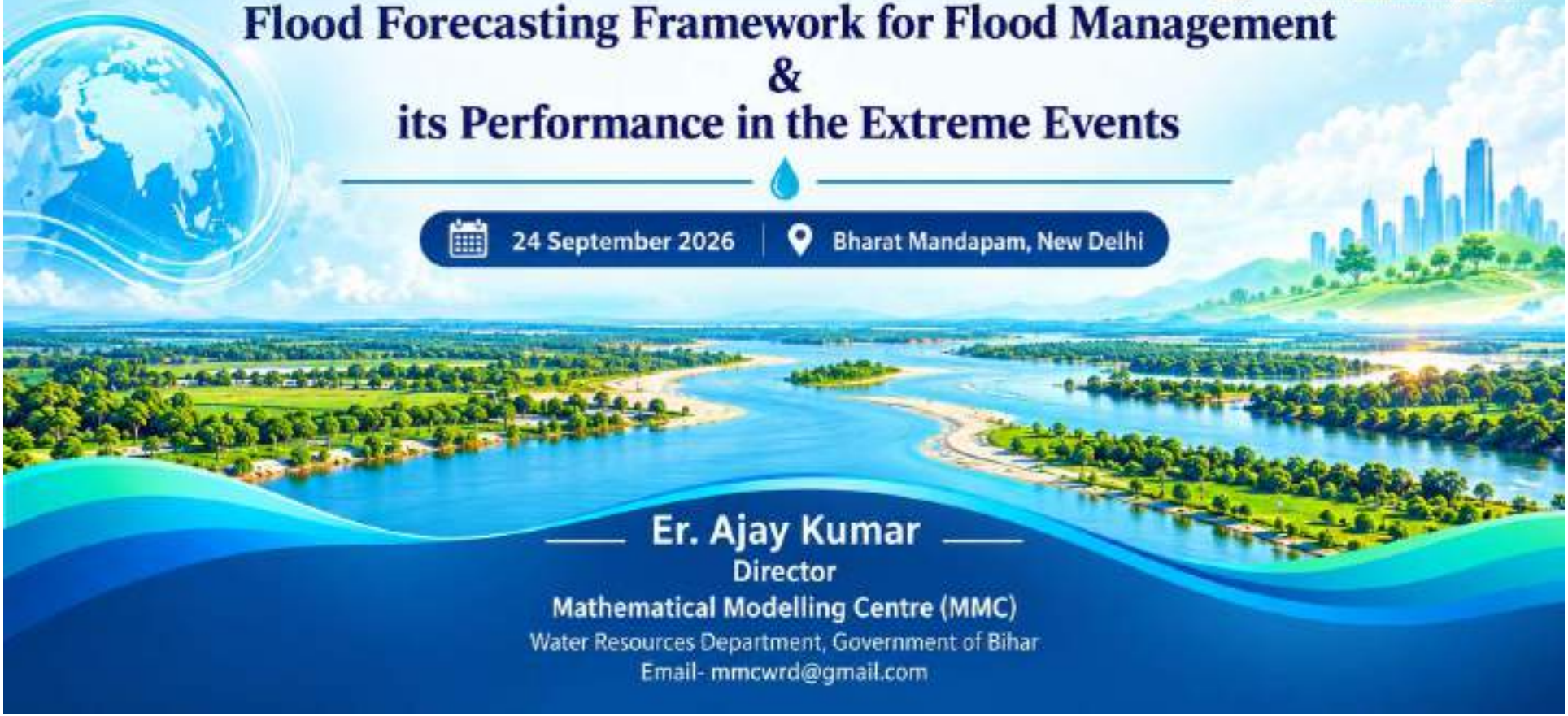
भारत सरकार
जल शक्ति मंत्रालय
Ministry of Jal Shakti
Government of India

सत्यमेव जयते

IIWW
INDIA INTERNATIONAL WATERWEEK 2026
Climate Resilient Water Management

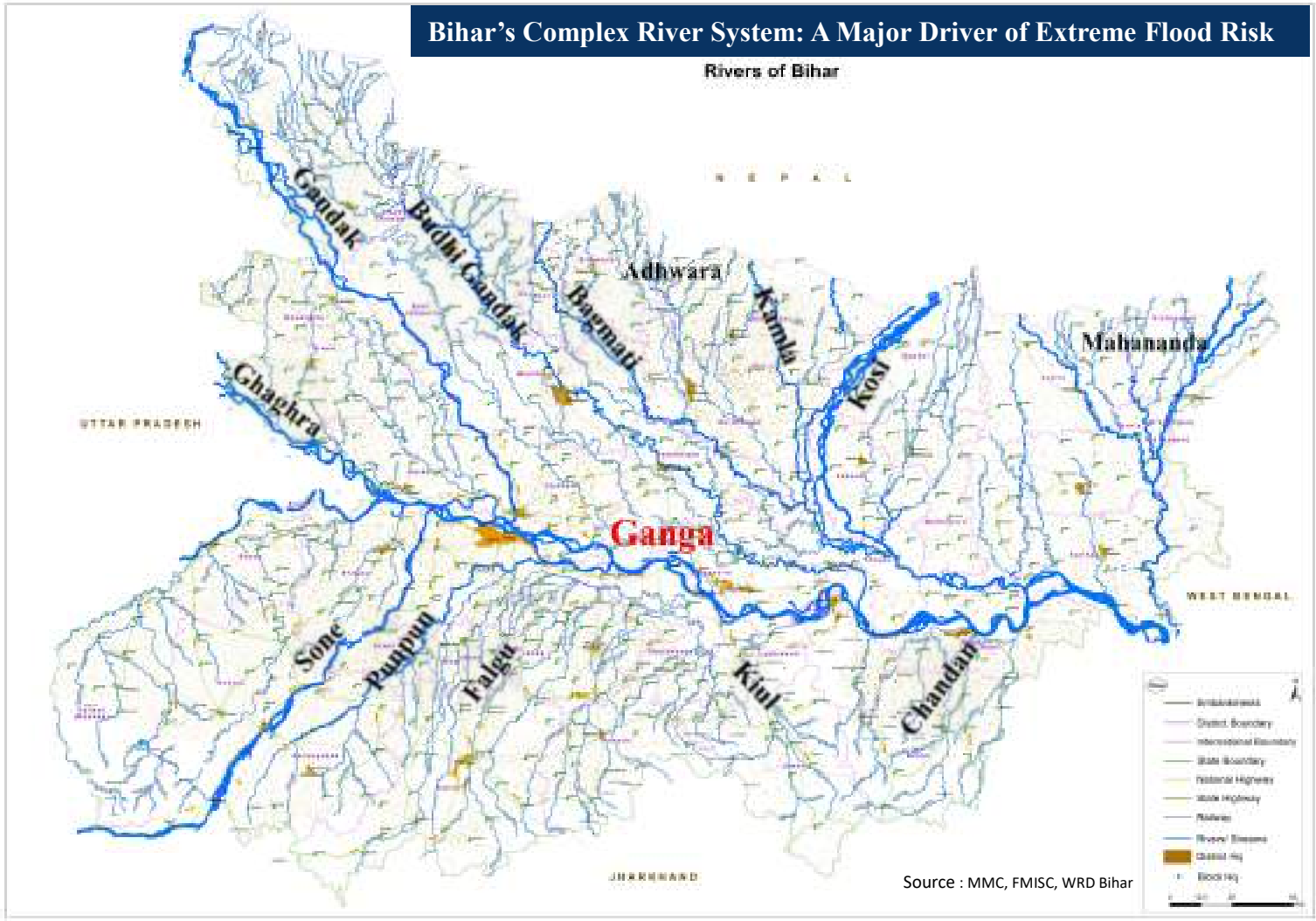
Flood Forecasting Framework for Flood Management & its Performance in the Extreme Events

24 September 2026 | Bharat Mandapam, New Delhi



Er. Ajay Kumar
Director
Mathematical Modelling Centre (MMC)
Water Resources Department, Government of Bihar
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Bihar's Complex River System: A Major Driver of Extreme Flood Risk



Source : MMC, FMISC, WRD Bihar

The Landscape of Bihar Flood

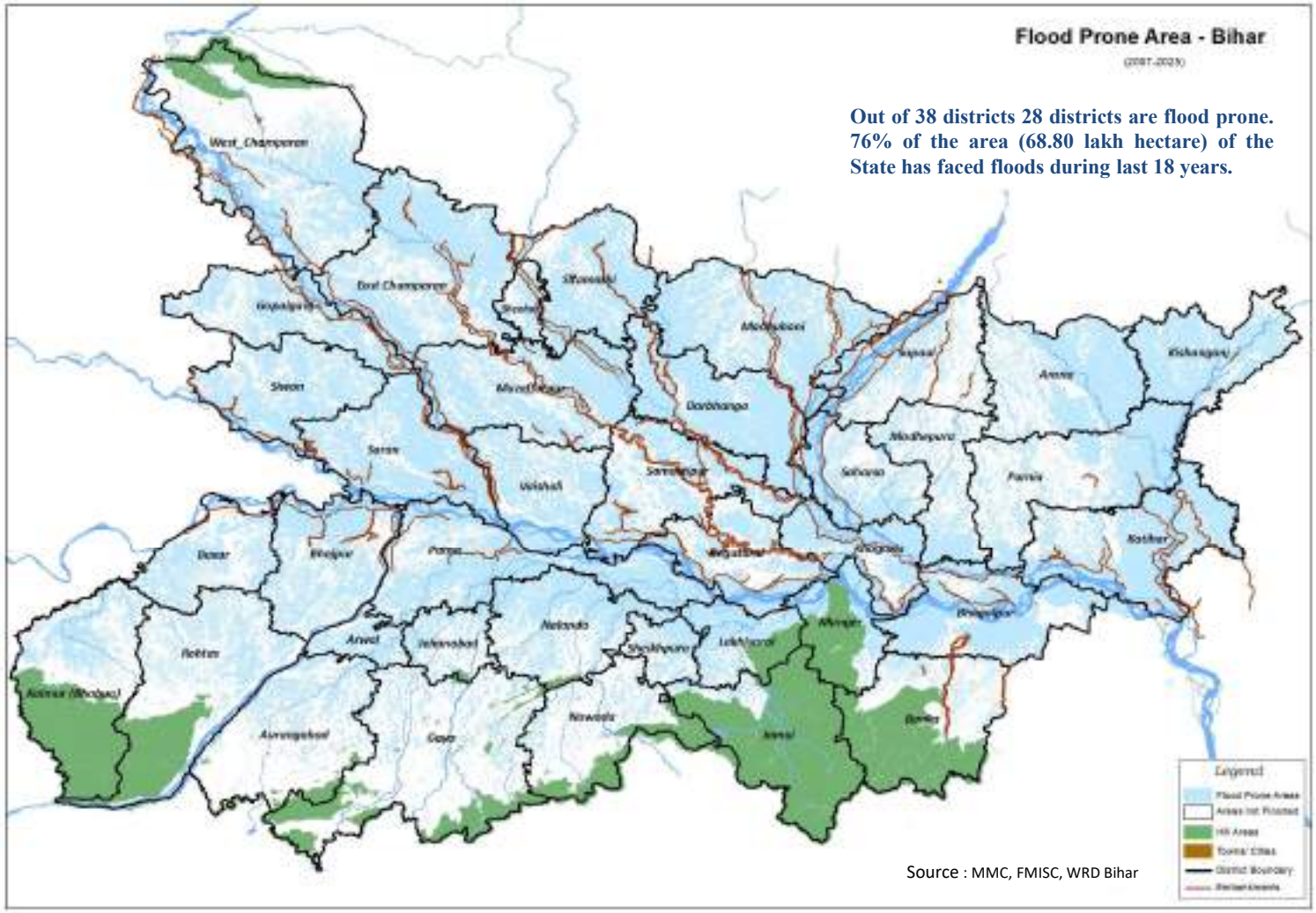
High-risk Geography

Bihar is uniquely susceptible to devastating floods due to its position at the foothills of Himalaya with multiple major River Systems.

Constant Risk of Floods

Major rivers including Ganga, Ghaghara, Kosi, Gandak, Sone, Bagmati, Mahananda & Kamla Balan which originate from high-altitude catchments make the region flood prone.

Climate Change is Intensifying Hydrological Extremes across Bihar



Source : MMC, FMISC, WRD Bihar

Impacts of Climate change : Recurring flood events



Bihar Flood-2008
Raghunathpur, Madhepura



Bihar Flood-2024
Karari Teentanga, Budhchak and Other Areas of Bhagalpur



Bihar Flood-2025
Supaul, District

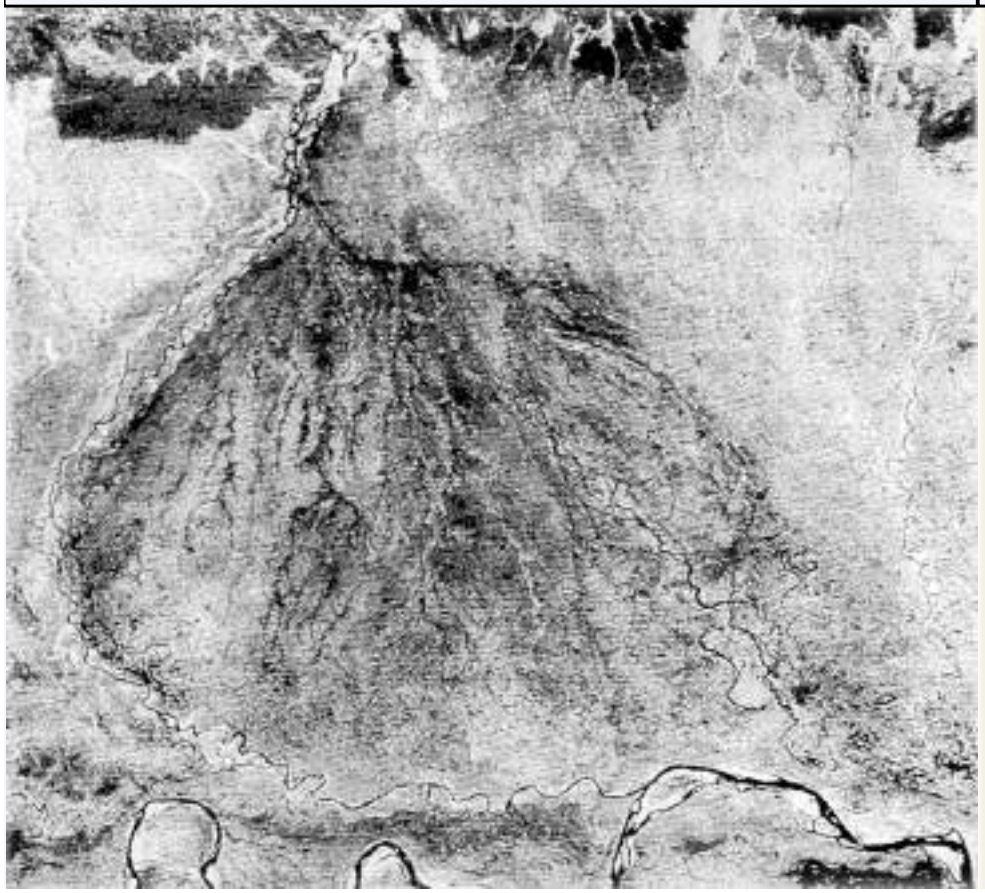


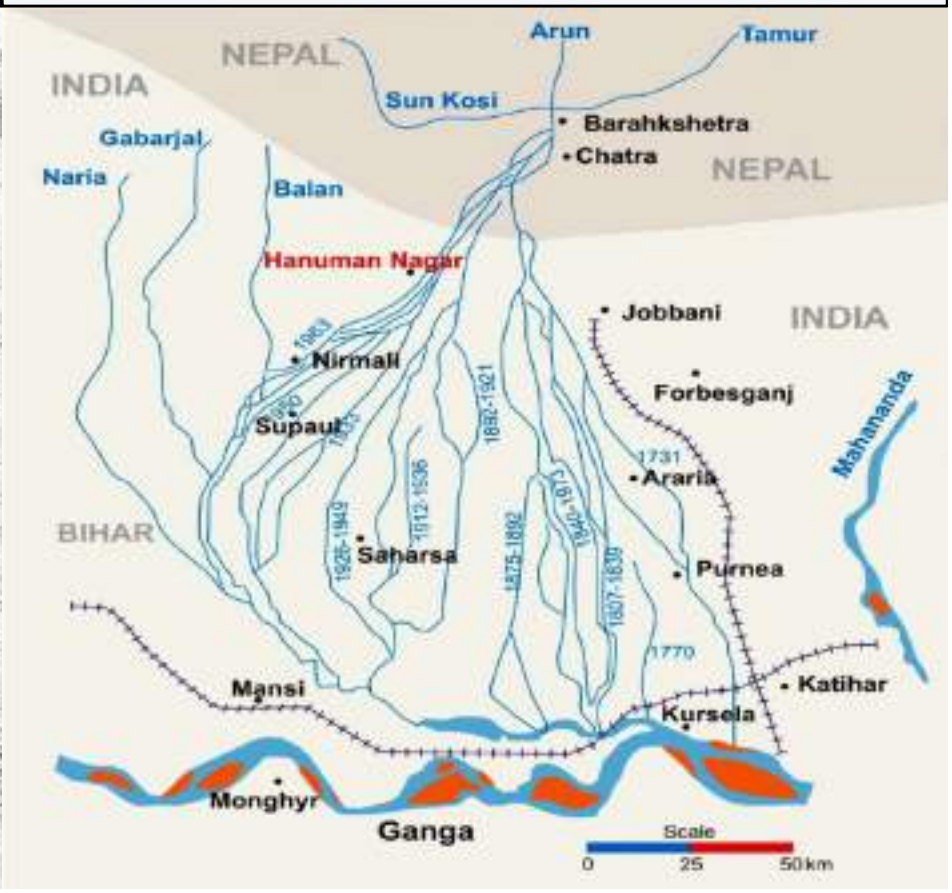
Bihar Flood-2026
Karari Teentanga, Budhchak and Other Areas of Bhagalpur

Source: Media Files

Kosi River- Sorrow of Bihar: A dynamic morphology

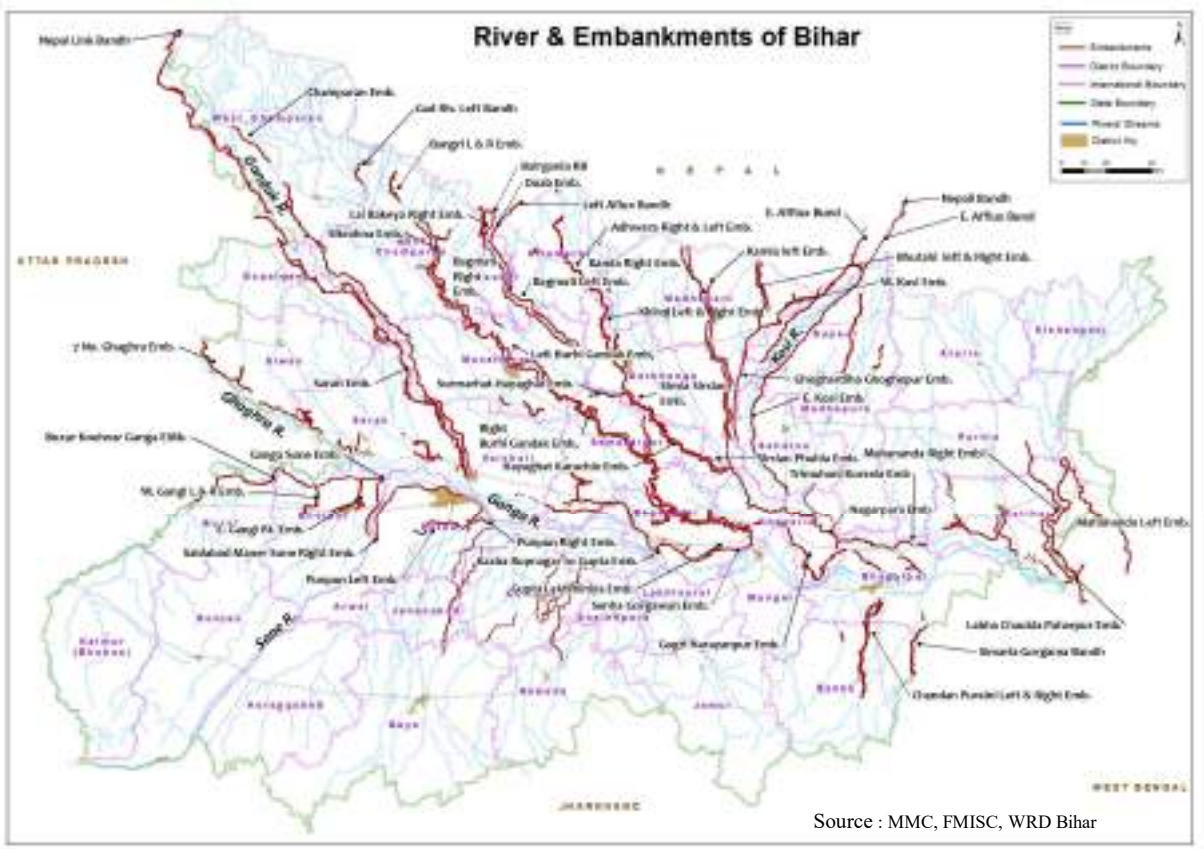
Satellite View of Kosi alluvial fan	Identified courses





Flood management through Structural Measures

As a structural measure 3974.45 Km of embankment have been constructed against major flood prone rivers.



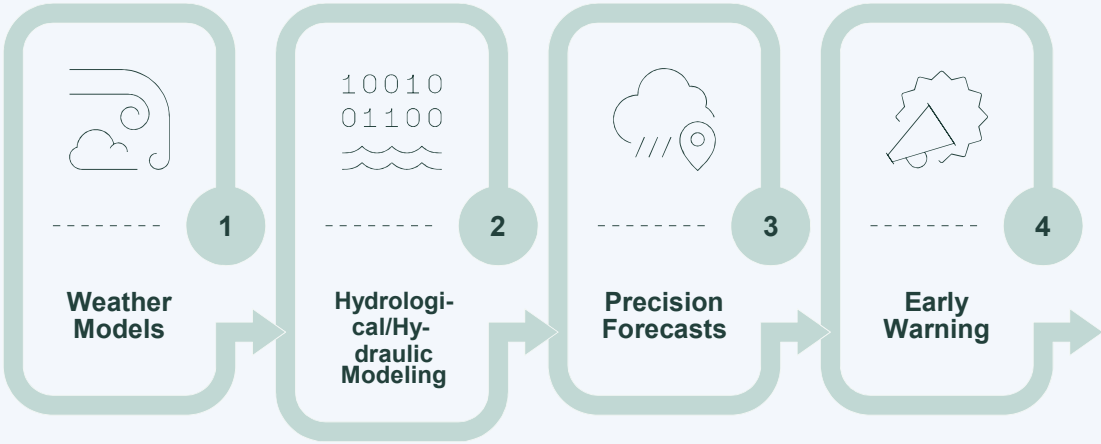
Source : MMC, FMISC, WRD Bihar

Flood Forecasting & Early Warning Systems (FF-EWS)

Transforming hydro-meteorological data into Actionable Intelligence for Proactive Flood Risk Management



- **Lead Time: Significant increase in time available for emergency response**
- **Accuracy: High-precision forecasts for localized action**
- **Operations: Reservoir management and Infrastructure protection**
- **Improved Emergency Planning**



Better Forecasts → Better Decisions → Greater Resilience

Flood Forecasting Framework for Flood Management

- Proactive approach for flood risk mitigation: Establishment of Mathematical Modeling Centre (MMC).



Flood Forecast (FF) – Modelling Framework

Software used for FF Model

- MIKE-11 of Danish Hydraulic Institute (DHI)

Rivers

- Regional Network Model of North Bihar Rivers
- Ganga, Bagmati-Adhwara Group, Kosi, Gandak, and Mahananda basin in Bihar

FF done for

- Water Level and Discharge in River

FF location

- 43 Nos. (Detail in next slide)

Water level and Discharge forecast

- for 3 days in major rivers of Bihar & its dissemination on Mobile Application, web portal, E-mail.
- for 5 days in major rivers of Bihar for study purpose.

•Data Used

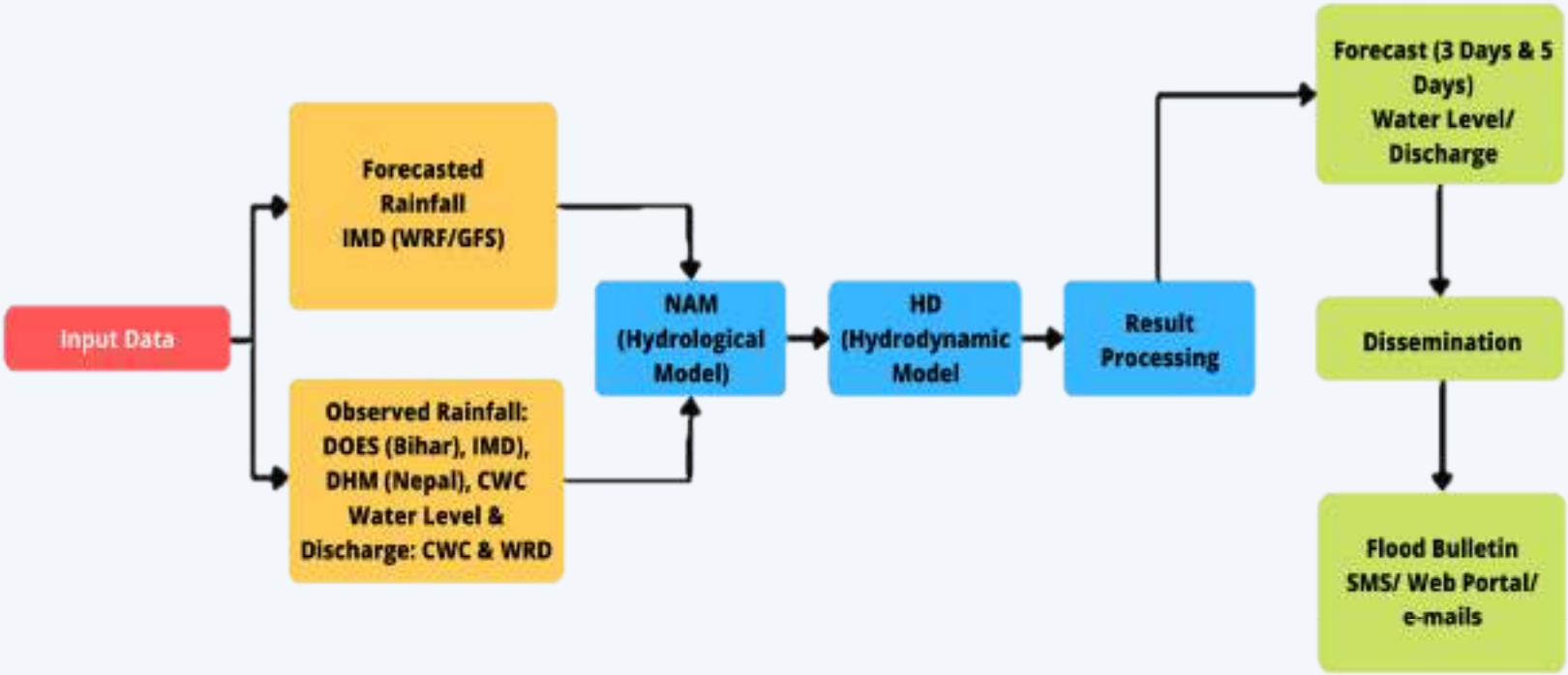
- Rainfall, Rainfall forecast, Water level

Data Type	Source	Frequency
Rainfall in Nepal	**DHM, MFD**	**DHM – hourly**
Rainfall in Bihar	**DoES**	**Once in a day**
Rainfall in India outside Bihar	**IMD, CWC**	**IMD – once in a day, CWC – 3 to 6 hourly**
Rainfall Forecast	**IMD**	**Daily**
Water Level	**CWC, WRD, DHM**	**CWC- Hourly. WRD – three times a day (6 am, 9 am and 12 noon) DHM –Hourly (Nepal)**

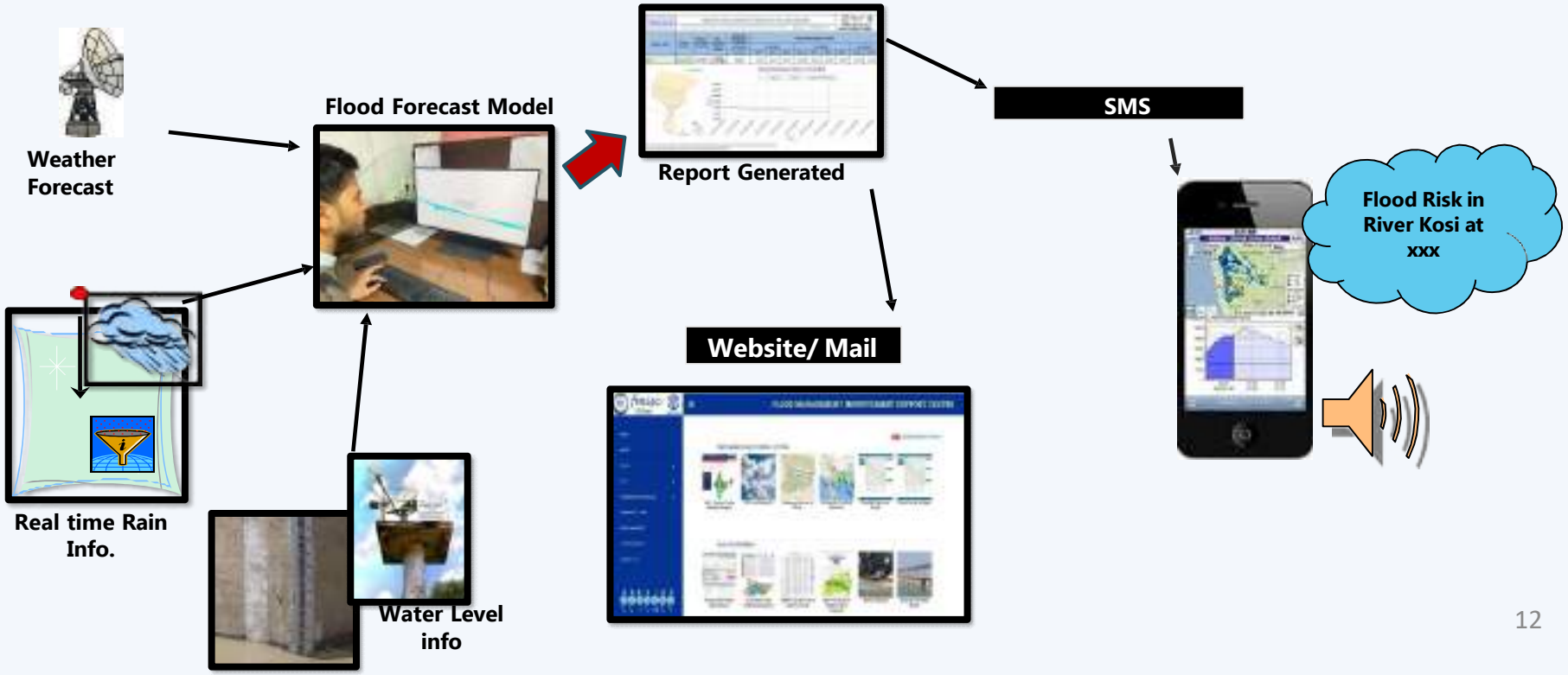
DHM- Department of Hydrology and Meteorology, Nepal,
MFD- Meteorological Forecasting Division, Nepal,
IMD- India Meteorological Department

DOES- Directorate of Economics and Statistics, Bihar
CWC- Central Water Commission.

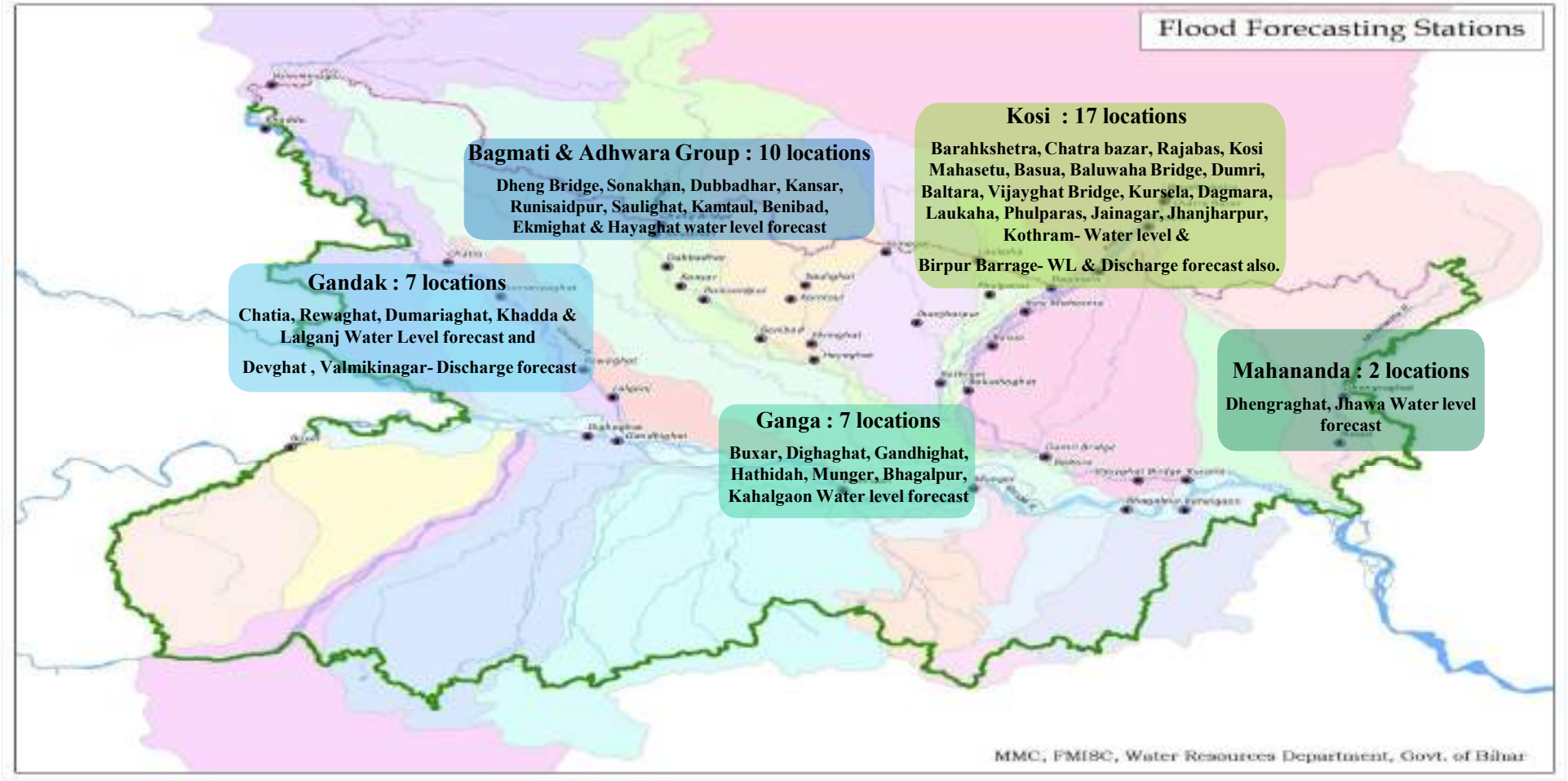
Flood Forecast - Methodology



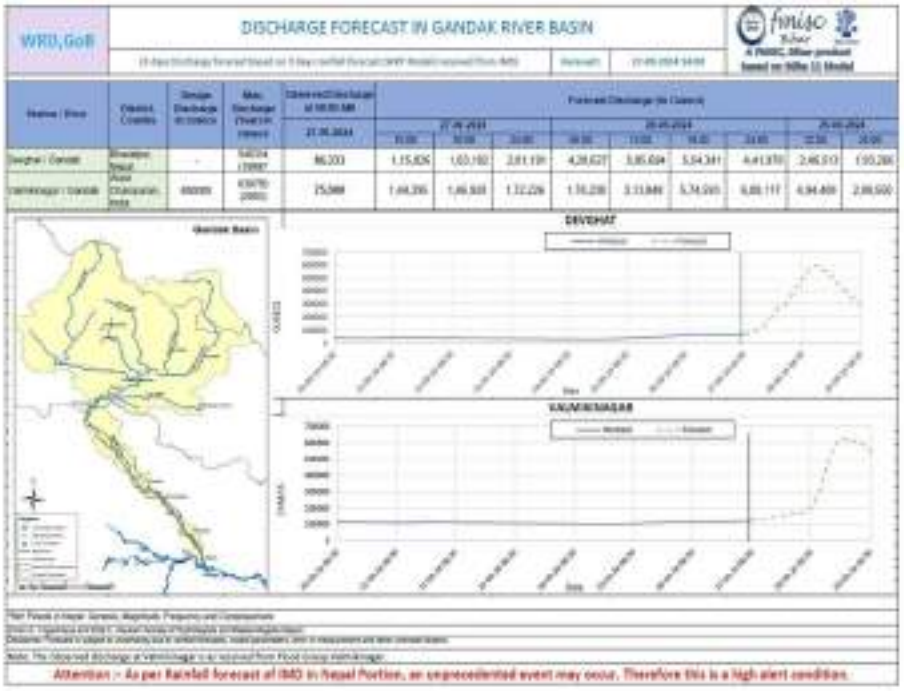
Flood Forecast - Approach



Flood Forecast - Locations



Flood Forecast Bulletin issued During Extreme Event



WRD,GoB

DISCHARGE FORECAST IN GANDAK RIVER BASIN

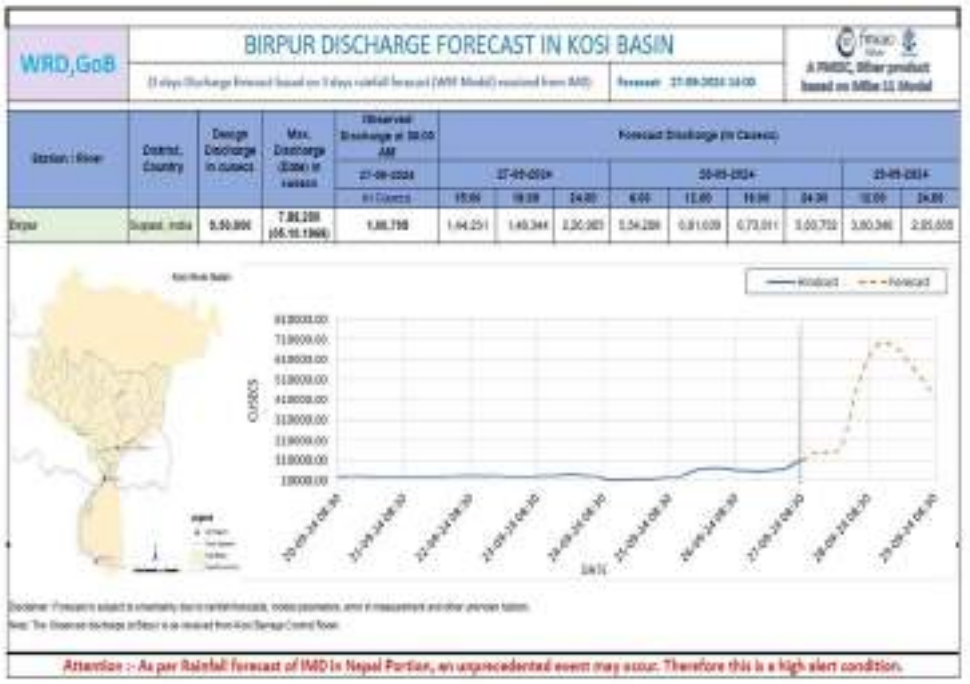
A FMISC, Bihar product based on Mike 11 Model

Station / River	District, Country	Design Discharge in cumecs	Max. Discharge (Date) in cumecs	Observed Discharge at 08:00 AM	Forecast Discharge (in Cumecs)								
				27-09-2024	27-09-2024			28-09-2024				29-09-2024	
					10:00	16:00	22:00	04:00	10:00	16:00	22:00	04:00	10:00
Valmikinagar / Gandak	Bihar, India	65000	83470 (2002)	75,000	1,44,205	1,46,503	1,32,226	1,16,230	2,13,849	3,74,005	6,00,117	6,94,469	2,89,500

DEVGHAT

VALMIKINAGAR

Attention :- As per Rainfall forecast of IMD in Nepal Portion, an unprecedented event may occur. Therefore this is a high alert condition.



WRD,GoB

BIRPUR DISCHARGE FORECAST IN KOSI BASIN

A FMISC, Bihar product based on Mike 11 Model

Station / River	District, Country	Design Discharge in cumecs	Max. Discharge (Date) in cumecs	Observed Discharge at 08:00 AM	Forecast Discharge (in Cumecs)								
				27-09-2024	27-09-2024			28-09-2024				29-09-2024	
					10:00	16:00	22:00	04:00	10:00	16:00	22:00	04:00	10:00
Birpur	Gujarat, India	9,50,000	7,80,259 (06.10.1968)	1,60,798	1,64,251	1,40,344	2,20,383	3,54,286	5,81,009	6,73,011	5,60,732	3,80,346	2,85,608

Attention :- As per Rainfall forecast of IMD in Nepal Portion, an unprecedented event may occur. Therefore this is a high alert condition.

Flood Forecast Performance in Extreme Event

Flood- 2024

- On 26-09-24, it was forecasted that in River Gandak a peak discharge of 5.20 lakh cusec is expected at Valmikinagar Barrage.
  - Next day on 27-09-2024, 6.00 lakh cusec was forecasted for the same river location.
  - Actual maximum discharge of 5.62 lakh cusec observed on 28-09-24 in River Gandak at Valmikinagar.

- Similarly, it was forecasted on 27-09-24 for a peak discharge of 6.81 lakh cusec in River Kosi at Birpur barrage.
  - Actual maximum discharge of 6.61 lakh cusec observed on 29-09-24 in River Kosi at Birpur barrage.

River	Forecasted Discharge	Observed Discharge
Gandak	**6.00 lakh cusec on 27-09-24**	**5.62 lakh cusec on 28-09-24**
Kosi	**6.81 lakh cusec on 27-09-24**	**6.61 lakh cusec on 29-09-24**

- **As per the Final Technical Review Report on the Kosi River Flood Forecasting Model, submitted by IISc, Bengaluru in May 2026, the model was comprehensively evaluated and found to have strong potential for operational Flood Forecasting and Early Warning System (FF-EWS). The review reported an approximately 98% accuracy for the first-day forecast.**

Recent Experiences and Conclusions

- 26 August 2026 Nepal-China Border catastrophic high-altitude glacier/rock-slope collapse.
- Despite 36% rainfall deficit(up to 9 September, 2026, as per IMD) in Bihar, River Ganga crossed the Highest Flood Level(HFL) at many gauging sites during 5-10 September, 2026.

These events highlights the need for-

- Next-generation multi-hazard, multi-source early warning system.
- Advanced flood forecast modelling.
- Real time International data exchange.

CLIMATE RESILIENT FLOOD MANAGEMENT IS NOW A NECESSITY


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जल संसाधन विभाग
बिहार

Thank You