Real-time flood inundation mapping for flood intelligence: A case study from India

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Presentation Overview

- **Context**
- Flood problem
- Study area
- **Forecasting framework**
- Design considerations
- Framework architecture
- Key operations
- **Next steps + summary**

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Context

Bihar's flood problem

- India's most flood prone state
- 76% of northern population at risk of recurrent flooding
- Flood levels elevated for months
- Mostly rural area, but many villages in floodplain
- Lower income and education
- Little ability / desire to build elsewhere

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Study area: state of Bihar

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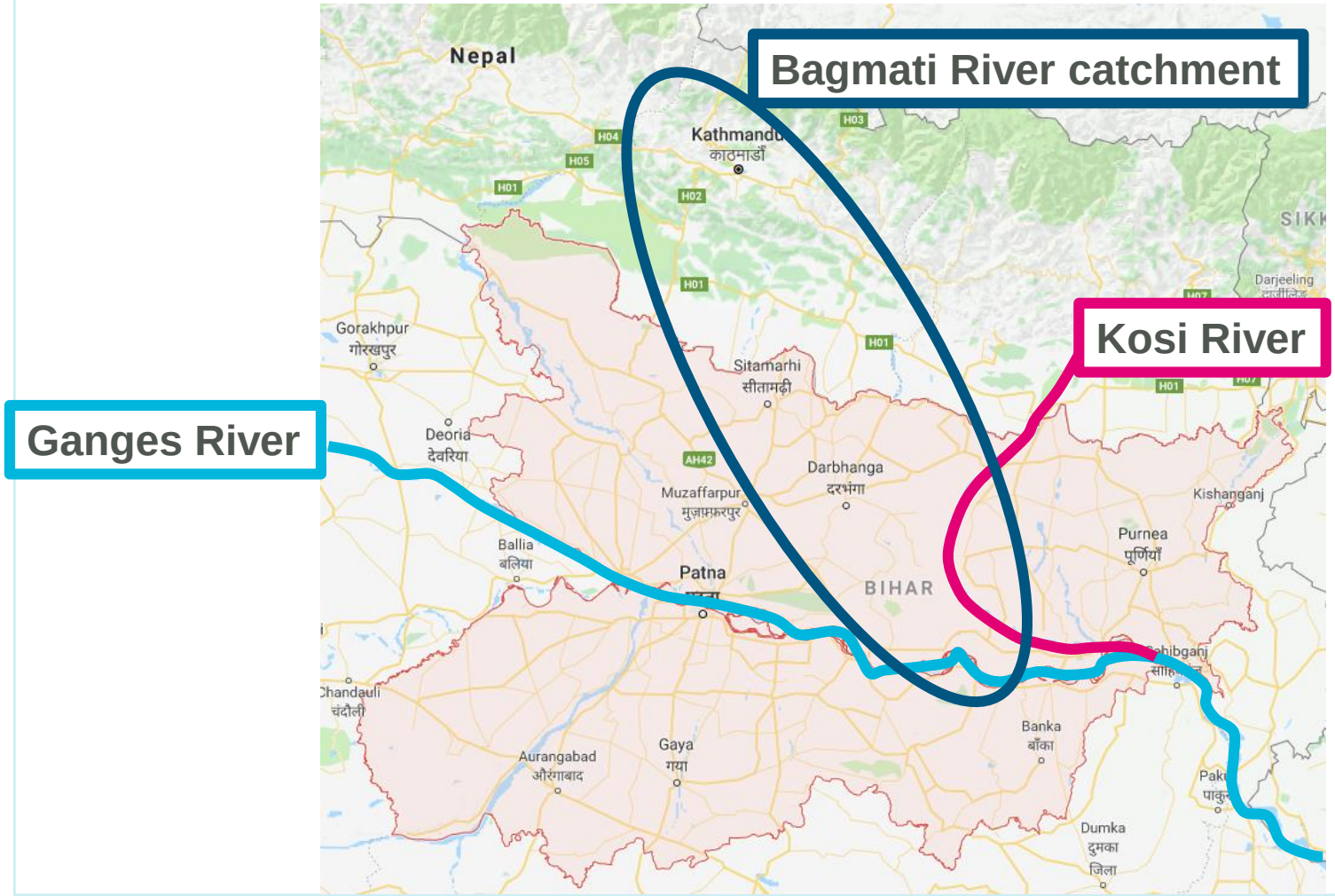
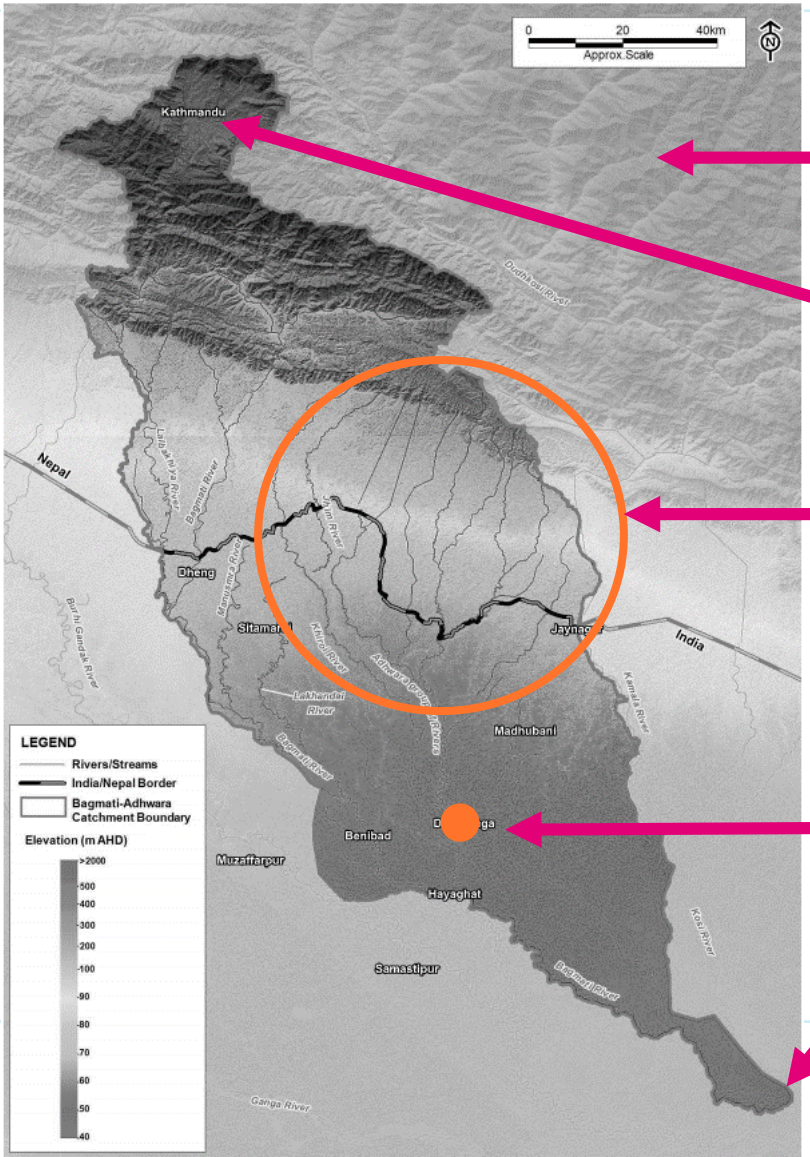
Study area: Bagmati River catchment



Study area: topography



Himalayas

Kathmandu Valley

Adhwara group of rivers

Darbhanga

Confluence with Kosi River

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Study area: land use

Typical land use: meandering river, small villages, farm land
Approx. 1,000km of embankments

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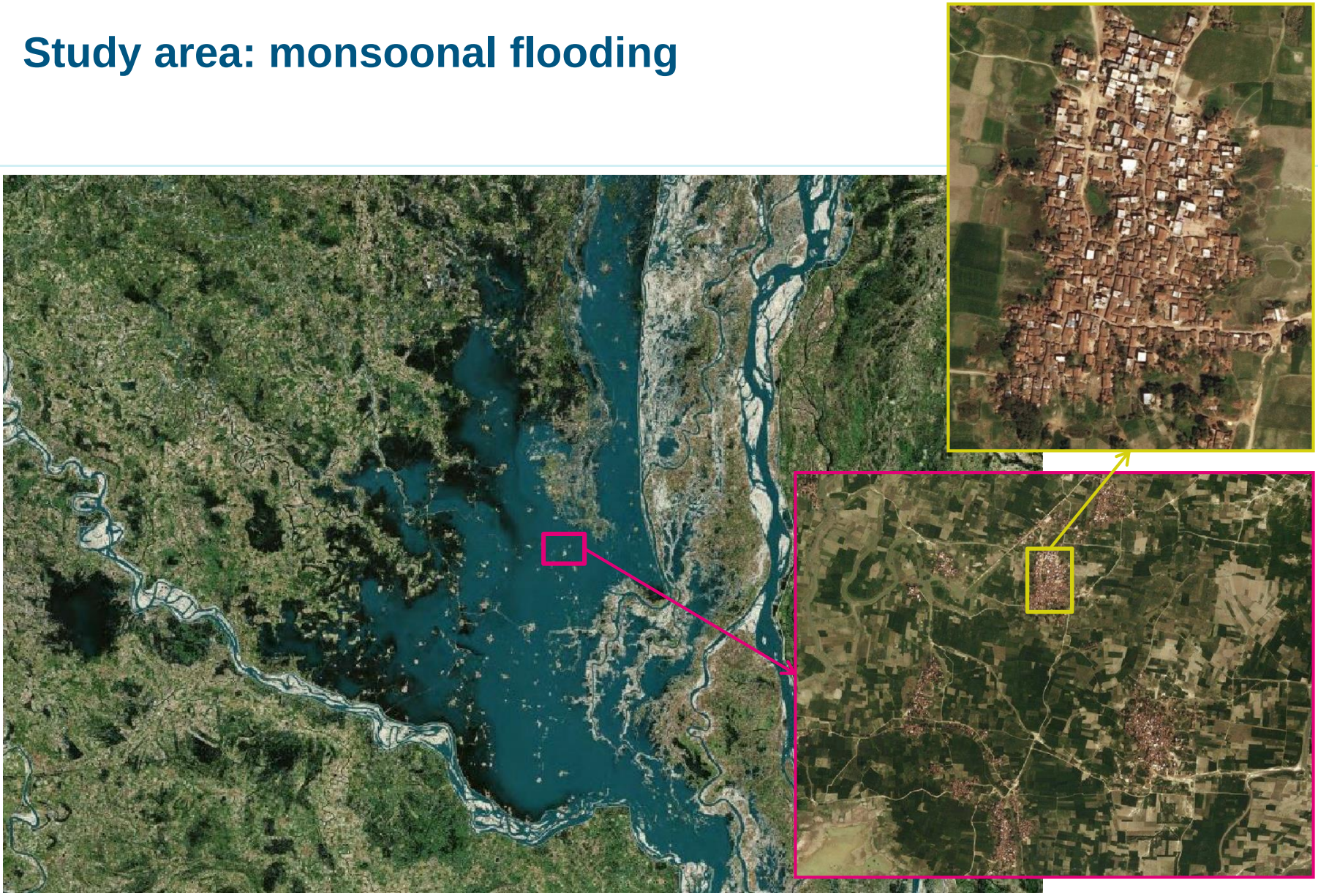
Study area: monsoonal flooding



Forecasting framework

Design considerations

- **Nature of flooding – annual, slow onset, long duration**

- **Availability of data – esp. topographic and rainfall**
  - Poor geographic coverage of gauges
  - No / difficult access to gauges in Nepal
  - LiDAR available for downstream areas
  - SRTM only in upper catchment – can be metres different to ground survey
  - Limited and dated bathymetry: dynamic streams and sedimentation bring challenges with representation of waterways

- **Capacity building – consideration of FMISC skill and experience**

- **System flexibility – ensuring capacity to grow and evolve**

Framework architecture

Three key components:

URBS

TUFLOW

Runoff-routing modelling for observed and forecast rainfall

Produces hydrographs (flow vs time)

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Framework architecture

Three key components:

URBS

TUFLOW

1D/2D hydraulic modelling of channel and floodplain behaviours

Uses hydrographs from URBS

Produces flood maps

Framework architecture

Three key components:

URBS

TUFLOW

Delft-FEWS flood forecasting software

Ingests rainfall and stream obs / forecast

Runs models and manages results

Main interface for users

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Key operations

Want to know 3 main things:

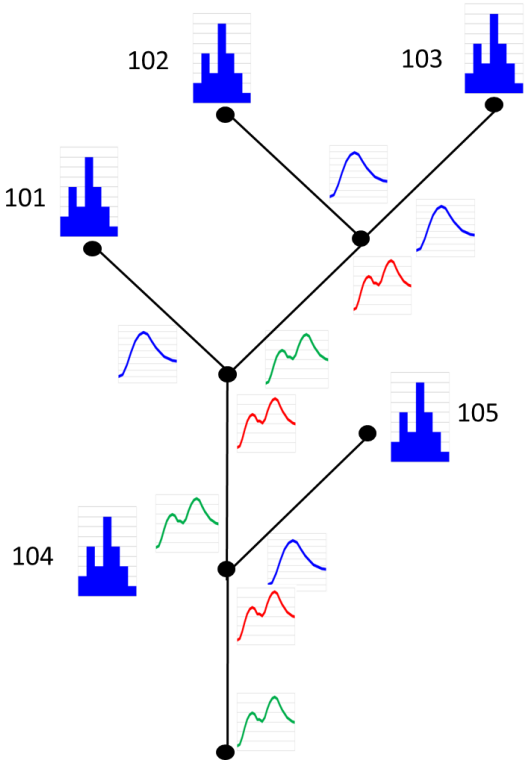
- **What is the current situation?**
- **What is the future situation?**
- **What happens if embankment breaches?**

Key operations: current situation

Poor rain gauge coverage means we don't know how much rain is entering the system in upper catchment

Solution? Test ensemble

- **Tested every day of monsoon**
- **Hydrology considers 7 x 7 scenarios**
- **Fast hydraulic model simulates 49 events**
- **Boundary conditions from previous days' simulation (represents water already in system / 'hot start')**
- **Hydraulic model output compared against recorded river levels**



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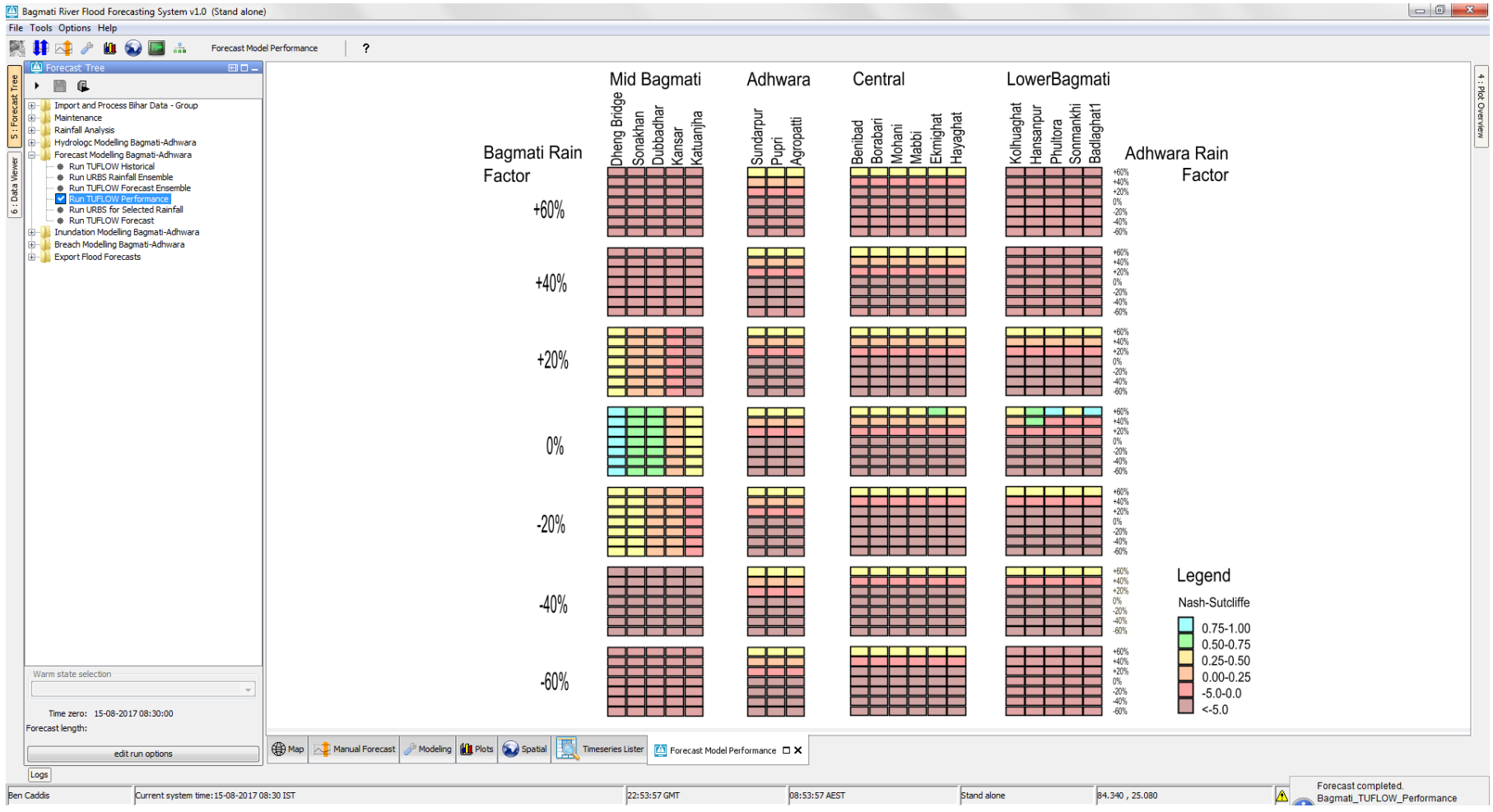
Key operations: current situation



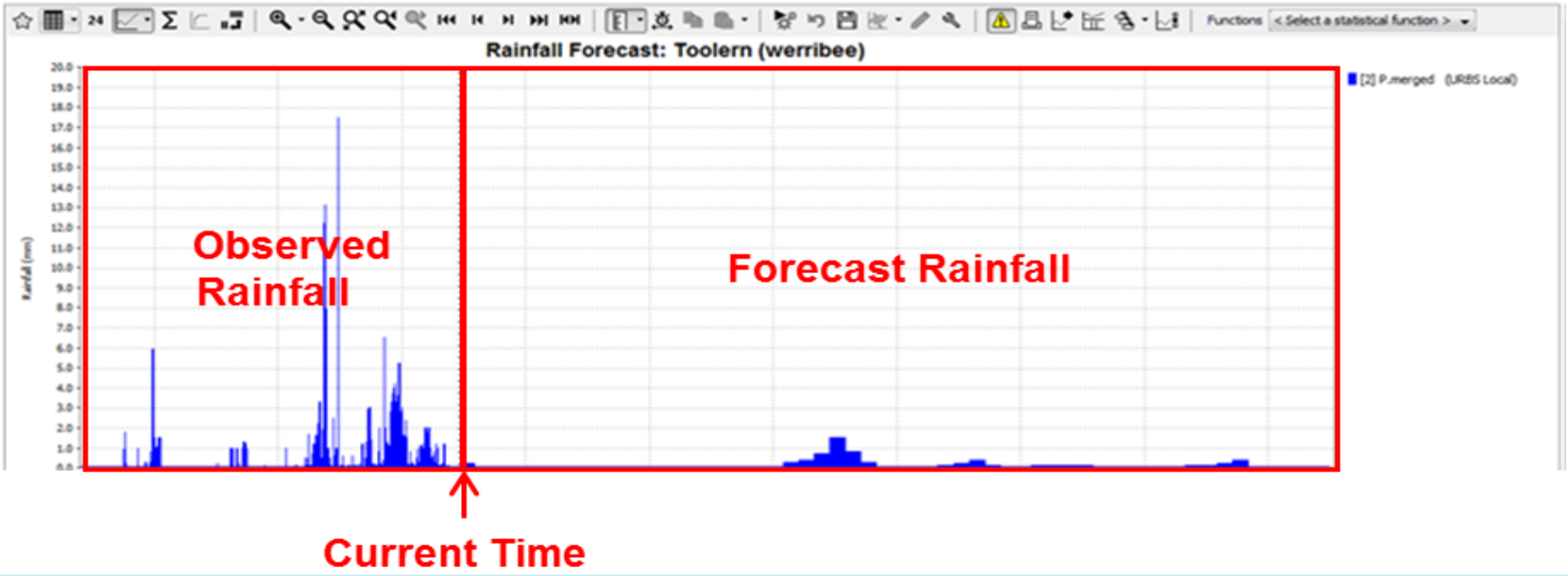
Key operations: future situation

What are river levels likely to be in the next few days?

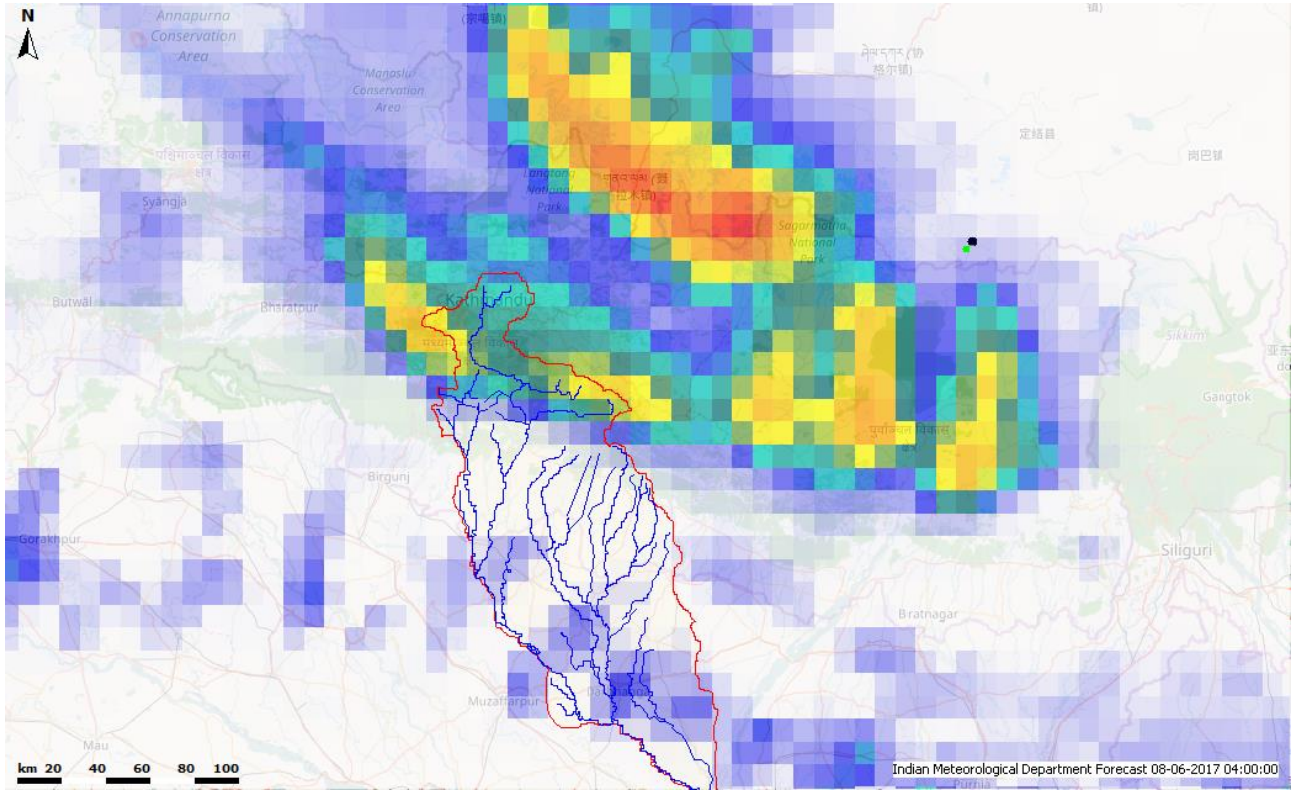
→ **Main purpose of system**

Select ‘current situation’ event which best matches recorded

Simulate in fast hydraulic model using observed + forecast



Key operations: future situation



Gridded rainfall forecast from IMD: daily forecasts, 6 hour steps for 3 days

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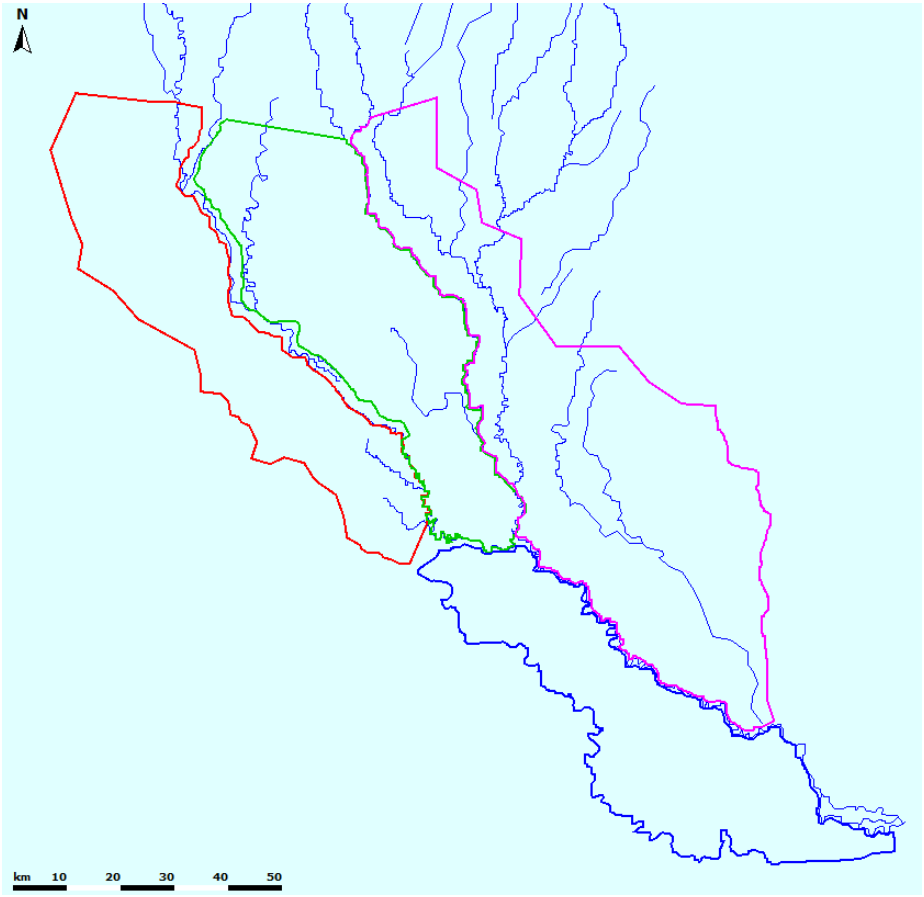
Key operations: embankment breach

- **Boundary conditions from:**
  - Forecast model results
  - Interpolated between obs river gauges
- **Informed by on-ground obs**
- **Operator identifies:**
  - Location
  - Length
  - Start time
  - Duration of failure
- **Breach simulated in 2D model**
- **Dynamic flood mapping produced**



4 separate 2D models

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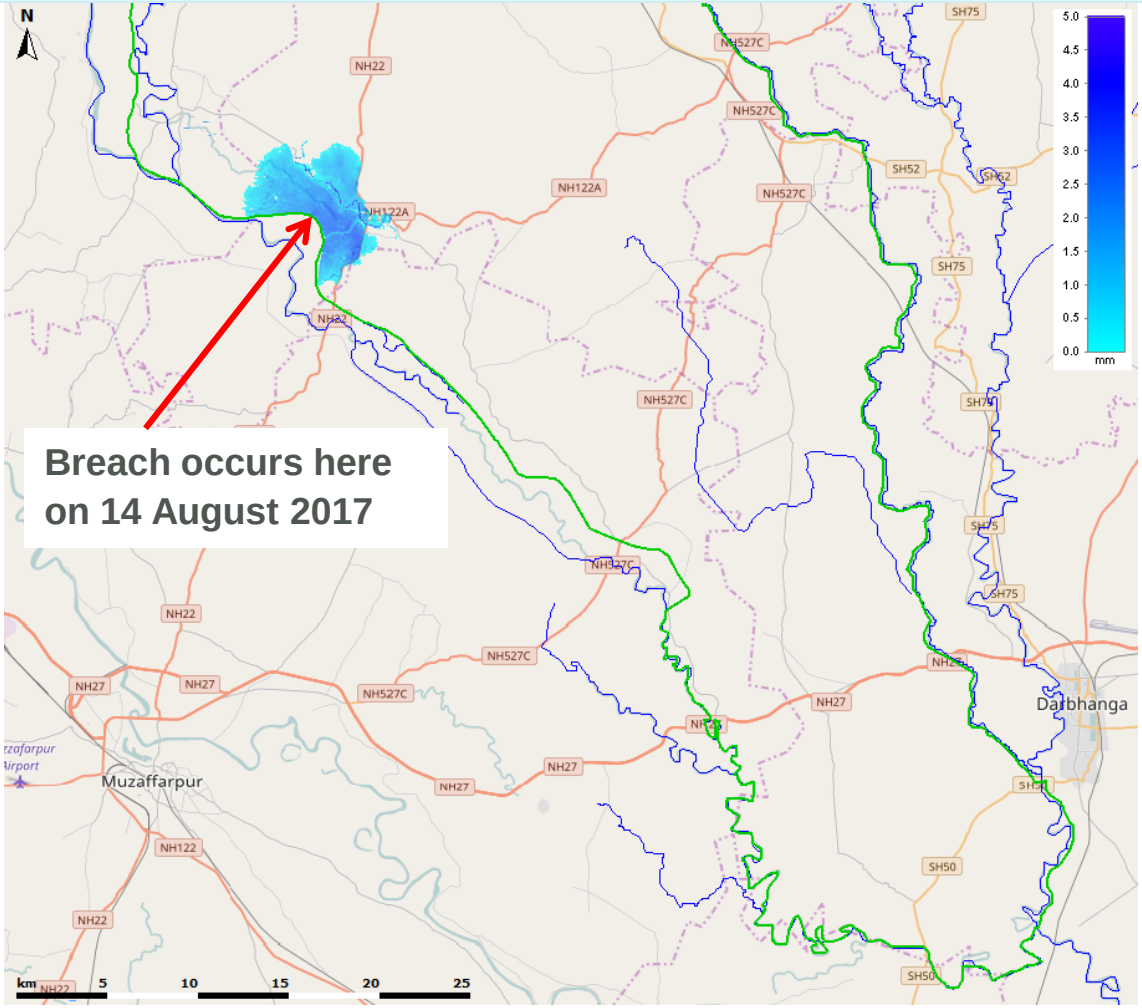
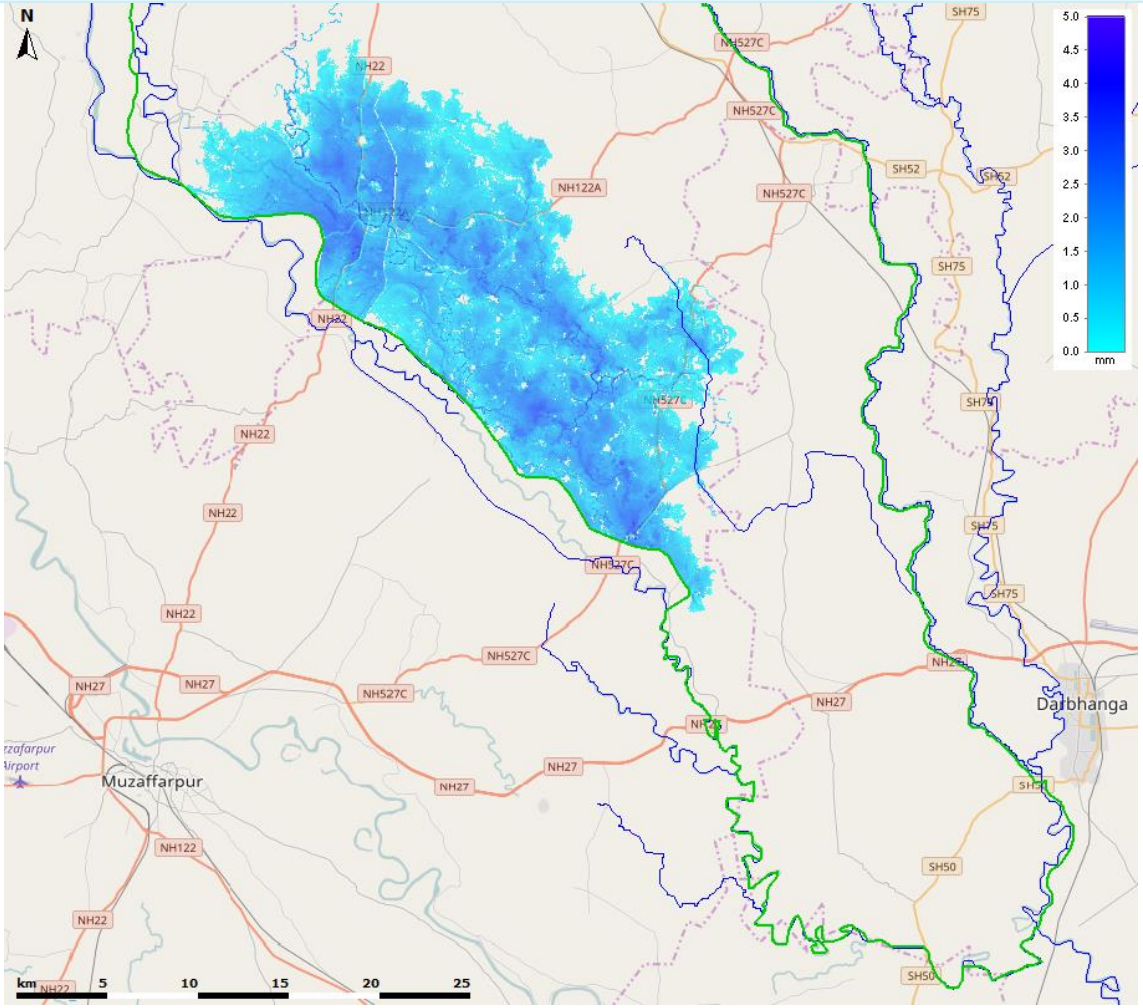
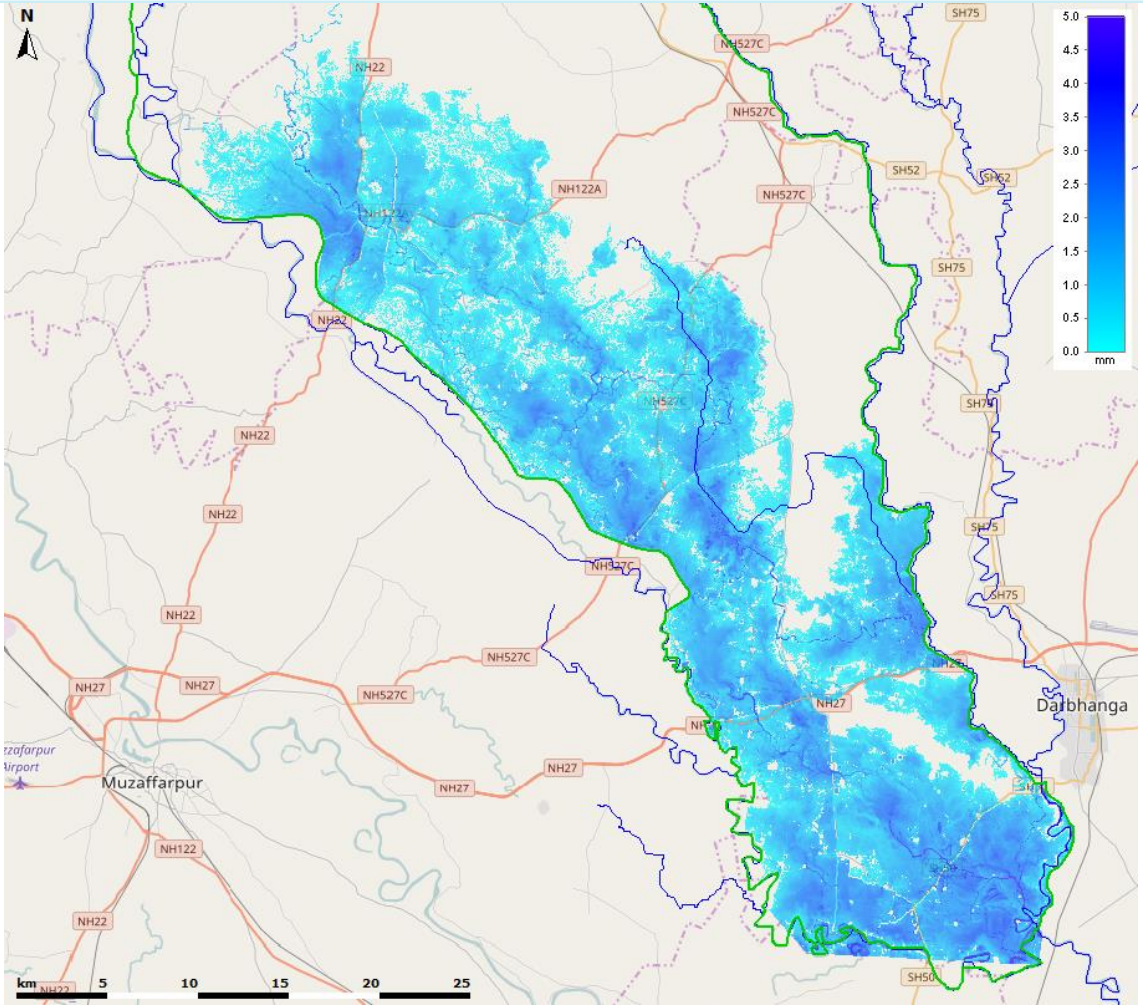
Key operations: embankment breach



Key operations: embankment breach



Key operations: embankment breach



Next steps + Summary

Next steps

- Testing during 2018 monsoon
- Ongoing training and modifications
- New observed and forecast data feeds
- Capture and inclusion of bathymetric data
- Extension to other river systems in Bihar
- Public-facing interface

Summary

- **Flood forecasting framework is a step-change improvement for FMISC and outcomes for locals**

- **Data limitations have been a big challenge**
  - Technical solutions, e.g. data filling and interpolation
  - Procedural solutions, e.g. ensembles and daily performance testing

- **Balance automation and human intervention**
  - Fully automated possible, but not desirable
  - Want to lock down some parameters or limit range

- **Technically, very exciting**
  - Multiple, advanced and industry best tools
  - Combined in new ways
  - New scripts to extend functionality (esp embankment breaching)

Want to know more?

Catch me after the presentation

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