAR | 2753 |
| 38 | UNNAO | 2597 |
| 39 | FIROZABAD | 2498 |
| 40 | JHANSI | 2063 |
| 41 | KANPUR DEHAT | 1888 |
| 42 | AURAIYA | 1351 |
| 43 | KANPUR | 1259 |
| 44 | PRATAPGRAH | 791 |
| 45 | MAINPURI | 780 |
| 46 | KAUSHAMBI | 718 |
| 47 | LUCKNOW | 427 |
| 48 | BIJNOR | 406 |
| 49 | BAREILLY | 347 |
| 50 | RAEBARELI | 332 |
| 51 | ST.RABIDAS NAGAR | 250 |
| 52 | LALITPUR | 180 |
| 53 | SAHARANPUR | 128 |
| 54 | PILIBHIT | 114 |
| | TOTAL | 639061 |

Figure 8 shows the overview of the districts affected along with the cumulative flood inundation maps. Flood Inundation map of Uttar Pradesh State during August-October 2022 is shown in Figure. 9. Major flood inundation observed along Rapti and Ghaghara rivers is depicted through Figure 10. Annexure -1 shows satellite Images and corresponding flood inundation information at various districts level / regions depicting the severity of the floods occurred in Uttar Pradesh State

Fig.8.

Flood Affected Districts of Uttar Pradesh During Aug-Oct, 2022



Cumulative Flood Inundated areas in parts of Uttar Pradesh State from 09-Aug-2022 to 24-Oct-2022

Fig.9.

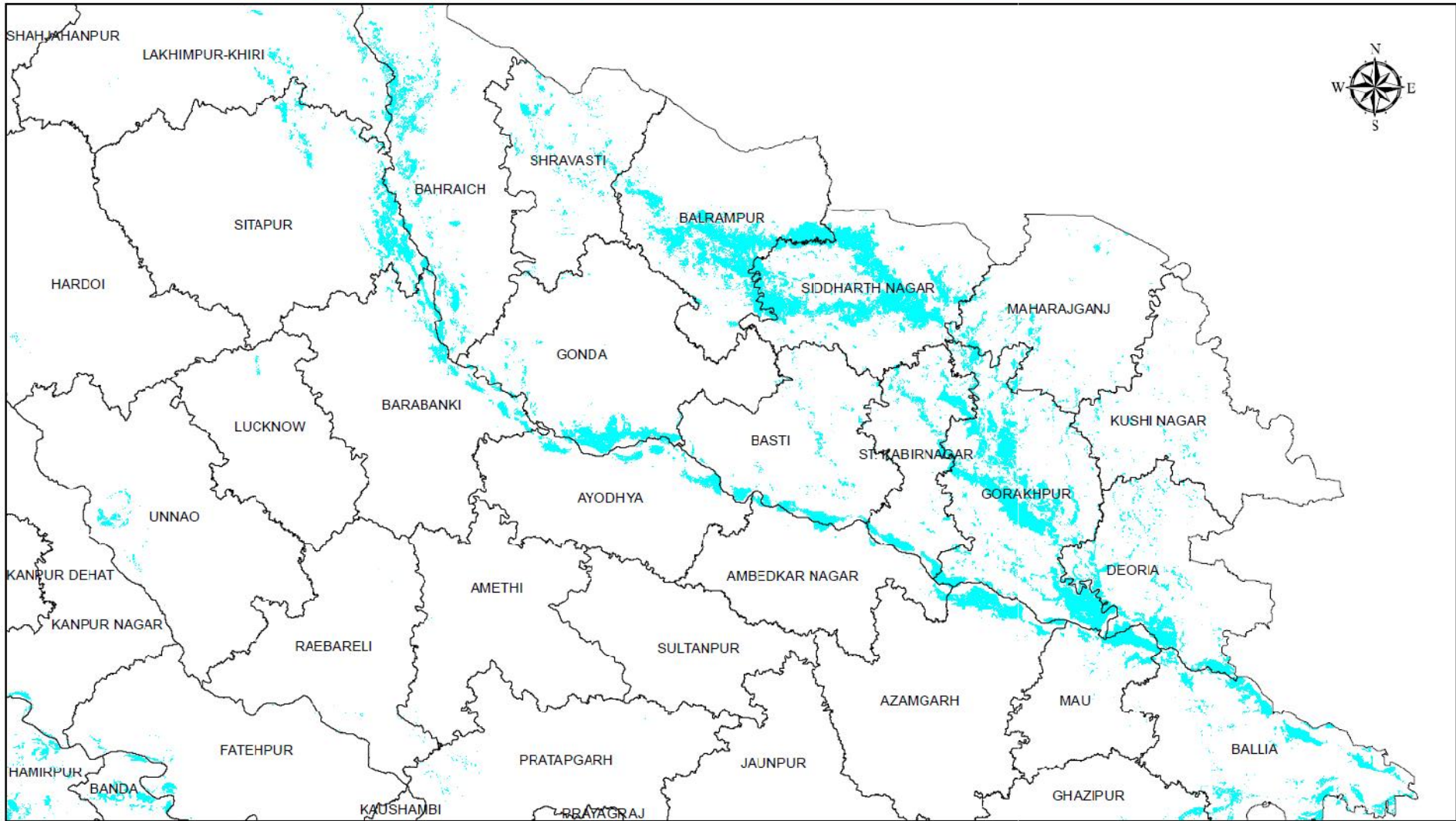


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Fig.10.

Cumulative Flood Inundated areas along Ghaghara and Rapti Rivers in Uttar Pradesh State during 09-Aug-2022 to 24-Oct-2022



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Legend

- District Boundary
- Flood Inundation

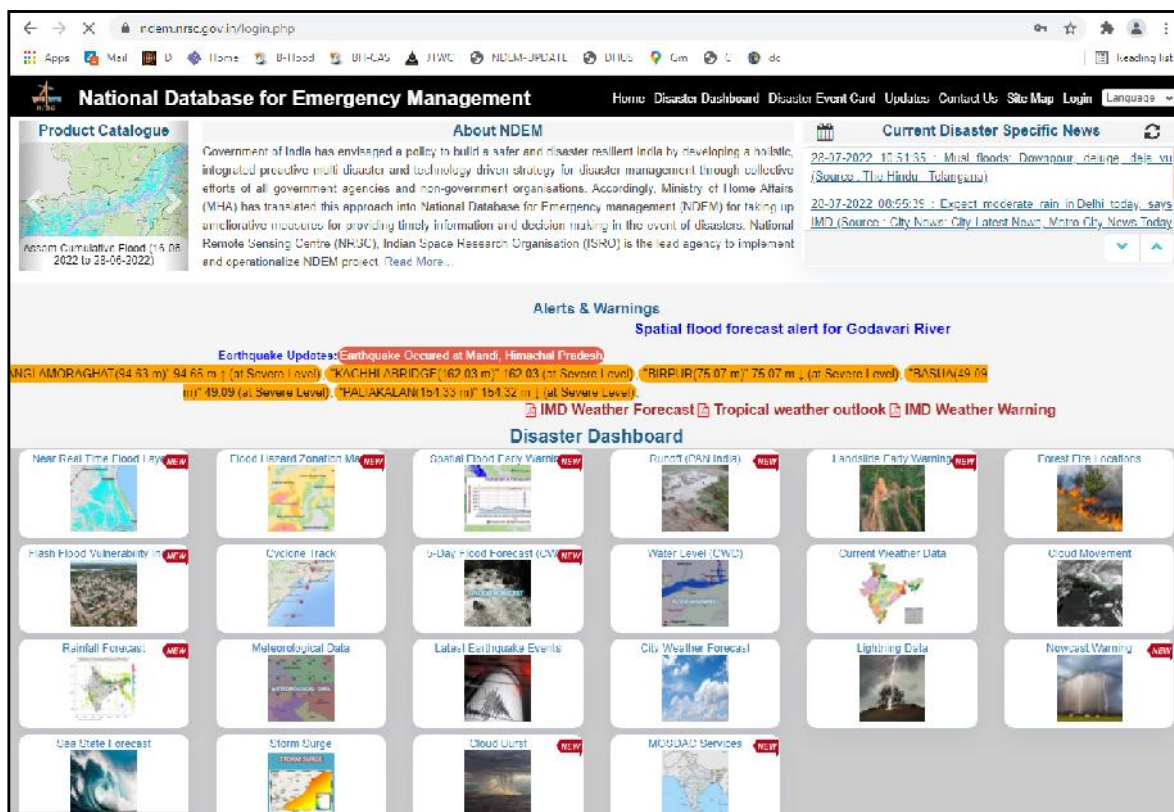


9. Dissemination to State / Central Disaster Management Organisations

9.1. Dissemination of Information through NDEM Web Portals

NRSC disseminated the maps and GIS and value added images by uploading GIS layers in National Database for Emergency Management (NDEM) portal for further visualisation of the current and historic flood information along with legacy layers and analytics

<https://ndem.nrsc.gov.in>

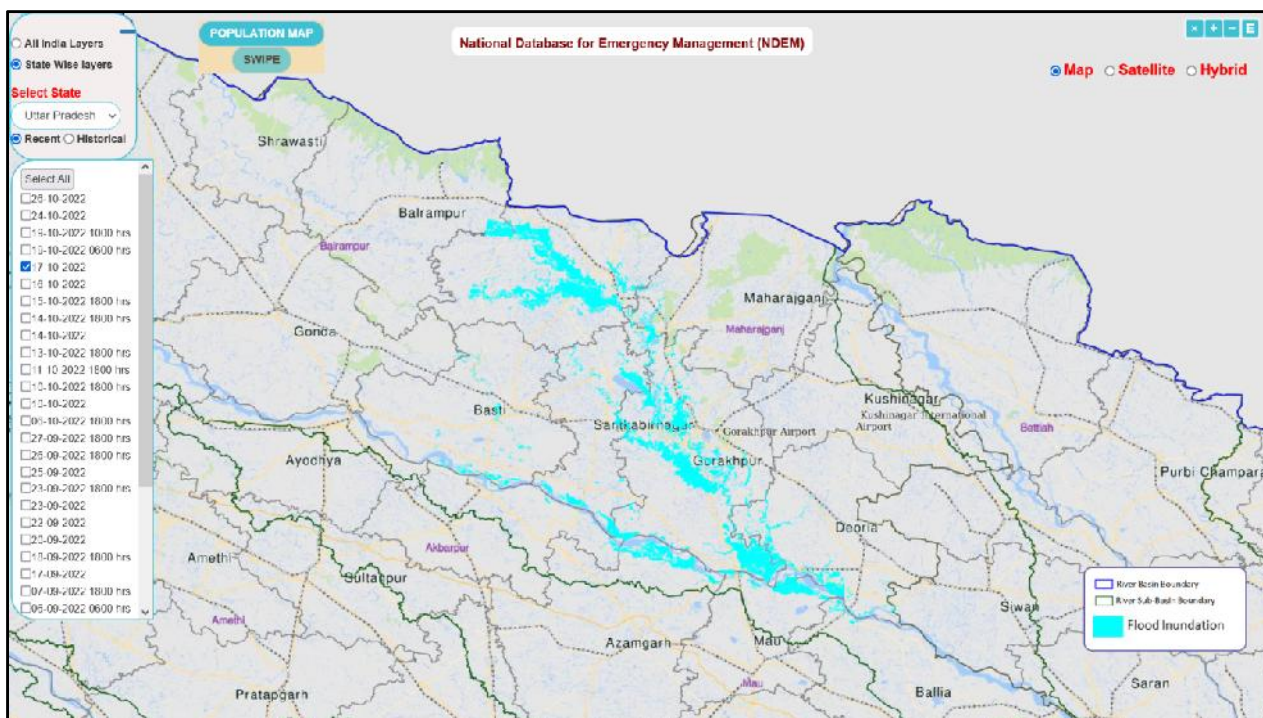


Click on **Near Real Time Flood Layers**

Near Real Time Flood Layers



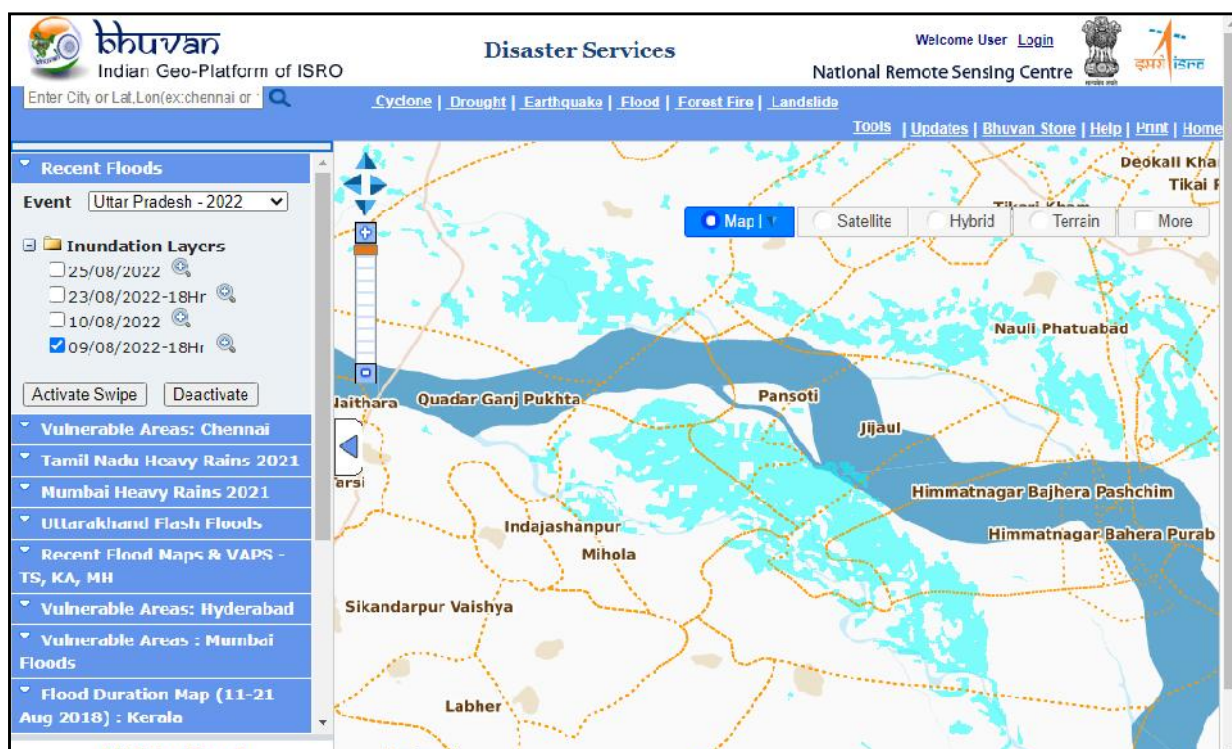
Select the State & Date of flood inundation map to zoom to the area of interest in NDEM Portal



9. 2. Dissemination of Information through Bhuvan Web Portals

Bhuvan Geoportal can be used for visualisation of the flood layers

<https://bhuvan-app1.nrsc.gov.in/disaster/disaster.php?id=flood>



Annexure-1

Satellite Images and corresponding flood inundation information at various districts level / regions depicting the severity of the floods occurred in Uttar Pradesh State.

Cumulative Flood Inundation in part of Balrampur and Siddharth Nagar districts, Uttar Pradesh State during 09-Aug-2022 to 24-October-2022

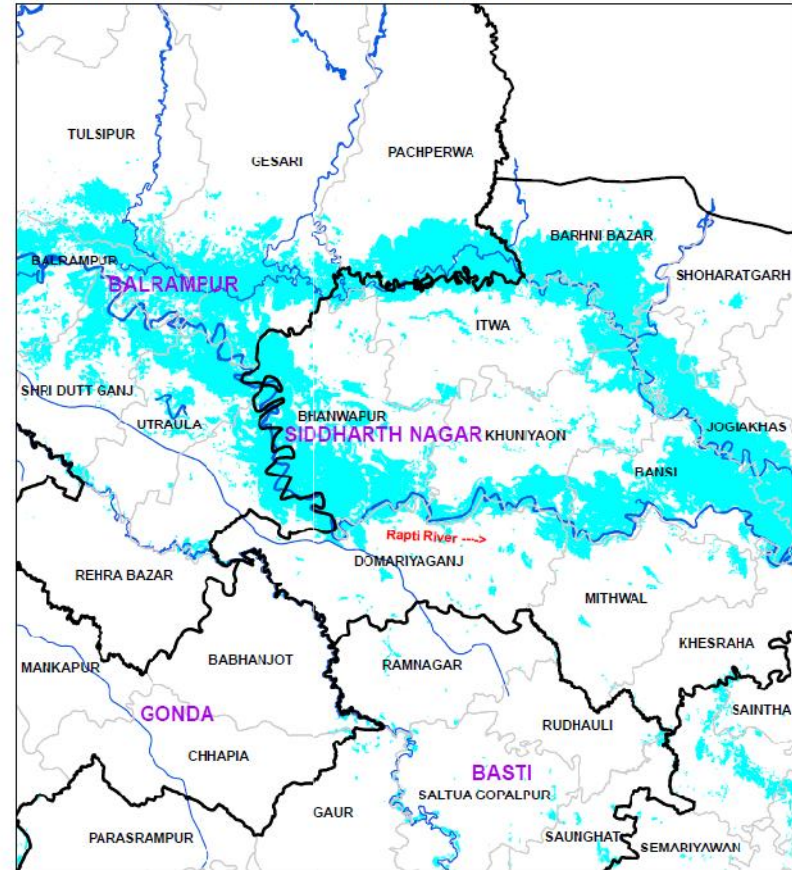
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Resourcesat-2A AWiFS image of 14-Oct-2022

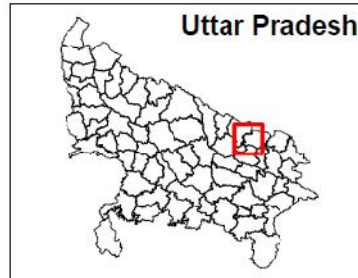


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Cumulative Flood Inundation Map during 09-Aug-2022 to 24-Oct-2022



INDIA

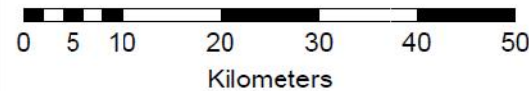


Uttar Pradesh



Legend

- Flood Inundation
- District Boundary
- Block Boundary



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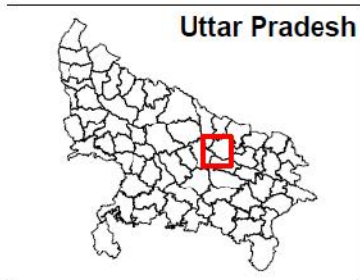
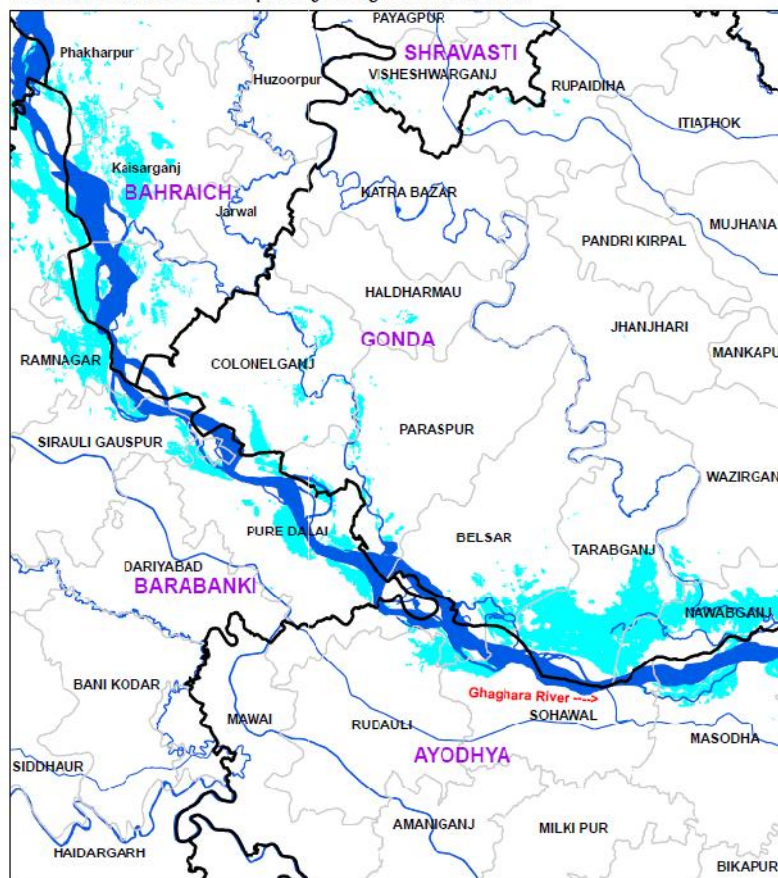
Cumulative Flood Inundation in part of Gonda and Bahraich districts, Uttar Pradesh State during 09-Aug-2022 to 24-October-2022

Resourcesat-2A WIFS image of 14-Oct-2022



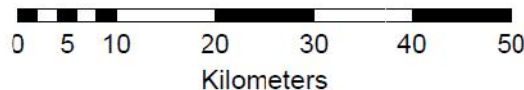
UP - FLOOD -2022-VAP No. 20 / dt.28.10.2022

Cumulative Flood Inundation Map during 09-Aug-2022 to 24-Oct-2022



Legend

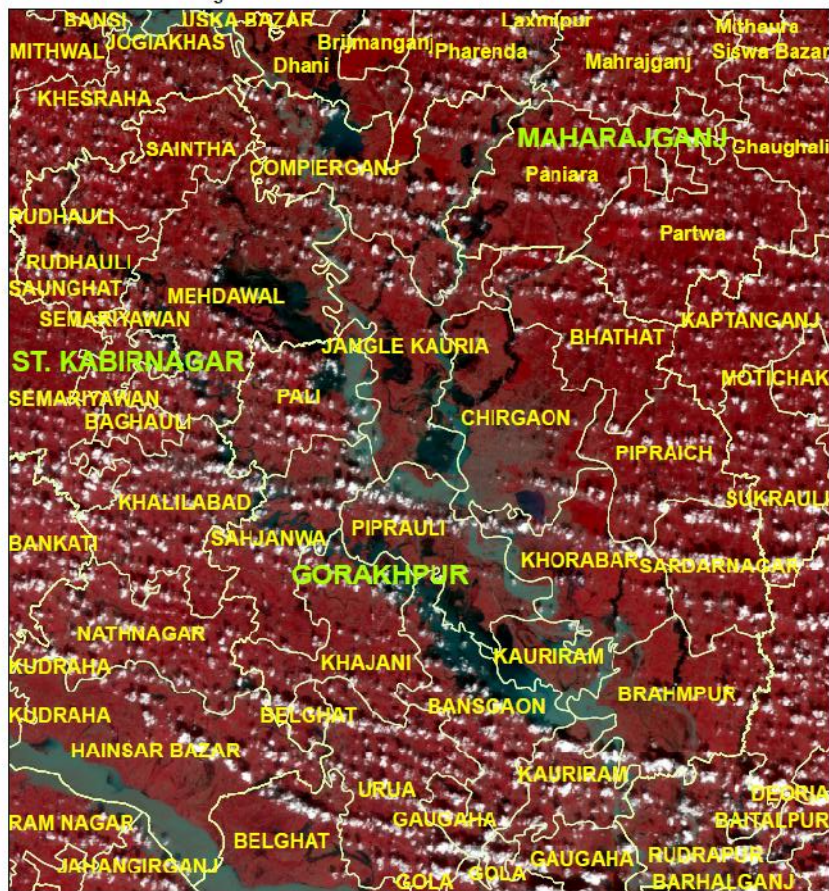
- Flood Inundation
- District Boundary
- Block Boundary



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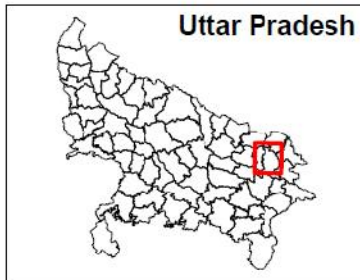
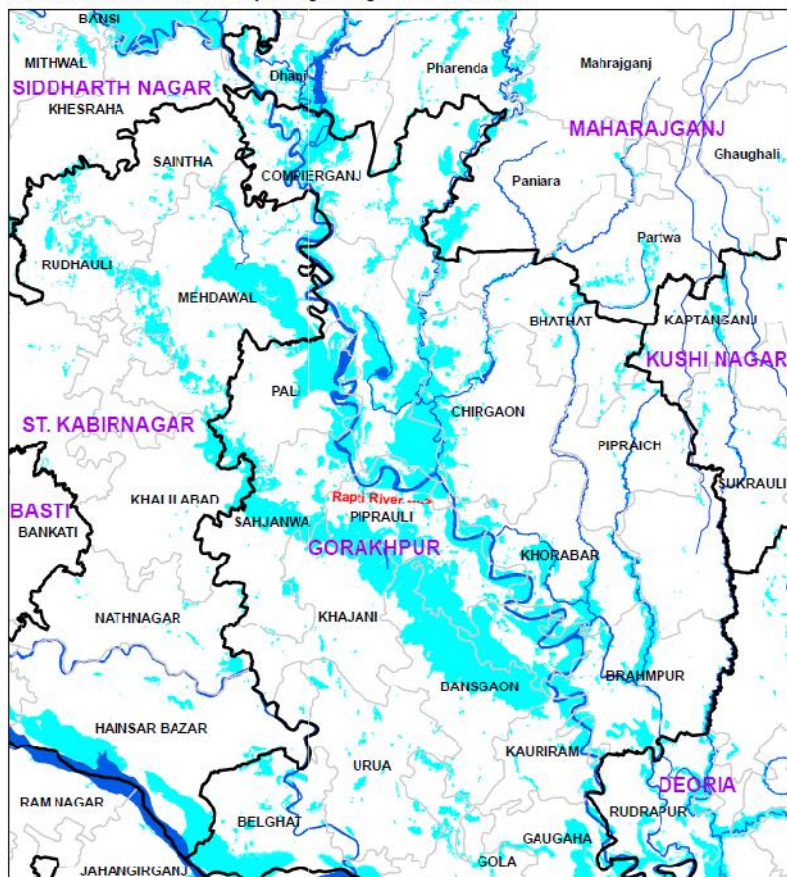
Cumulative Flood Inundation in part of Gorakhpur district, Uttar Pradesh State during 09-Aug-2022 to 24-October-2022

Resourcesat-2A WIFS image of 14-Oct-2022



Cumulative Flood Inundation Map during 09-Aug-2022 to 24-Oct-2022

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Legend

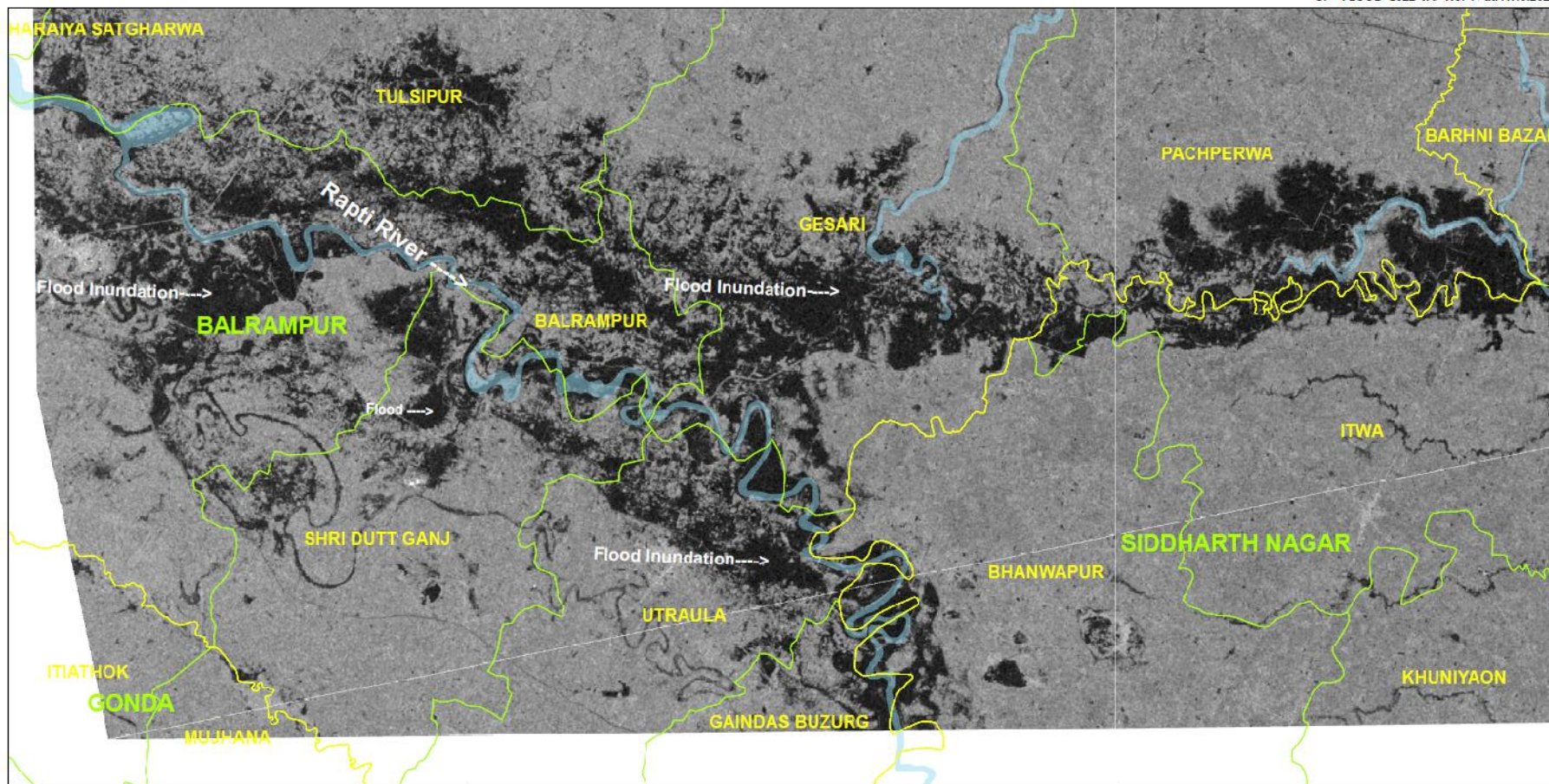
- Flood Inundation
- District Boundary
- Block Boundary



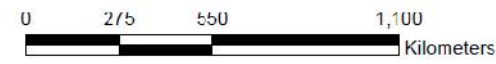
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Sentinel-1A SAR Satellite Image Showing Flood Inundation in parts of Balarampur District along Rapti River Uttar Pradesh State as on 10-October-2022 (1800 Hrs)

UP - FLOOD -2022-VAP No. 4 / dt.11.10.2022



- Legend**
- District Boundary
 - Block Boundary
 - River

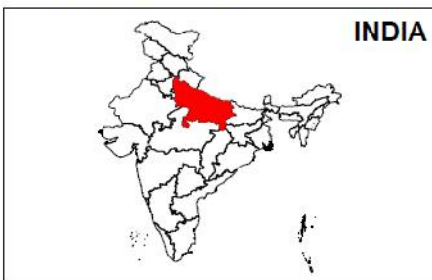
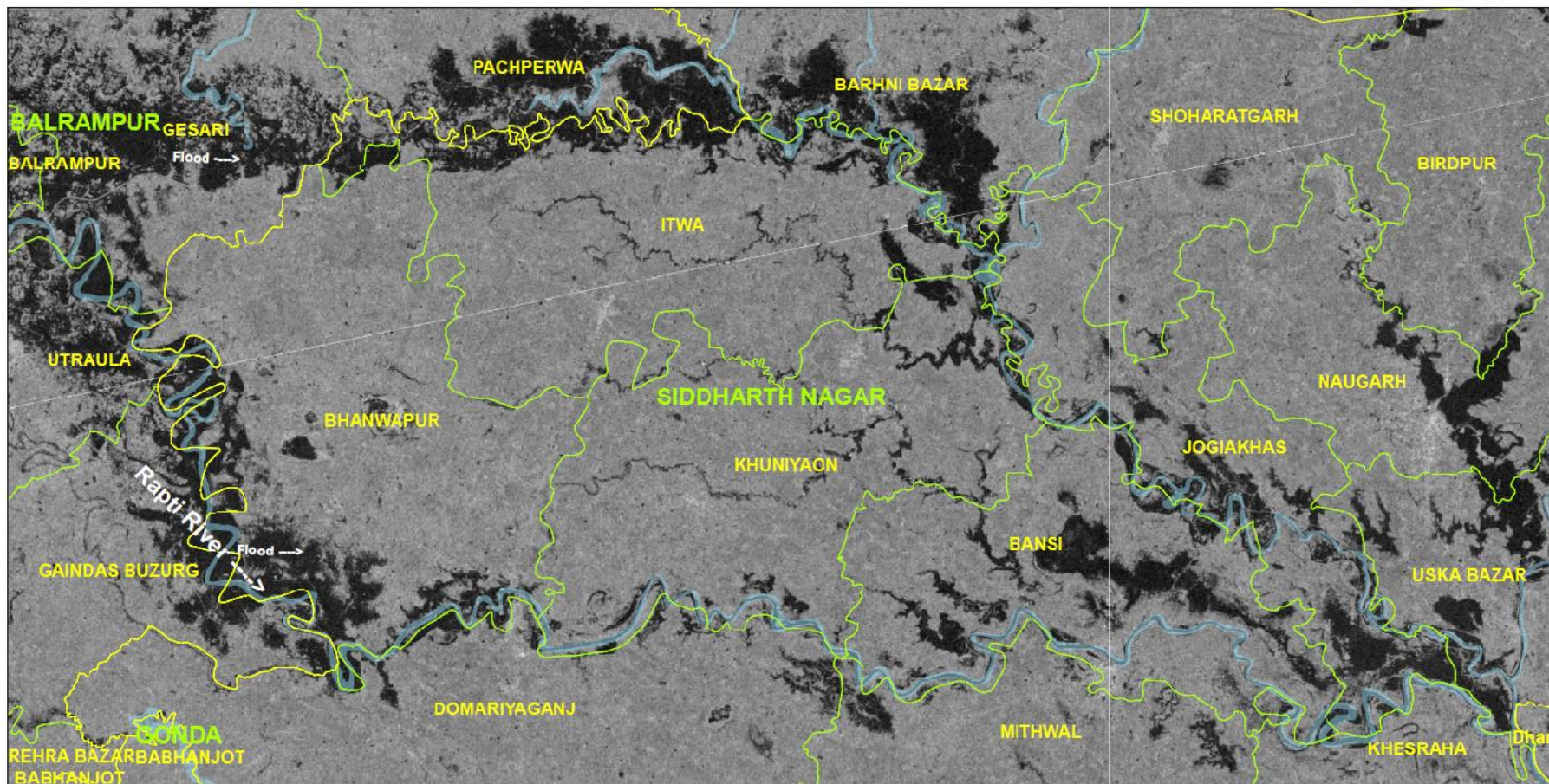


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Note : Interpretation of SAR Satellite Image : Areas reflected as black in colour adjacent to river boundary is interpreted as Flood Inundation

Sentinel-1A SAR Satellite Image Showing Flood Inundation in parts of SIDDARTH NAGAR District along Rapti River Uttar Pradesh State as on 10-October-2022 (1800 Hrs)

UP - FLOOD -2022-VAP No. 6 / dt.11.10.2022



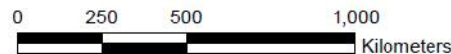
INDIA



UP State



| Legend | |
|--------|-------------------|
| | District Boundary |
| | Block Boundary |
| | River |

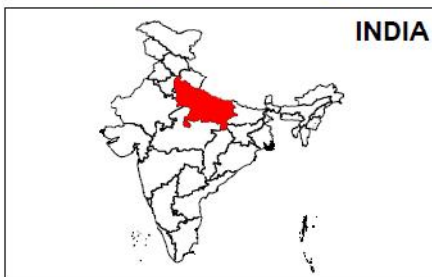
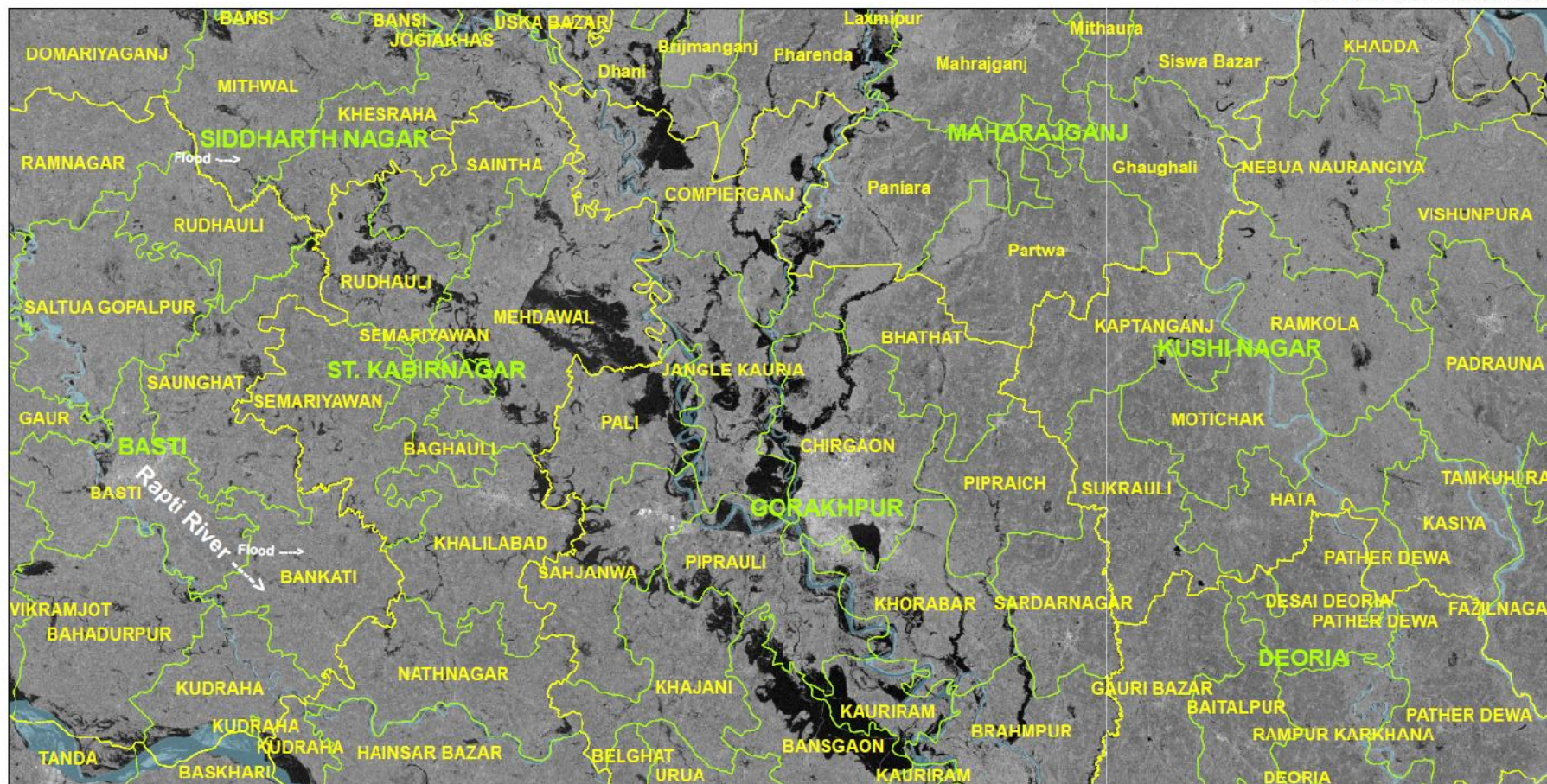


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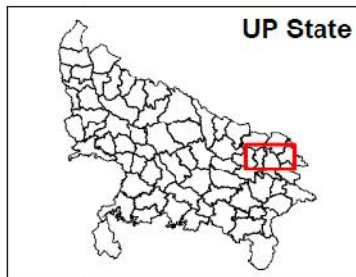
Note : Interpretation of SAR Satellite Image : Areas reflected as black in colour adjacent to river boundary is interpreted as Flood Inundation

Sentinel-1A SAR Satellite Image Showing Flood Inundation in parts of GORAKHPUR District along Rapti River Uttar Pradesh State as on 10-October-2022 (1800 Hrs)

UP - FLOOD -2022-VAP No. 6 / dt.11.10.2022



INDIA



UP State



Legend

- District Boundary
- Block Boundary
- River

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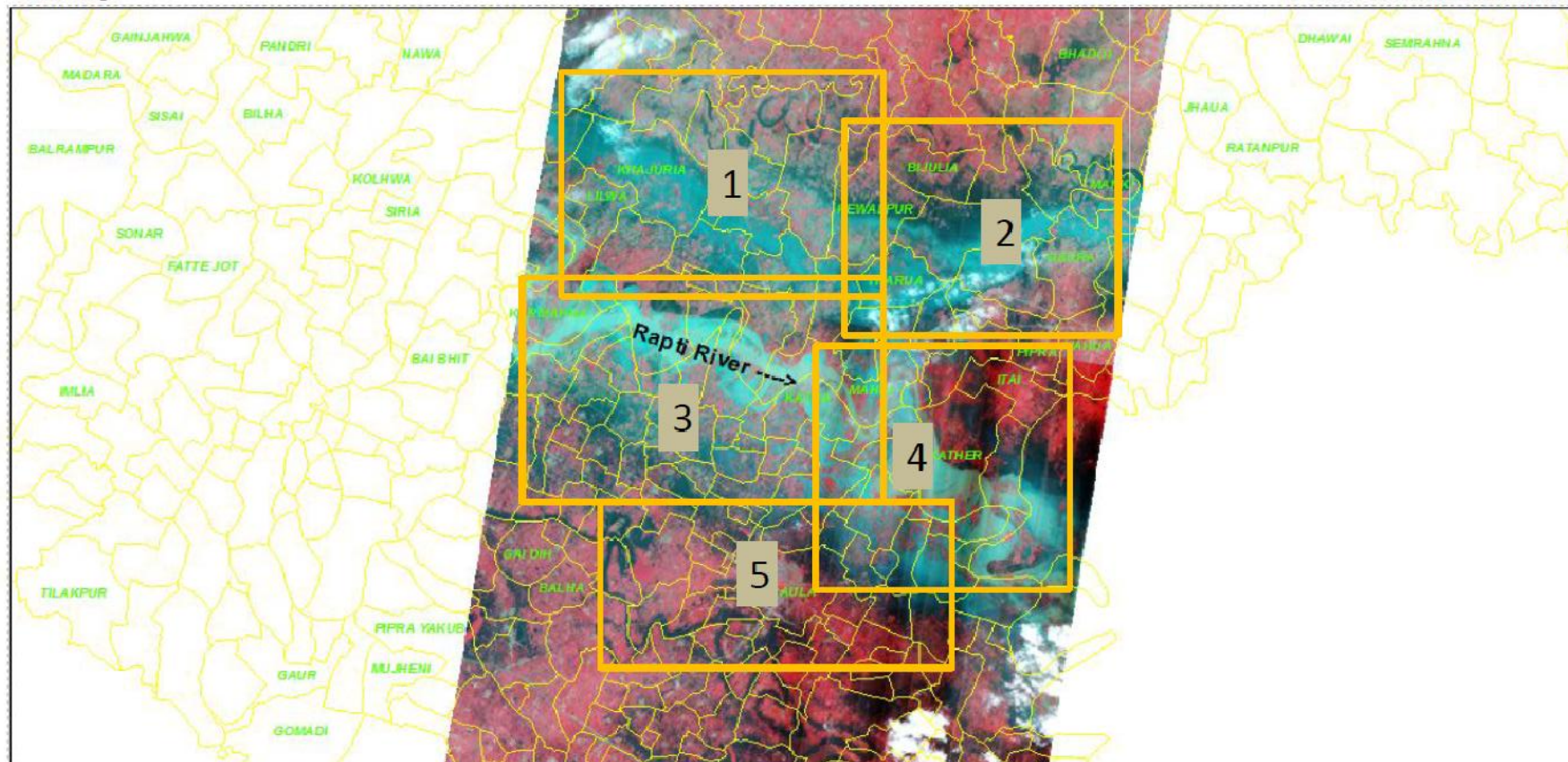


Note : Interpretation of SAR Satellite Image : Areas reflected as black in colour adjacent to river boundary is interpreted as Flood Inundation

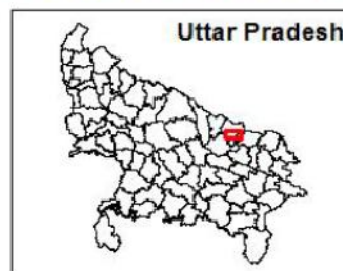
Cartosat-3 MX High Resolution Satellite Image Showing Flood Inundation in Parts of Balrampur, Gesari, Shri Dutt Ganj, Bhanwapur and Utraula Blocks, Uttar Pradesh State as on 16-October-2022

Satellite Image

UP - FLOOD -2022-VAP No. 17 / dt.17.10.2022



INDIA

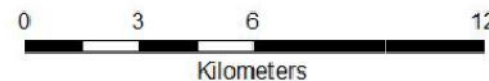


Uttar Pradesh



Legend

Village Boundary



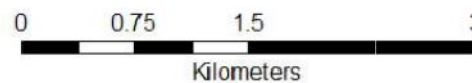
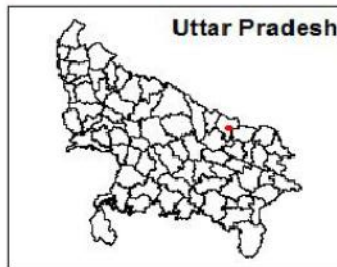
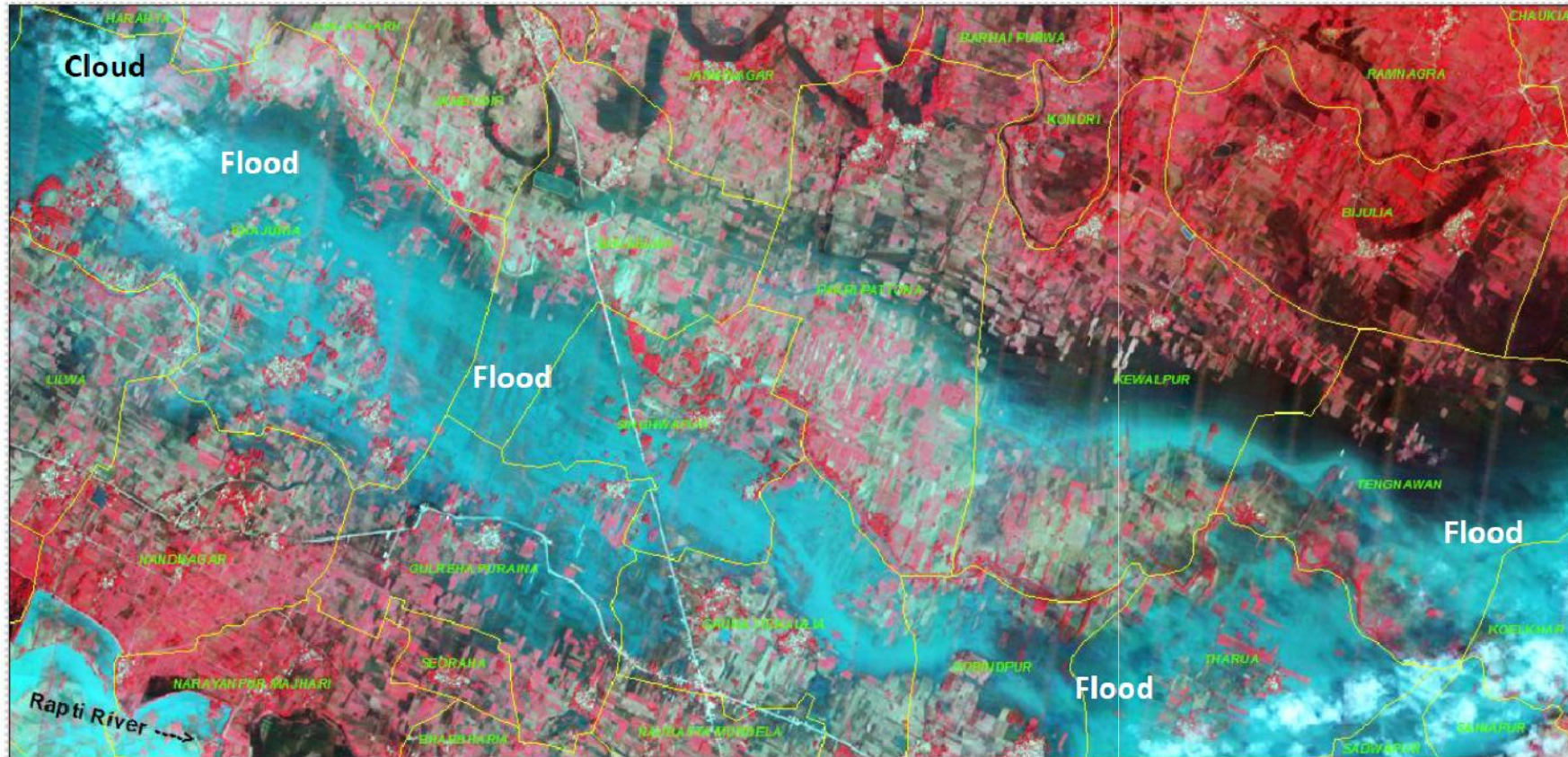
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Cartosat-3 MX High Resolution Satellite Image Showing Flood Inundation in Parts of Balrampur and Gesari Blocks, Uttar Pradesh State as on 16-October-2022

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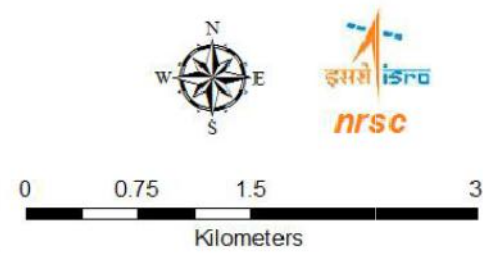
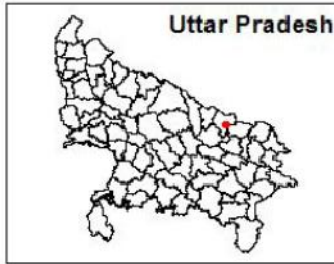
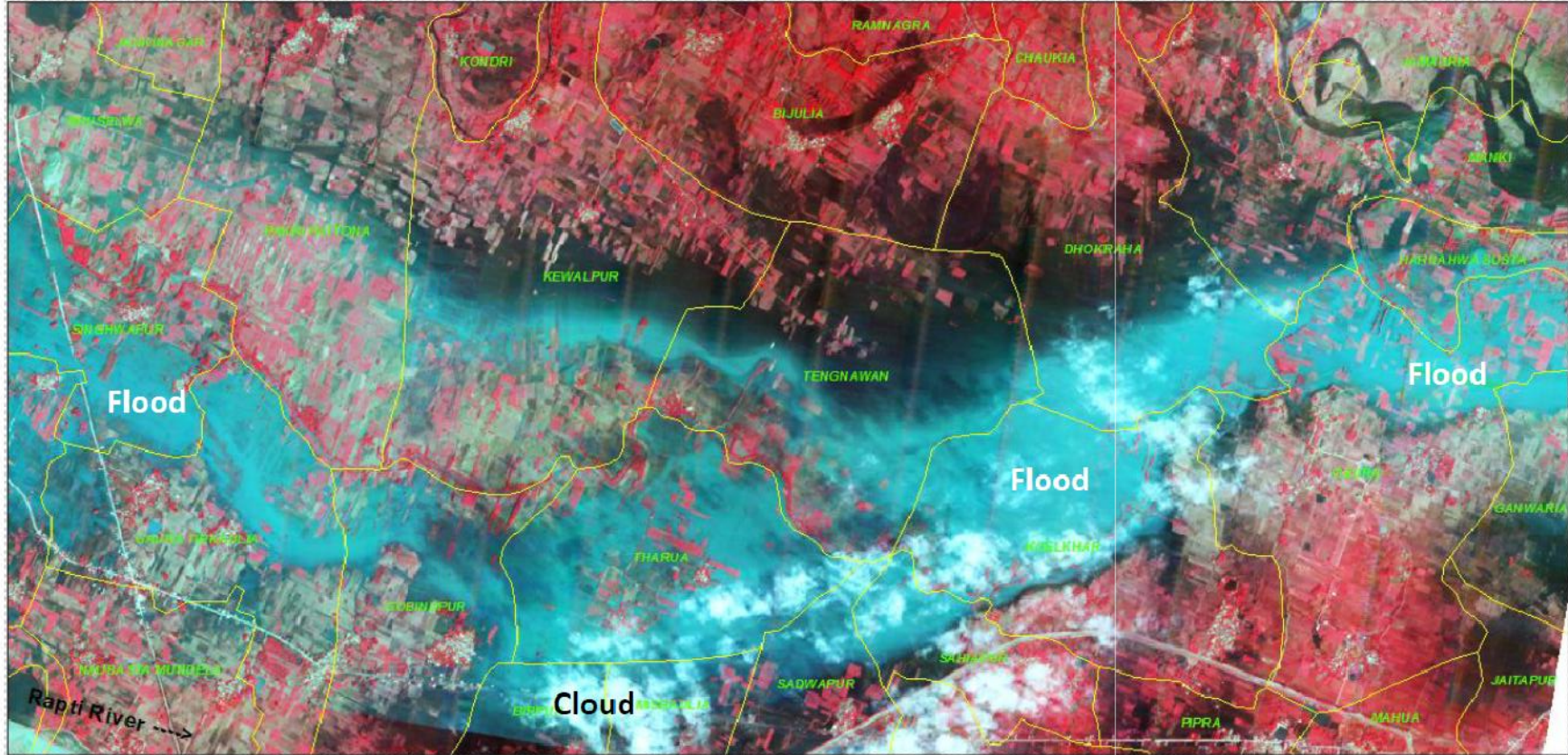
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Cartosat-3 MX High Resolution Satellite Image Showing Flood Inundation in Parts of Balrampur and Gesari Blocks, Uttar Pradesh State as on 16-October-2022

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Legend
 Village Boundary

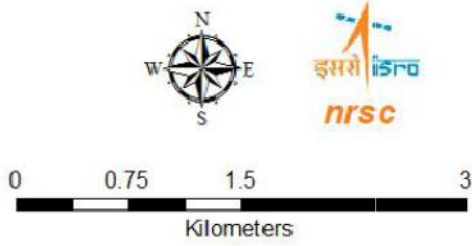
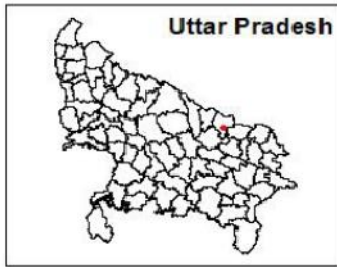
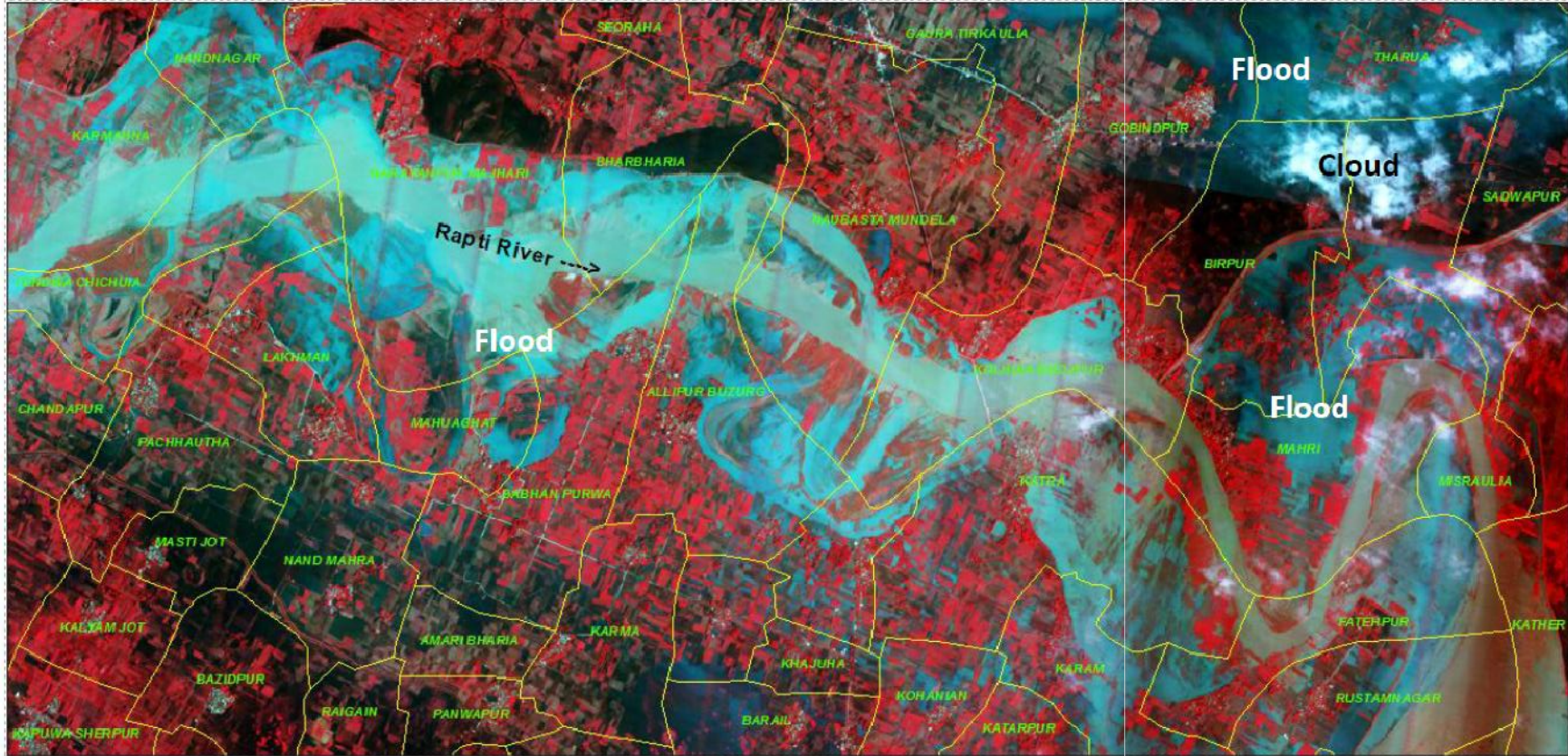
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Cartosat-3 MX High Resolution Satellite Image Showing Flood Inundation in Parts of Balrampur, Shri Dutt Ganj, Utraula and Gesari Blocks, Uttar Pradesh State as on 16-October-2022

Satellite Image

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Legend
 Village Boundary

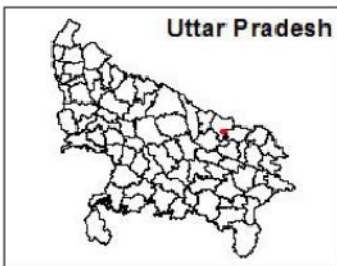
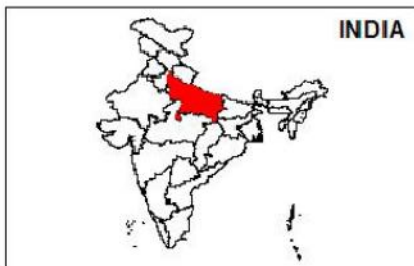
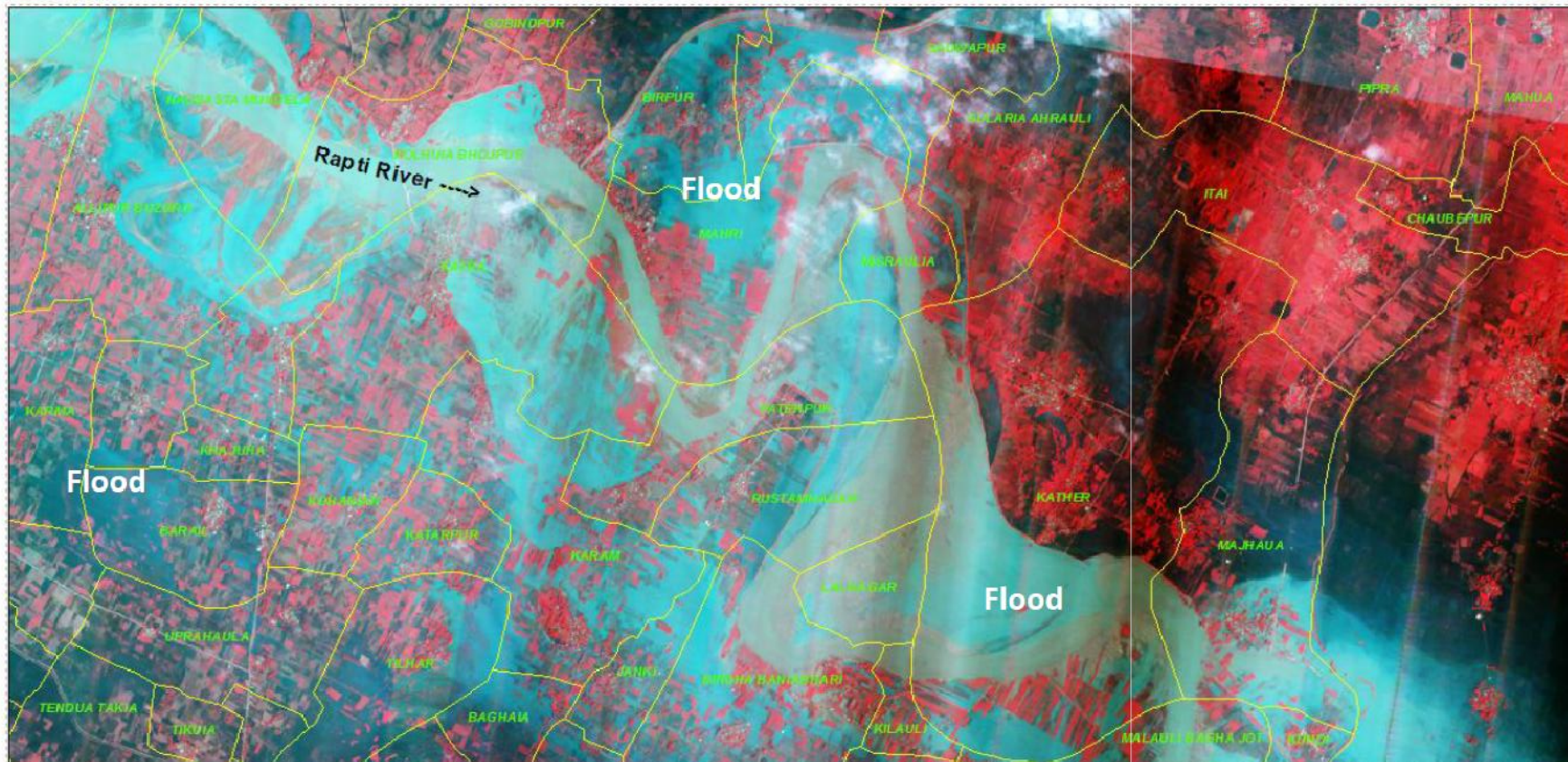
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Cartosat-3 MX High Resolution Satellite Image Showing Flood Inundation in Parts of Bhanwapur, Shri Dutt Ganj, Utraula and Gesari Blocks, Uttar Pradesh State as on 16-October-2022

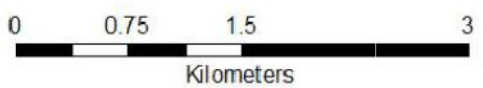
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Legend
 Village Boundary



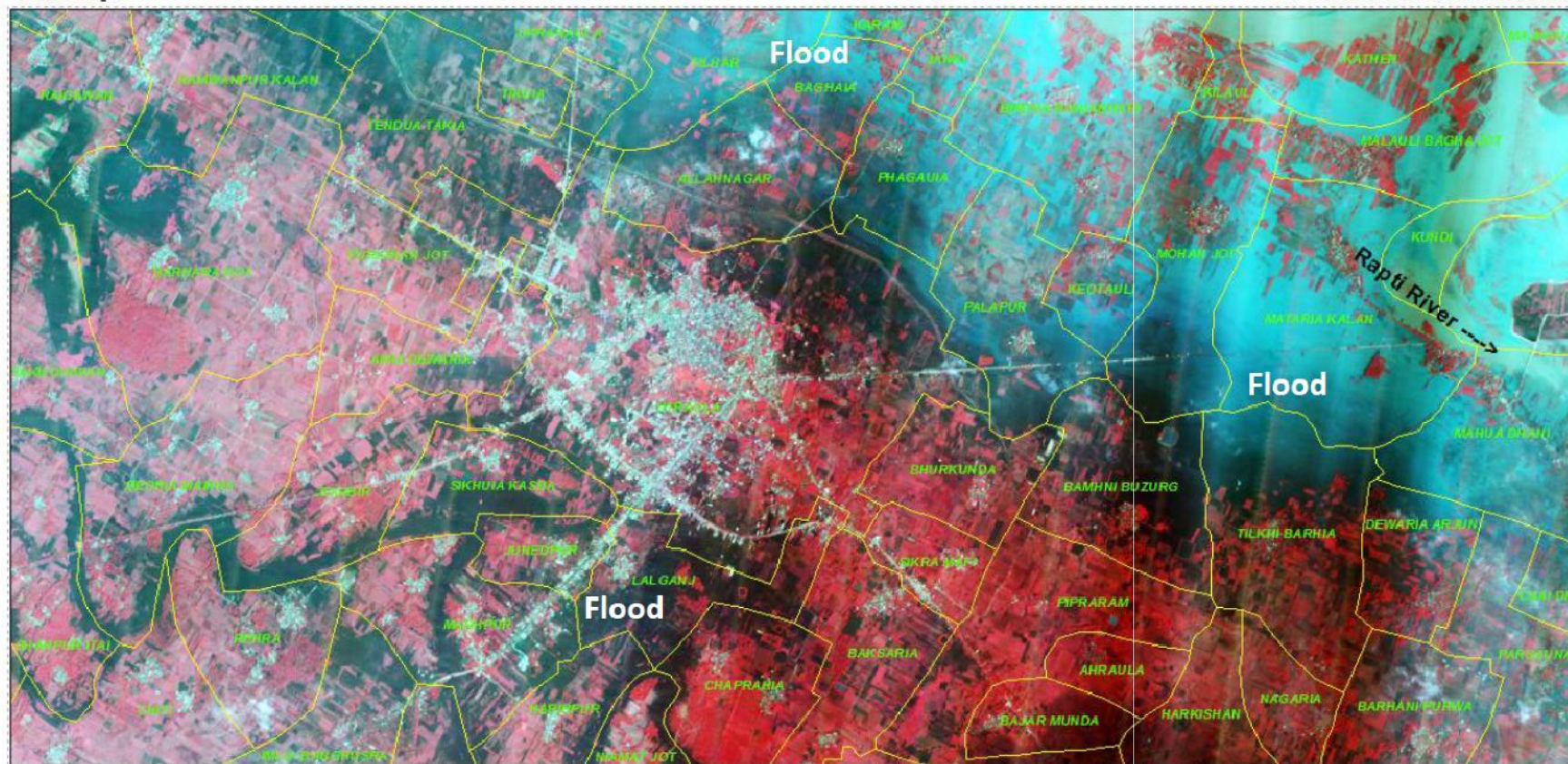
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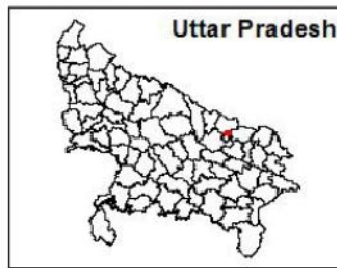
Cartosat-3 MX High Resolution Satellite Image Showing Flood Inundation in Parts of Utraula Block, Uttar Pradesh State as on 16-October-2022

Satellite Image

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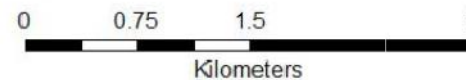


Uttar Pradesh



Legend

Village Boundary



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