AUGUST 2024 FLOODING IN NORTHEASTERN INDIA & BANGLADESH: AN OBSERVATIONAL ANALYSIS AND TOOL

Faisal Hossain, Pritam Das and Sanchit Minocha
Department of Civil and Environmental Engineering
**UNIVERSITY OF WASHINGTON (Seattle)**
USA
Email: fhossain@uw.edu; www.saswe.net

AUGUST 2024 FLOODING IN NORTHEASTERN INDIA & BANGLADESH

- August 20-21, 2024: Northeastern & mountainous Indian state of Tripura received heavy rainfall
- Destructive flooding and loss of life
- Lack of preparation impacted a million people
- 80,000 individuals into 557 makeshift relief camps

Agartala, Tripura, August 21, 2024 (from UW student Pritam Das, native of Tripura, India)
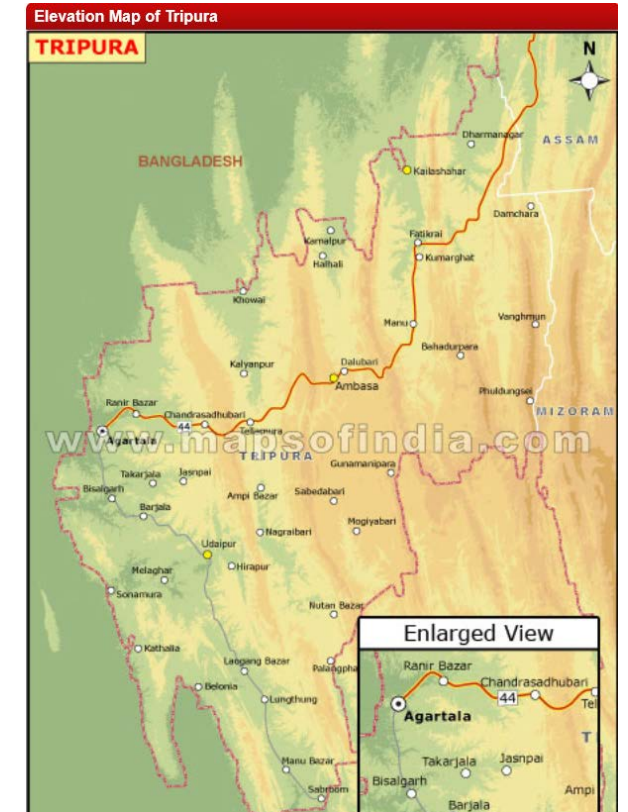
Elevation map of Tripura and neighboring (lowland) Bangladesh

WHAT MAKES THIS FLOODING INTERESTING?

- A hydro-electric dam (Dumboor) in upstream India apparently opened its gate (first in 31 years) on August 21, 2024

- **Controversy ensued** in Bangladesh media circles that India did this on purpose to flood downstream Bangladesh (due to recent political situation/change in government)

- **Indian Ministry of External Affairs** issued statement confirming nothing was deliberate (gates opened automatically) and that rainfall was intense and widespread

- **Massive and widespread inundation on both sides of the border**

- **SWOT Satellite!** (for Dumboor reservoir and inundation mapping)

A 48 HOUR COMMANDO MISSION (Aug 23-24)

THE MISSION?
- Rapidly prototype a Satellite data/model based system that tracks and forecasts reservoir state along with inundation state using SWOT and other satellites/ models.
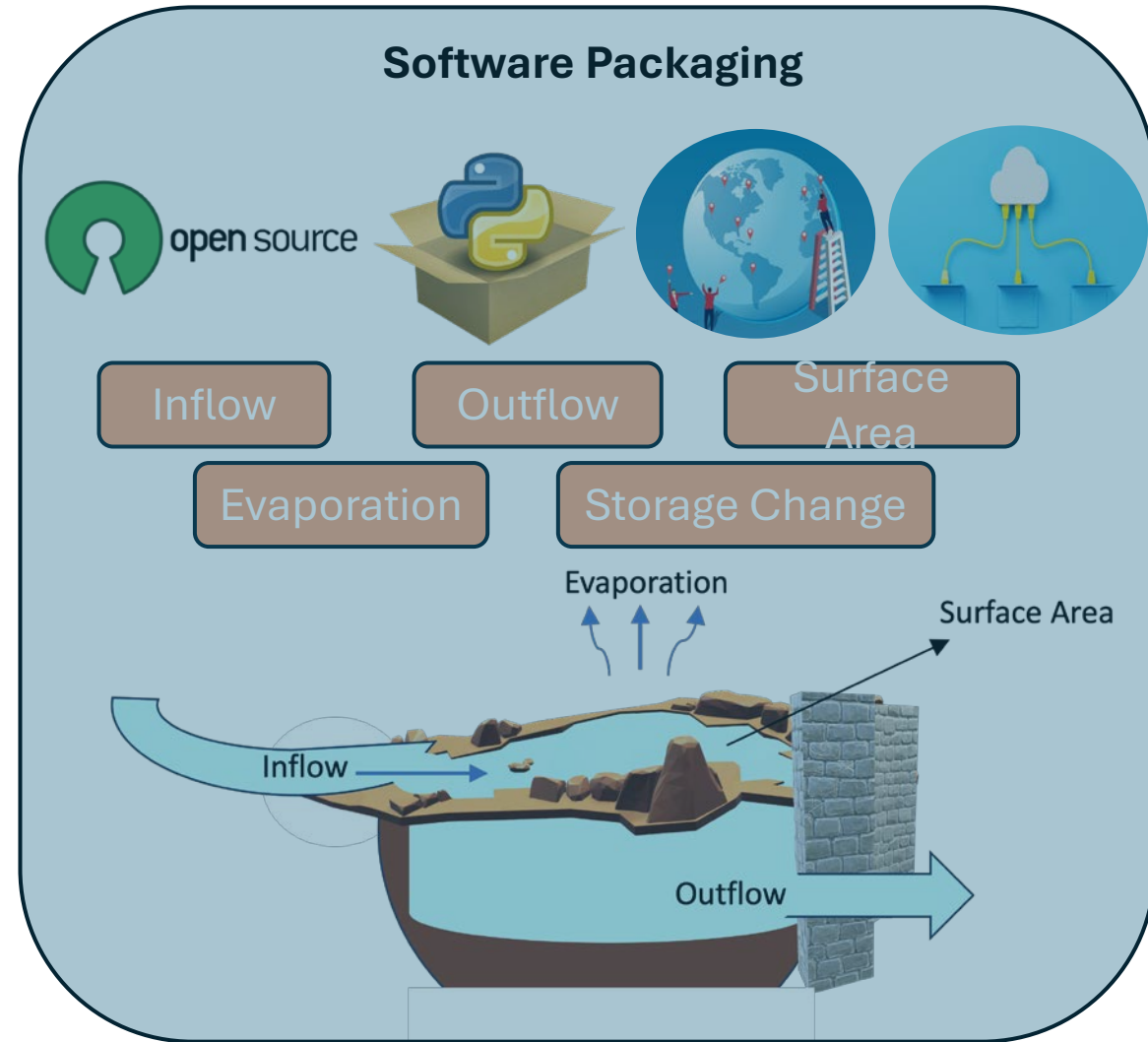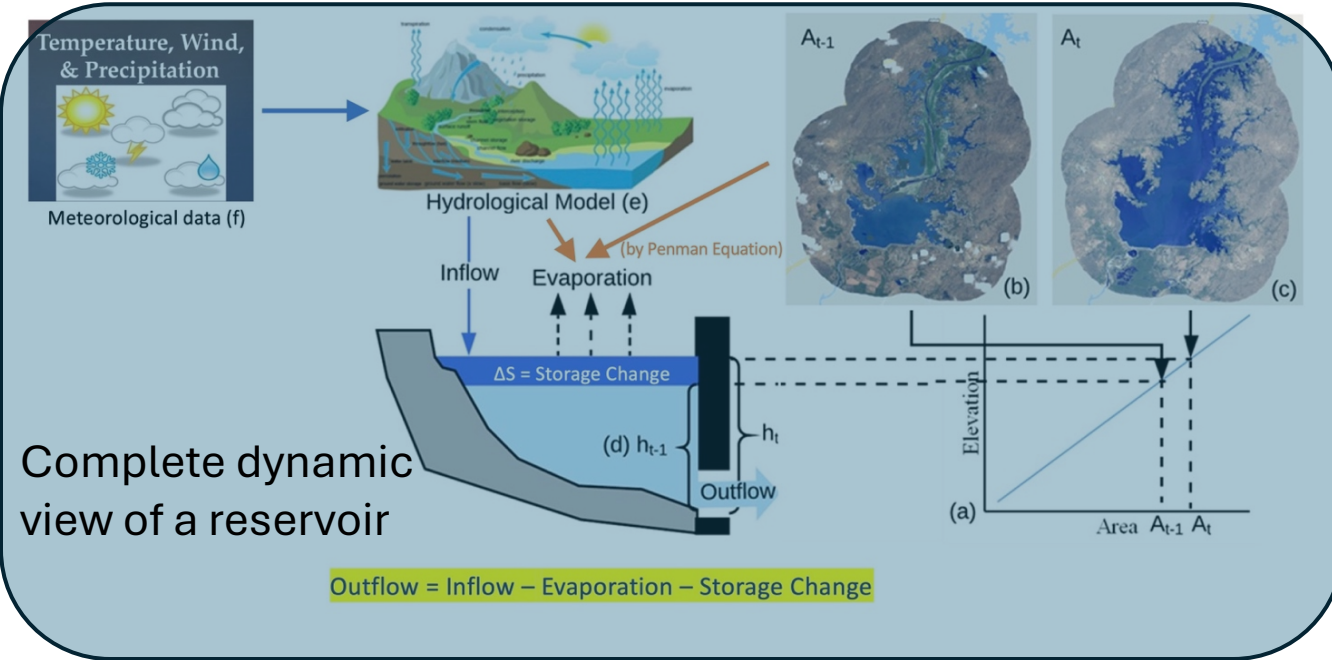**RESERVOIR ASSESSMENT TOOL (RAT)-TRIPURA**

- **RAT-TRIPURA** should run in near real-time using lowest latency data and produce routine updates of the flooding and reservoir situation (inflow and outflow)

- **RAT-TRIPURA** should be publicly accessible to empower water management agencies and improve lives/livelihoods on both sides of the India-Bangladesh border

- **RAT-TRIPURA** should show the value of SWOT (from Earth Science to Action)

- 48 hours to do the above and officially hand over to Bangladesh Water Development Board (BWDB)!!
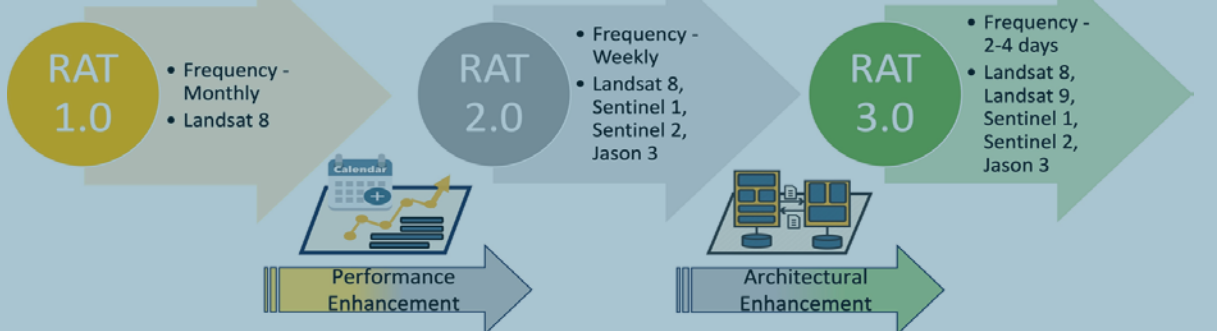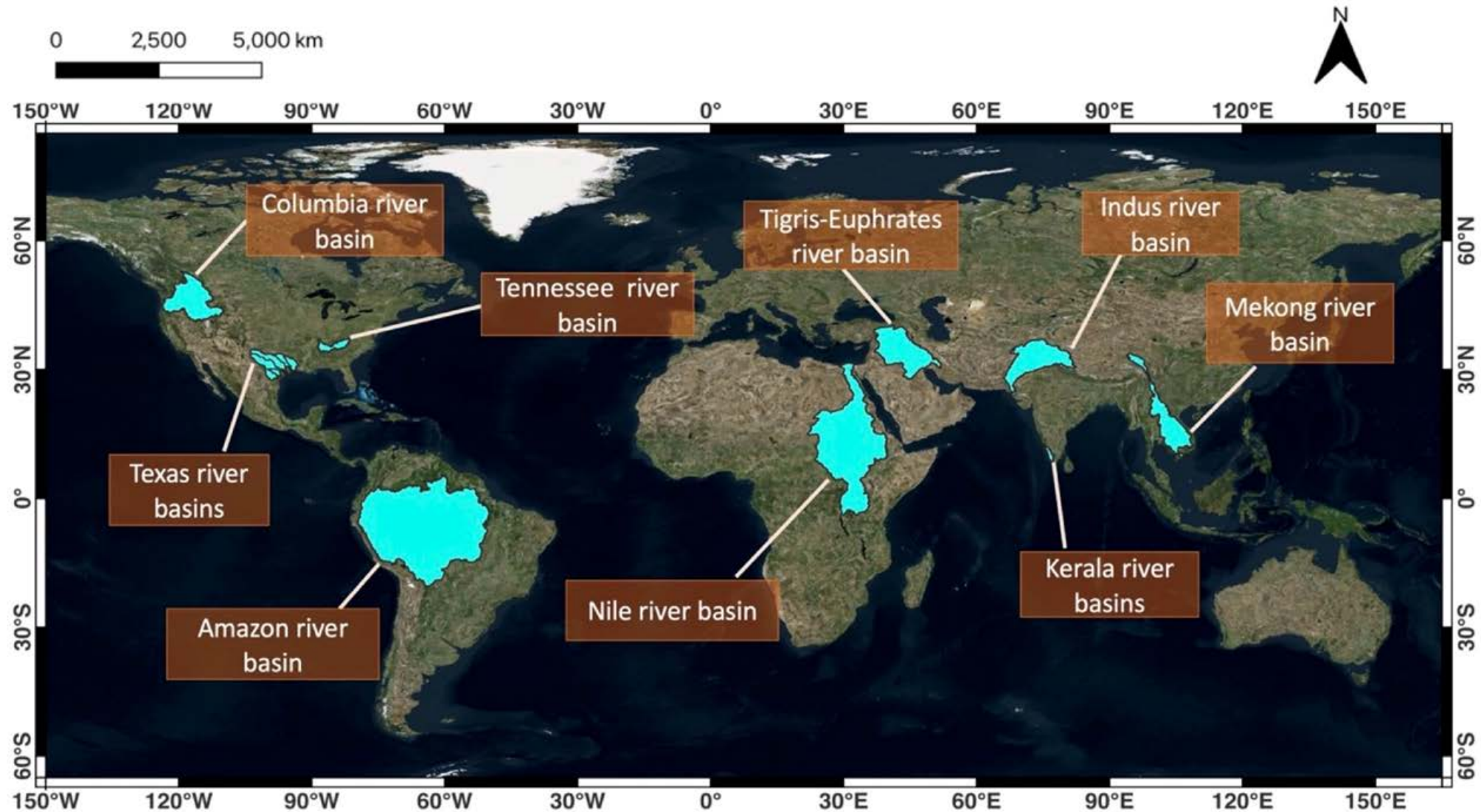
WHAT IS RESERVOIR ASSESSMENT TOOL (RAT)?

Physical processes modeled by RAT

Temperature, Wind, & Precipitation

Meteorological data (f)

Hydrological Model (e)

A_{t-1}

A_t

(by Penman Equation)

Inflow

Evaporation

ΔS = Storage Change

(d) h_{t-1}

h_t

Outflow

Elevation

(b)

(c)

(a)

Area A_{t-1} A_t

Complete dynamic view of a reservoir

Outflow = Inflow – Evaporation – Storage Change

Software Evolution to open-science, open-source, low barrier to entry

RAT 1.0
• Frequency - Monthly
• Landsat 8

RAT 2.0
• Frequency - Weekly
• Landsat 8, Sentinel 1, Sentinel 2, Jason 3

RAT 3.0
• Frequency - 2-4 days
• Landsat 8, Landsat 9, Sentinel 1, Sentinel 2, Jason 3

Performance Enhancement

Architectural Enhancement

Software Packaging

open source

Inflow

Outflow

Surface Area

Evaporation

Storage Change

Evaporation

Surface Area

Inflow

Outflow

RAT USERS AROUND THE WORLD

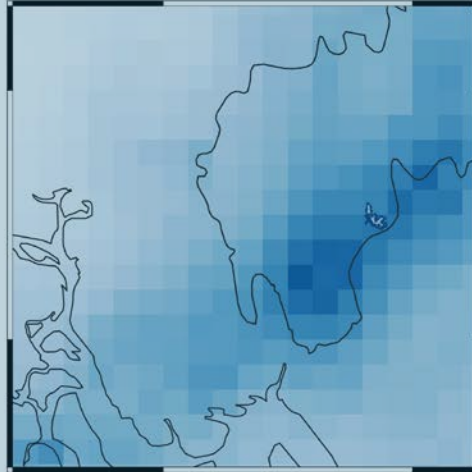# FIRST LET'S LOOK AT THE PRECIPITATION EVENT OF AUG 21, 2024

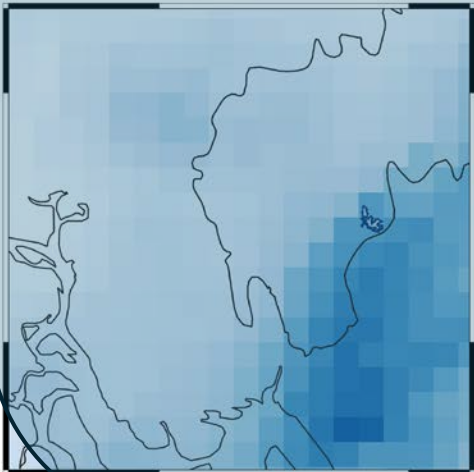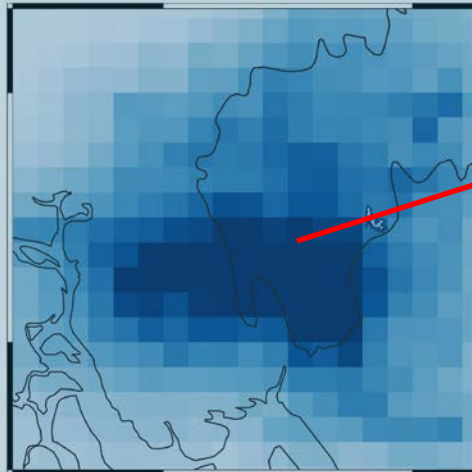**Satellite-based Nowcast (IMERG) – available within 12 hours)**

August 18, 2024 | August 19, 2024
August 20, 2024 | August 21, 2024

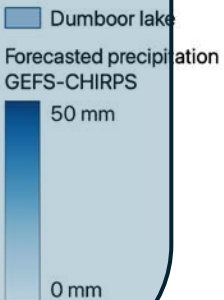Dumboor Lake
Daily precipitation
250 mm
0 mm

Forecast Precipitation (GEFS-CHRPS) made on Aug 18, 2024

Precipitation forecast generated on August 18, 2024

August 20, 2024 | August 21, 2024

Dumboor lake
Forecasted precipitation GEFS-CHIRPS
50 mm
0 mm

- Most of the precipitation and runoff occurred downstream and outside of Dumboor dam catchment
- Forecast is underestimated (needs dynamic downscaling)
- Poor spatial precision of heavy events
- For disaster preparation, focus could be on trends
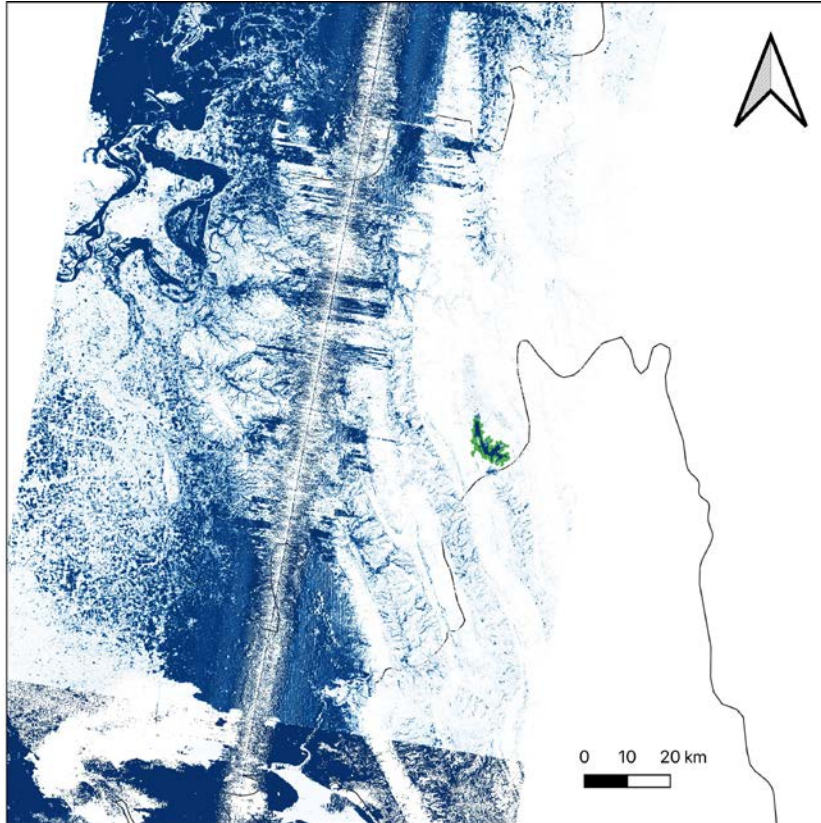- Need use WRF-based downscaled forecast for extreme weather from Hi-WAT (NASA SERVIR HQ)

WHAT ABOUT SWOT SATELLITE?
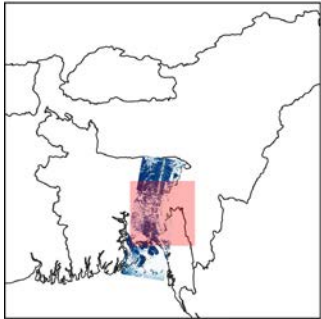
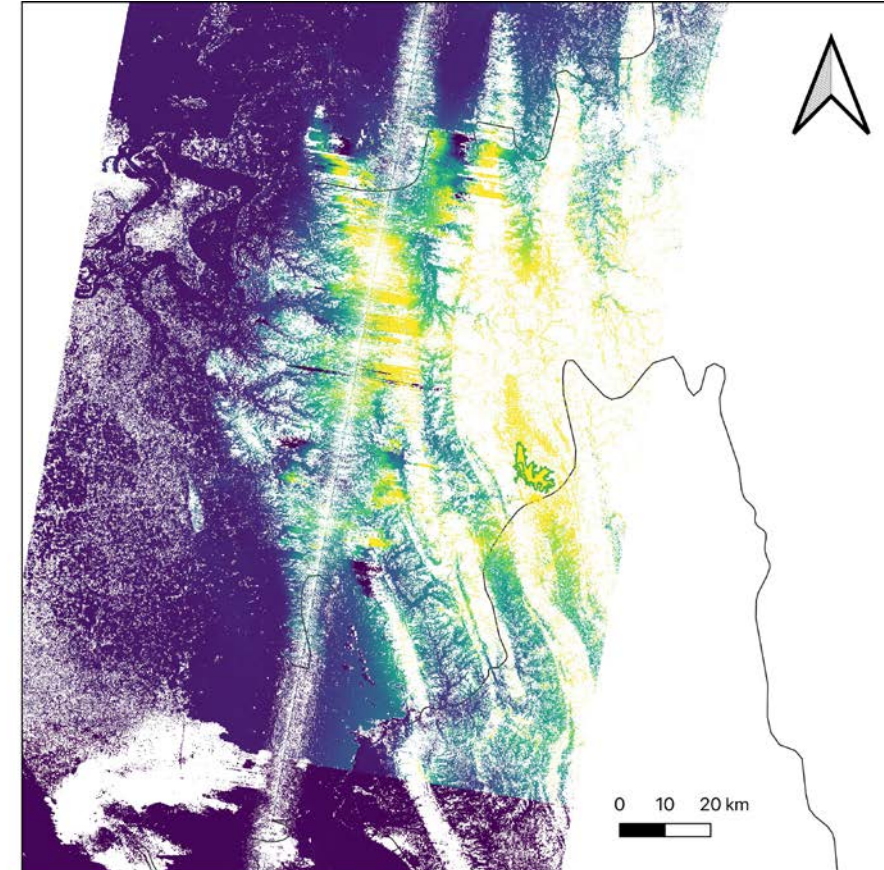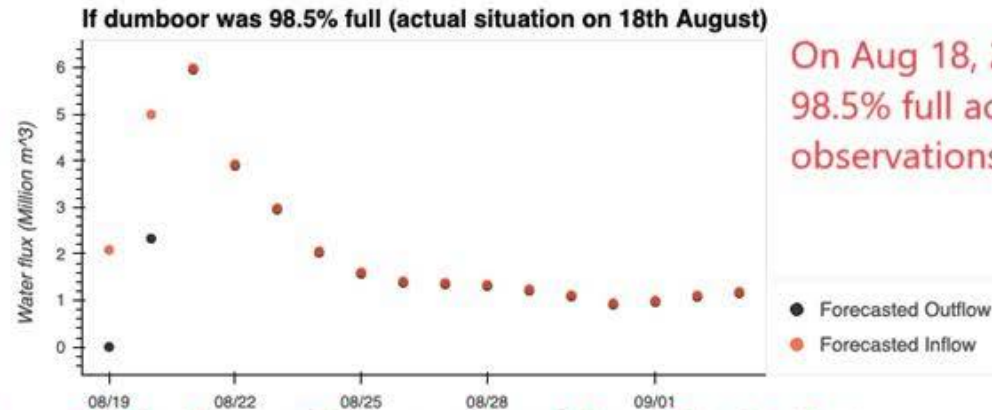As of August 24, SWOT's latest overpass was on August 16, 2024
Pre-flood conditions indicate border regions of Feni having higher water elevation

INITIAL RESERVOIR ANALYSIS (WITHOUT SWOT)

HOW COULD DUMBOOR DAM HAVE MITIGATED THE FLOOD IF IT HAD USED FORECASTED INFLOW ON AUGUST 18, 2024 THAT WAS PREDICTED TO PEAK ON AUG 21 2024 ?

If dumboor was 90% full

Downstream flood is mitigated almost 100%

If dumboor was 95% full

Downstream flood is mitigated 50%

If dumboor was 98.5% full (actual situation on 18th August)
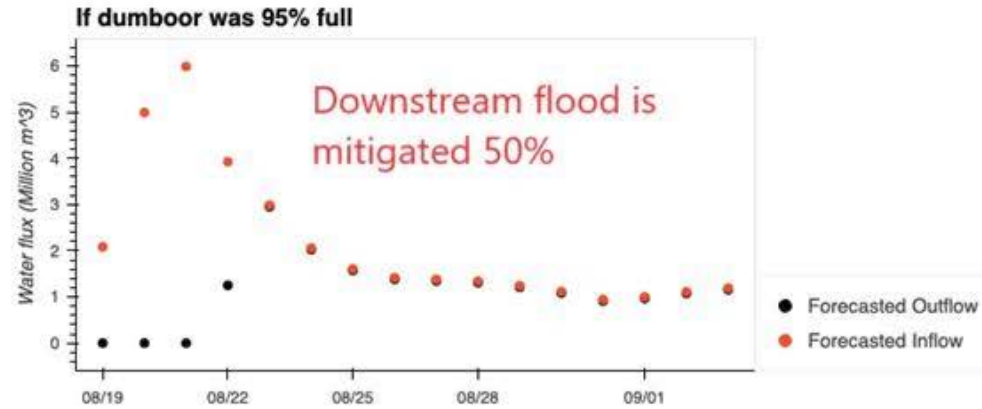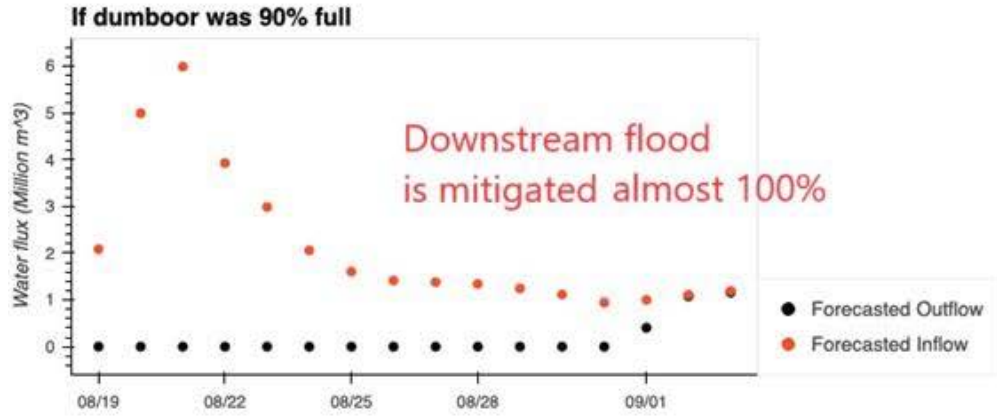
From Aug 18 (or even a few days earlier), Dumboor lost all its flood moderation capability

On Aug 18, 2024, Dumboor was already 98.5% full according to satellite observations

Dumboor is a relatively small reservoir with < 1 km3 of storage capacity and the river carries flow that is a small fraction of the total runoff due to heavy rainfall observed in the area

INITIAL ANALYSIS (WITHOUT SWOT)

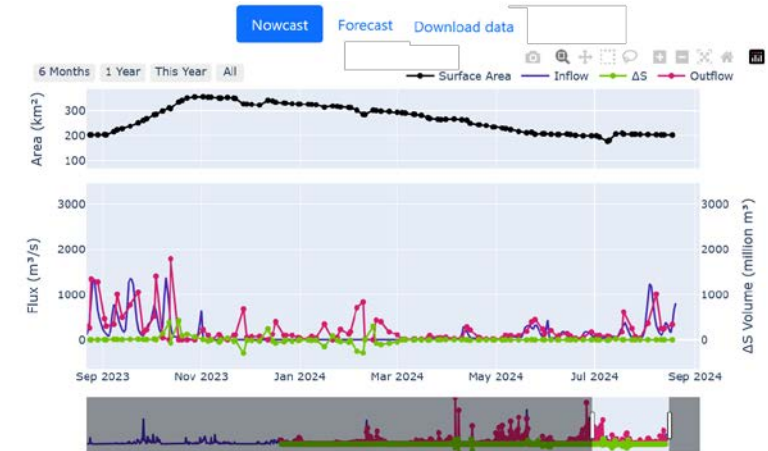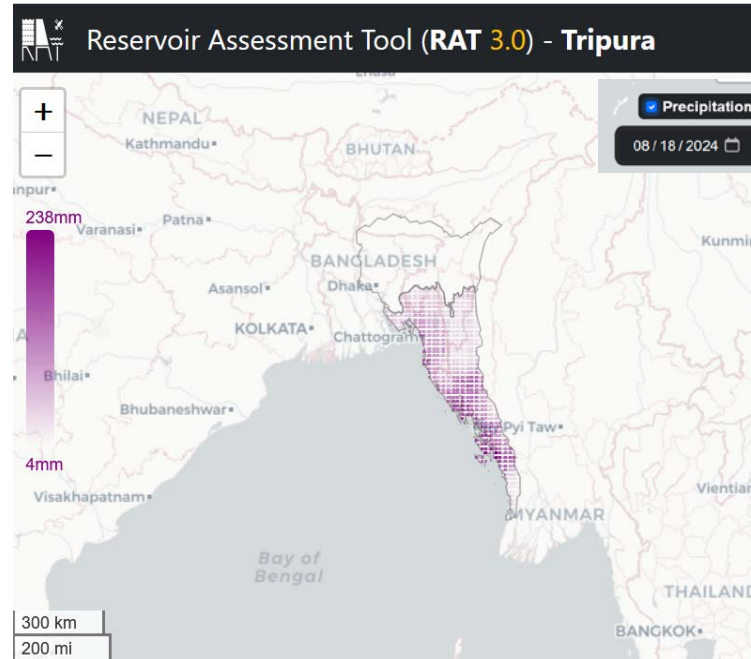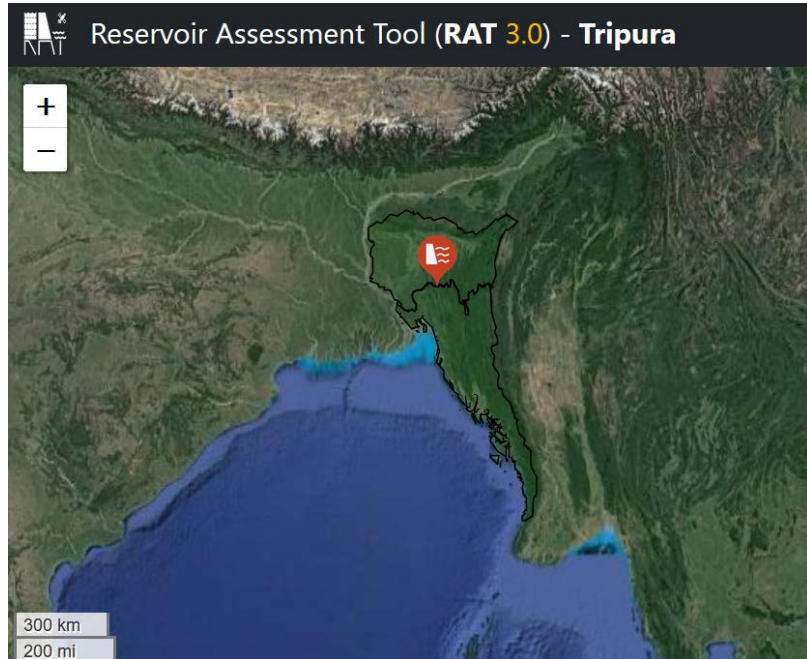Probability Density Function of Area based on last 5 years
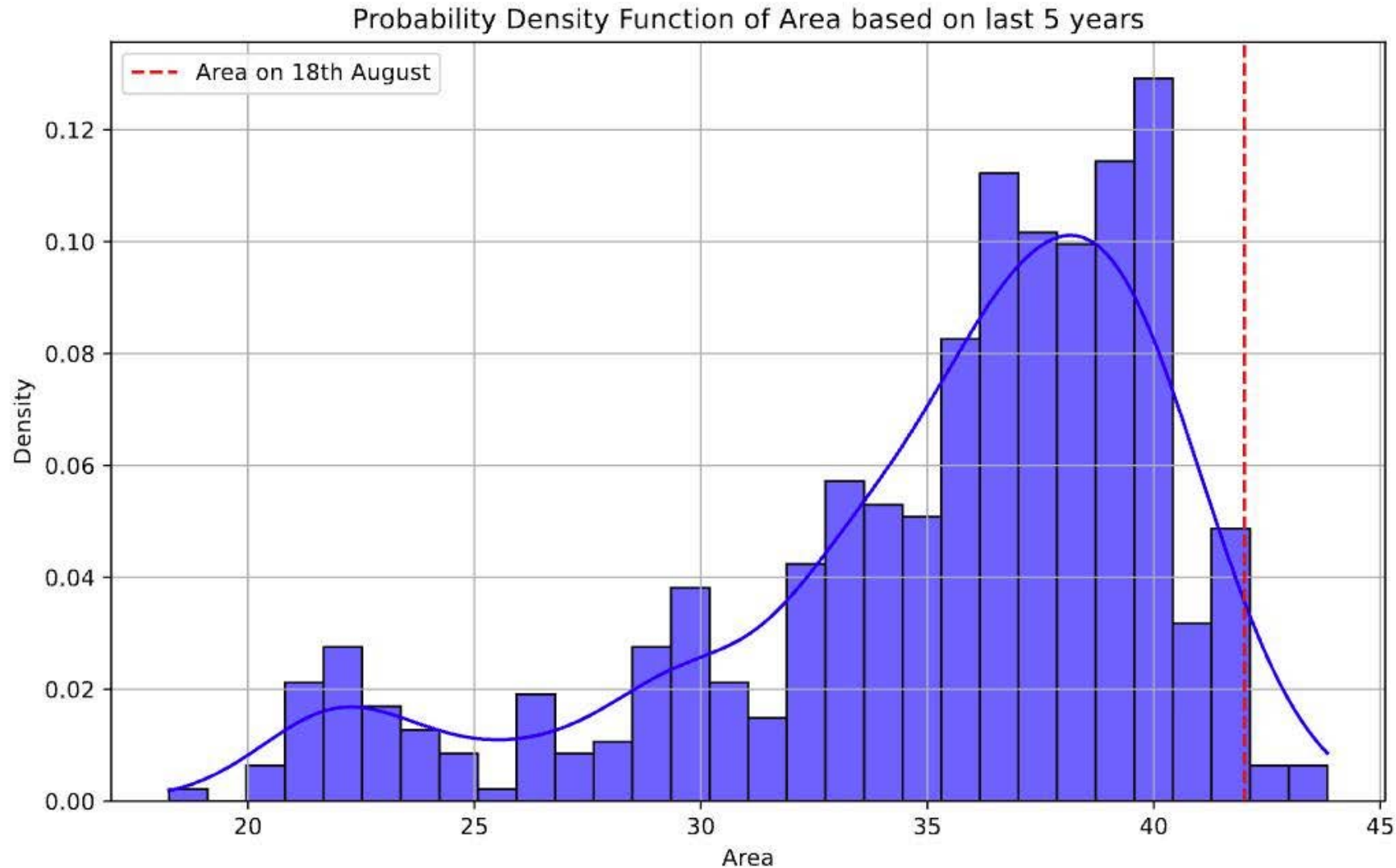
On Aug 18, Dumboor reservoir was already > 98% full with no flood moderation capacity

Using 5 years of Landsat and Sentinels (1 and 2) to create a PDF of surface area

SIGNED, SEALED, DELIVERED: RAT-TRIPURA (IN 48 HOURS!!!)

For Bangladesh Water Development Board and Tripura Water Department
https://tinyurl.com/IndoBDFloods

A gift from Pritam Das and Sanchit Minocha of University of Washington to the people of India and Bangladesh