Sentinel Asia, the 9th Joint Project Team Meeting
Training Workshop II: Demonstration of flood monitoring/forecasting systems

Flood monitoring and forecasting using GSMaP-IF

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JICA Expert (Advisor on Water Management Policy and Technology, Bangladesh)

6th November 2024, Manila, Philippine

- What is GSMaP-IF?
- Example of utilize GSMaP-IF in Bangladesh.
- Example of flood monitoring using with GSMaP data.

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What is the GSMaP ?

- GSMaP stands for Global Satellite Mapping of Precipitation.
- GSMaP is a product of the Global Precipitation Measurement (GPM) mission, which provides global precipitation observations at three-hour intervals.
- Provides a global hourly rain rate with a 0.1 x 0.1degree resolution.
- Values are estimated using multi-band passive microwave and infrared radiometers from the GPM Core Observatory satellite and with the assistance of a constellation of other satellites.

What is the GSMaP-IF ?

- Satellite Rainfall Correction Tool.

- To correct GSMaP original data by calibrating them with available observed ground-based rainfall data.

- GSMaP-IF was developed by UNESCO Pakistan project funded by JICA's ODA. Copyright of the GSMaP-IF model program is jointly owned by the UNESCO (United Nations Educational, Scientific and Cultural Organization) and JAXA (the Japan Aerospace Exploration Agency)

- Provides several correction methods. Users need to consider which method is suitable for their target basin.

GSMaP-IF version history

Version	Date	Comment	Author(s)
1.0	2012/05/29	First version	JAXA
1.1	2012/07/26	[Updated] -Linear correction method -New correction method (Corparam) -Output JPEG image files	JAXA
2.0	2014/6/30	[Added] -Real-time correction function	JAXA
3.0	2016/12/28	[Updated] -Improved real time correction method -Support of IFAS format (ground rainfall data)	JAXA
3.1	2017/3/31	[Updated] -Improved rainfall correction accuracy by a method of rainfall correction based on rain-cloud object based algorithm	JAXA
3.2	2018/1/31	[Updated] -Improved Weight calculation method -Output ASCII files -Expanded calibration area limit	JAXA
4.0	2018/8/24	[Final vesion] -Improved rainfall correction accuracy by a method of rainfall correction based on triangulation based algorithm	JAXA

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The table is from the GSMaP Customization IF Real-time correction function User's Guide

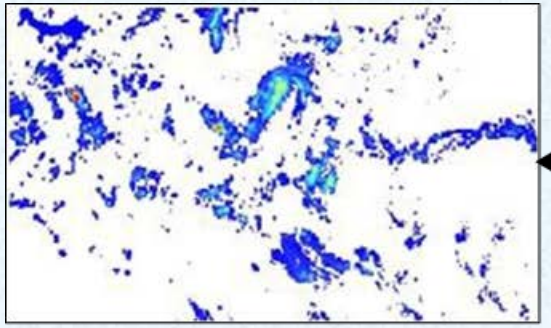
What is “GSMaP-IF version 4.0”?

After GSMaP-IF version 2 focuses on the correction of short term (hourly/daily) rainfall. GSMaP-IF corrects GSMaP by using ground observatory rainfall data taken in synchronization with GSMaP. In Version 4.0, the corrections accuracy have been improved by using a TIN based algorithm.

Input ground observatory data

start time	term	000001	000002	000003
2010/6/17 0:00	24	0	8	5.2
2010/6/18 0:00	24	100	25	58
2010/6/19 0:00	3	0	0	0
…	…	…	…	…

GSMaP Rainfall Data (Original)



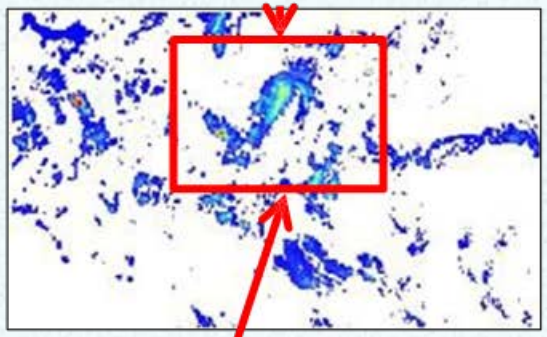
Download

GSMaP-IF

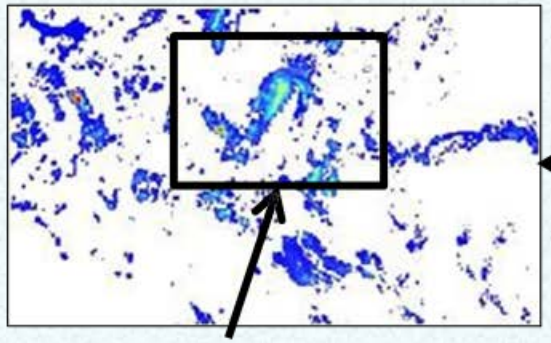
Extracting Subset Area

Correction

Version 2/3 real-time Corrected Data



Version.1 Corrected Data



Correction Area

Correction Area

Subset Data

Lat	Lon	Rainfall
N31.75	E75.85	1.456448
N31.75	E75.95	1.362135
N31.75	E76.05	1.77756
N31.75	E76.15	0.274333
N31.75	E76.25	1.046201
N31.75	E76.35	0
N31.75	E76.45	0

Subset Area

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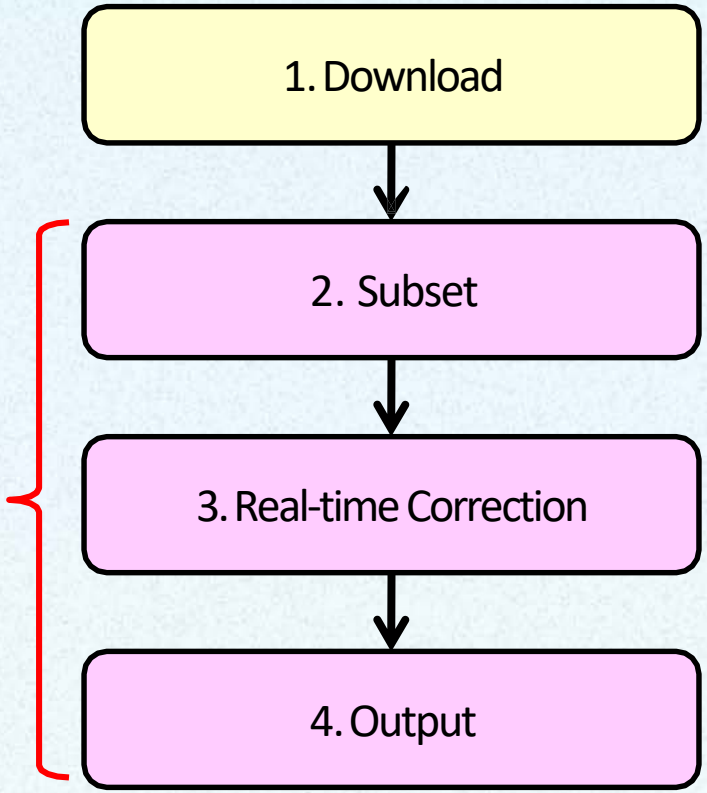
The figure is from the GSMaP Customization IF Real-time correction function User’s Guide

Process Flow of GSMaP real-time correction IF

Ver. 1 function

Ver. 2 function



1. Download hourly rainfall, satellite information and time information from GSMaP server.
2. Extract subset data in area of interest.
3. Correct hourly rainfall in area of interest.
4. Output corrected GSMaP data

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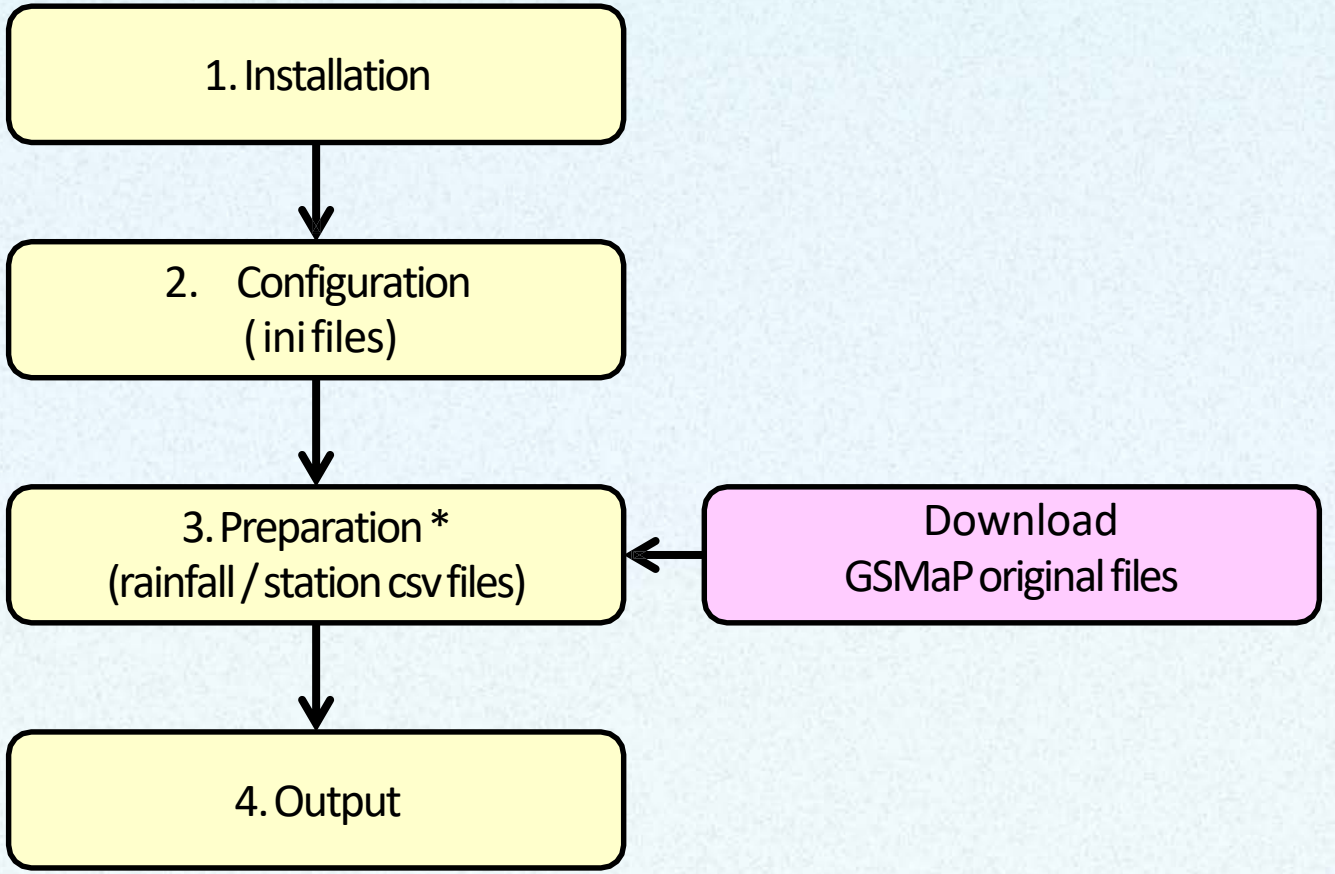
The figure is from the GSMaP Customization IF Real-time correction function User's Guide

User's Work Flow of GSMaP real time correction IF



* Preparation is necessary for each processing for different date or place.

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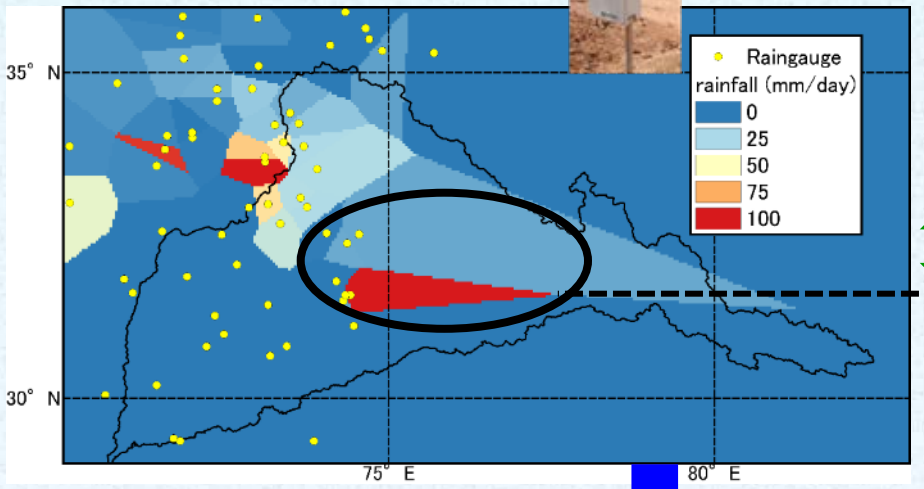
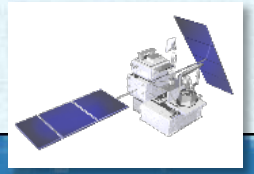
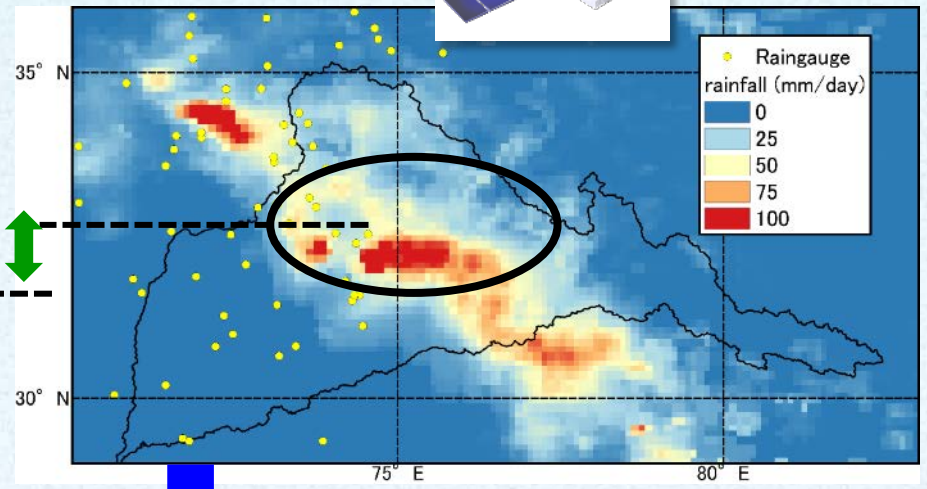
Example -- Bias correction of Satellite precipitation(GSMaP)

Ground



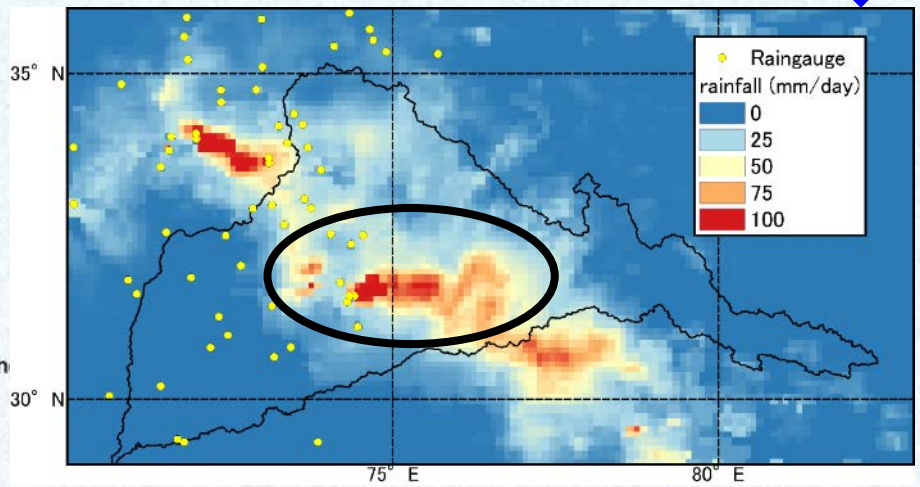
GSMaP_NRT



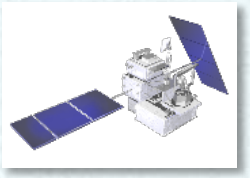


Bias correction (GSMaP-IF)

Corrected GSMaP (GSMaP-IF)



+



GSMaP: Global Satellite Mapping of Precipitation by JAXA

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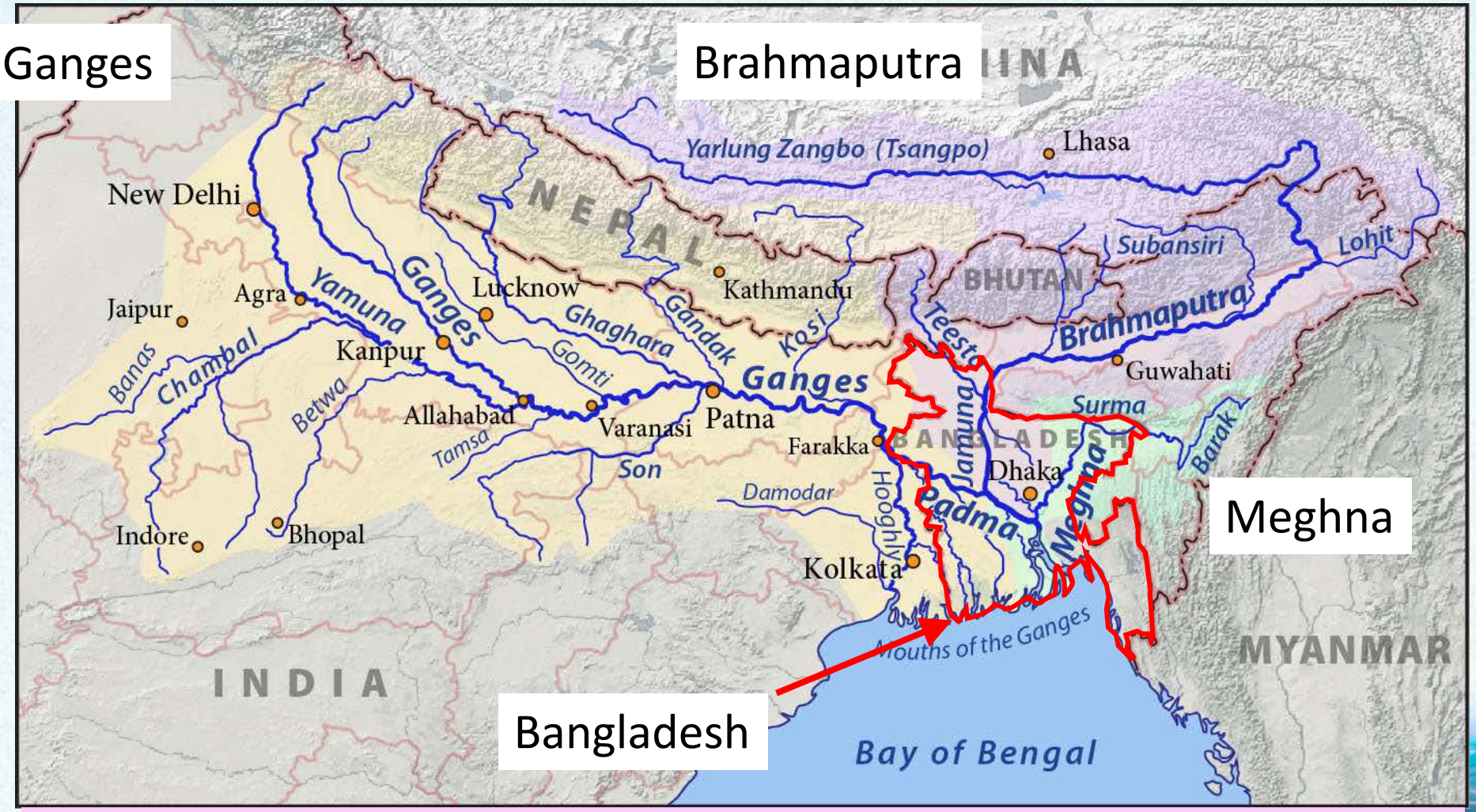
- What is GSMaP-IF?
- Example of utilize GSMaP-IF in Bangladesh.
- Example of flood monitoring using with GSMaP data.

[Case study 1] -- Ganges, Brahmaputra, Meghna river basins



Total catchment area of three basins : 1.72 million km2

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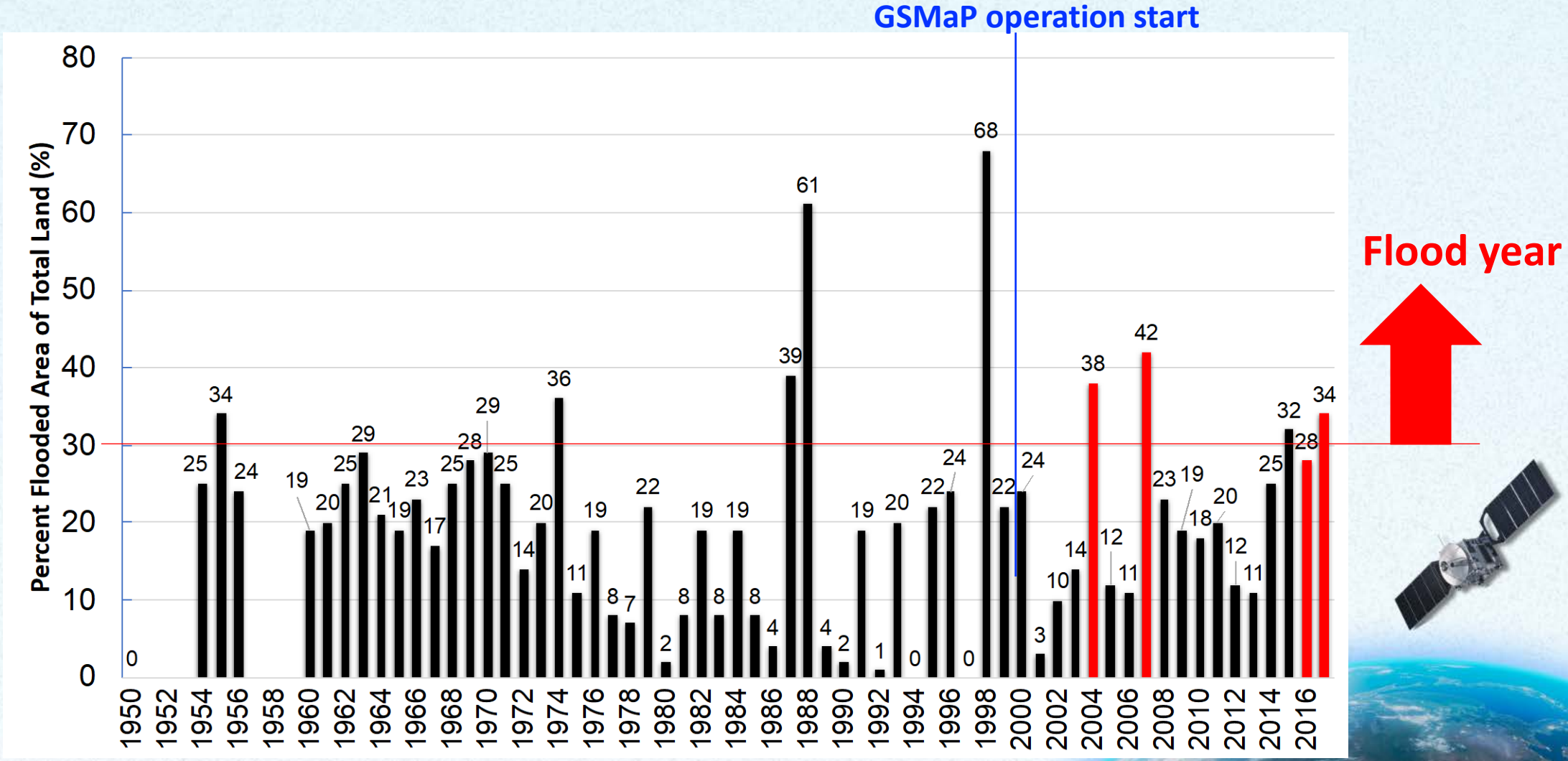
Flood in Bangladesh



Percent flooded area of total land（1950～2017）

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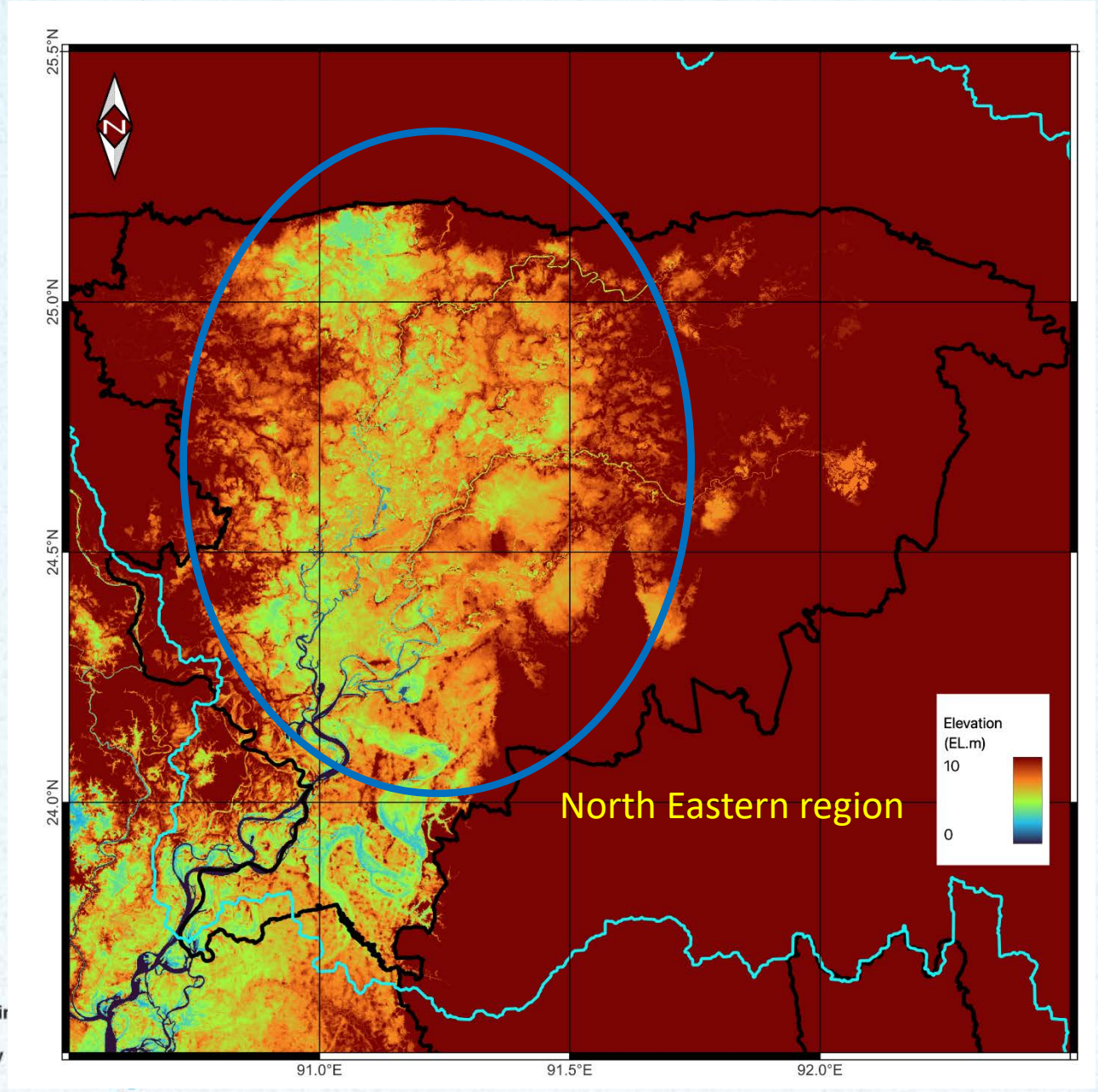
Haor region at North Eastern Bangladesh



Only 1-4m above the mean sea level

Wet Season

Dry Season

MERIT Hydro by Tokyo Univ.

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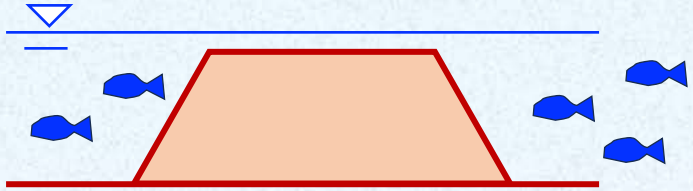
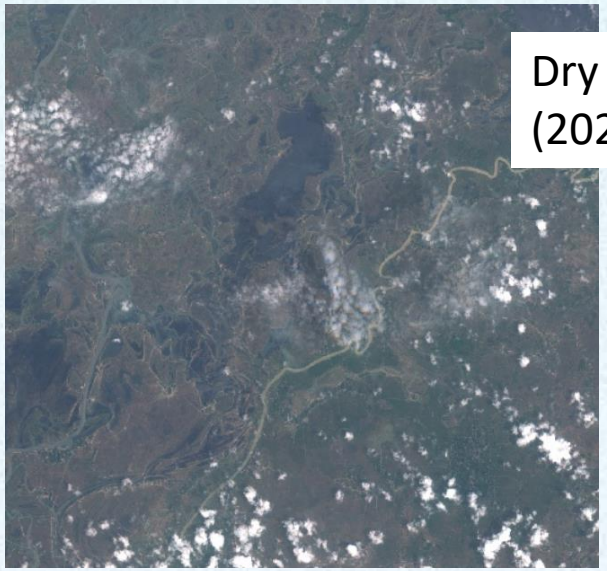
Flood control by submergible embankment

Before harvesting in May：Protection of cropland by embankment

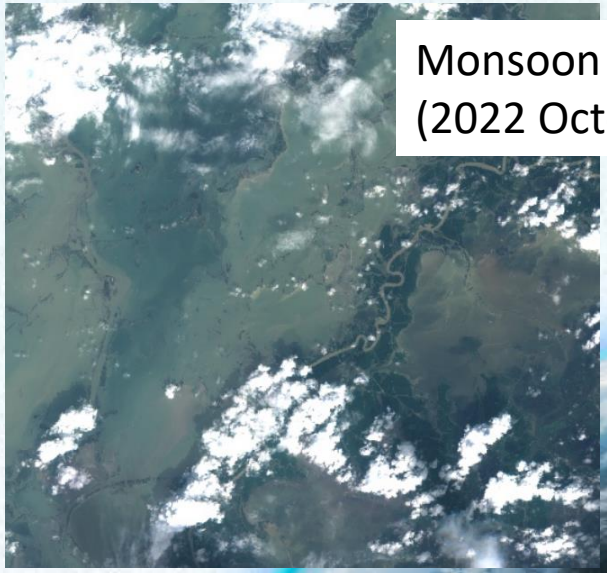


After May： Fishery work

Rui Beel Haor (2023 January)

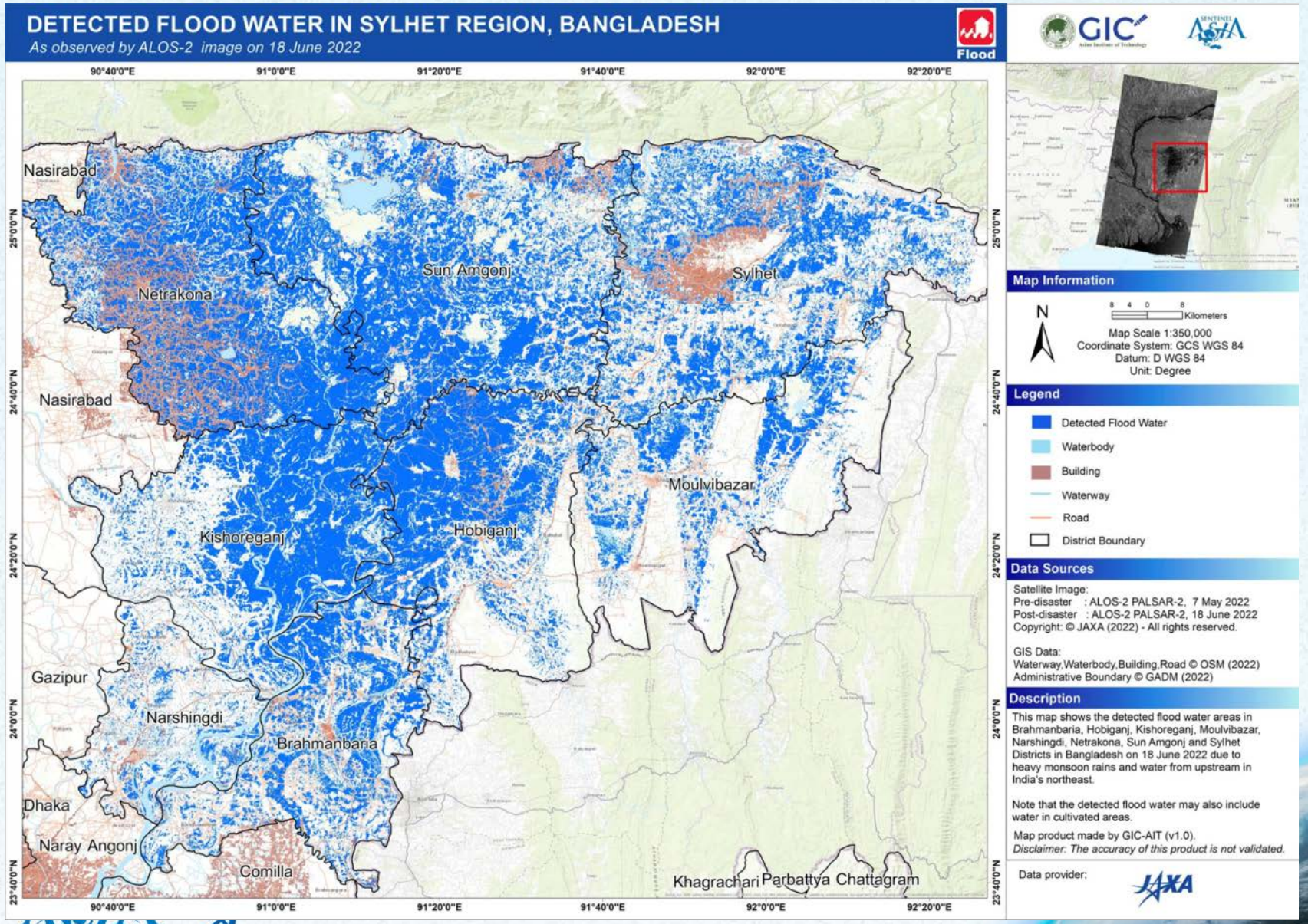


Dry season (2022 May)



Monsoon season (2022 October)

2022 Monsoon flood in Haor area



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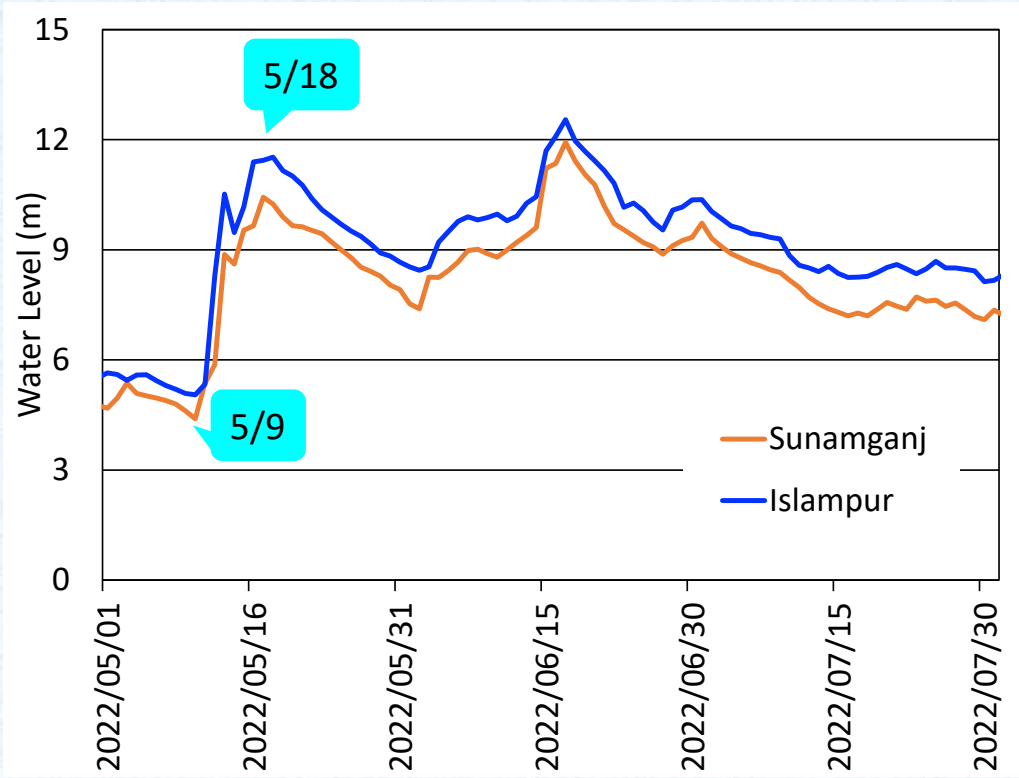
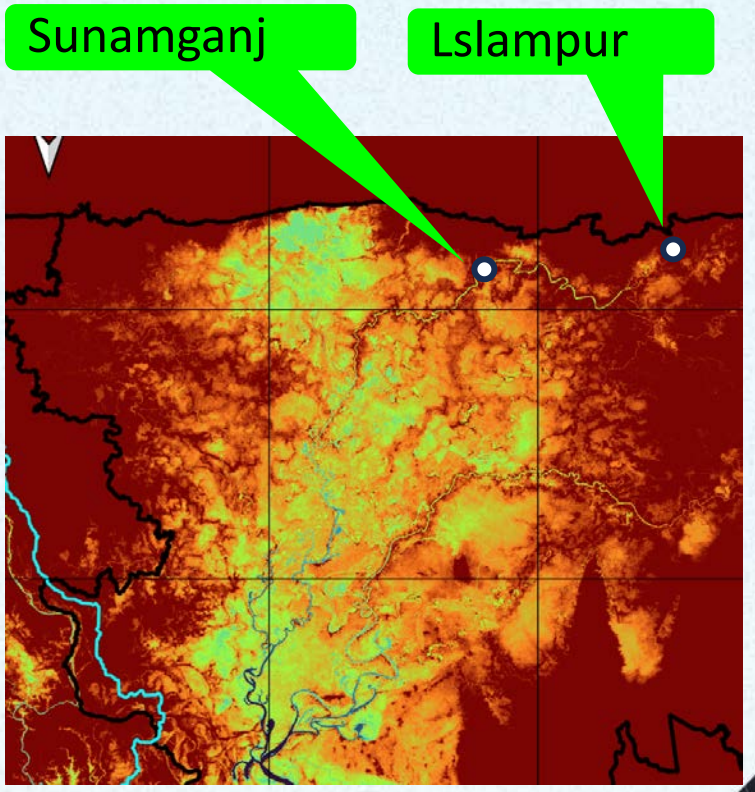
JAXA ALOS2 image

Water Level at upstream of Haor region





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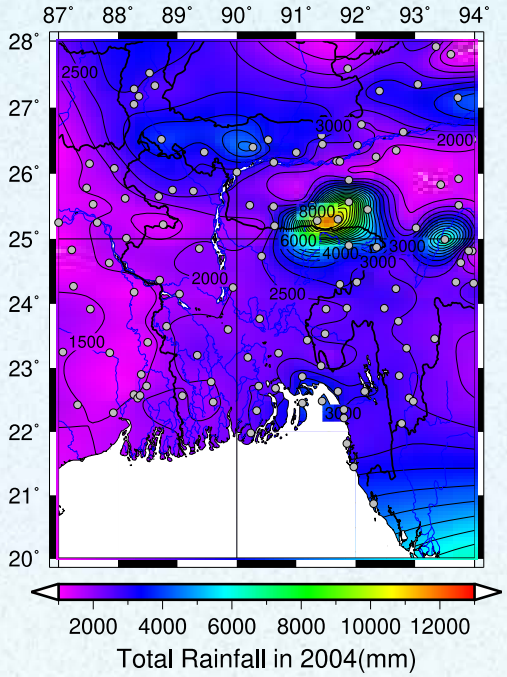
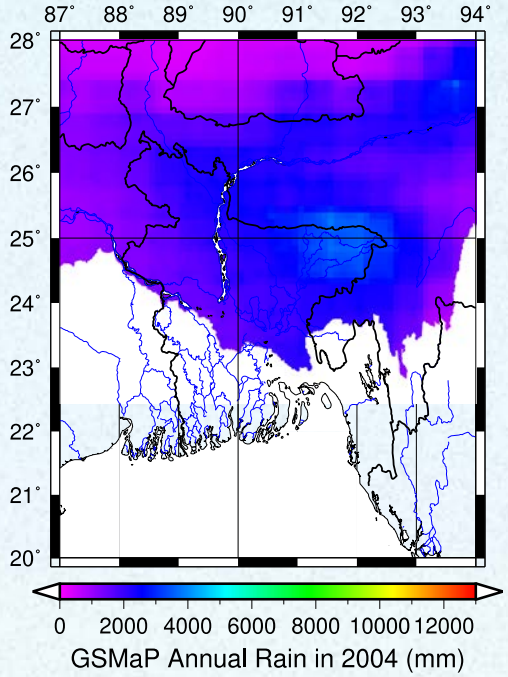
Comparison with ground rainfall data

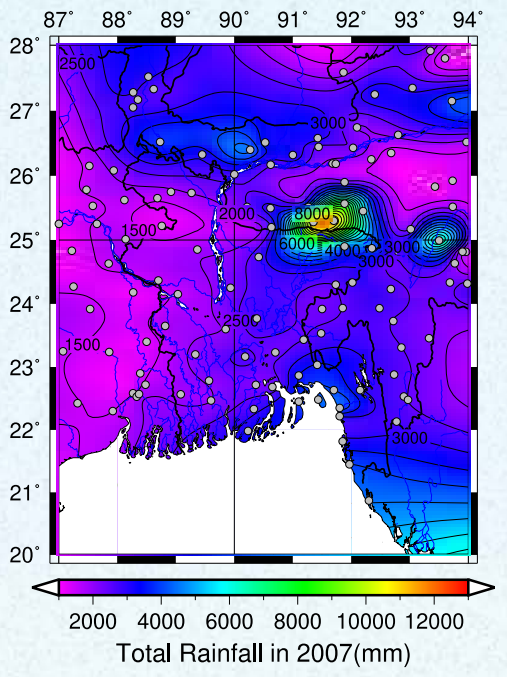


Annual Rainfall
(Grand rain gage)

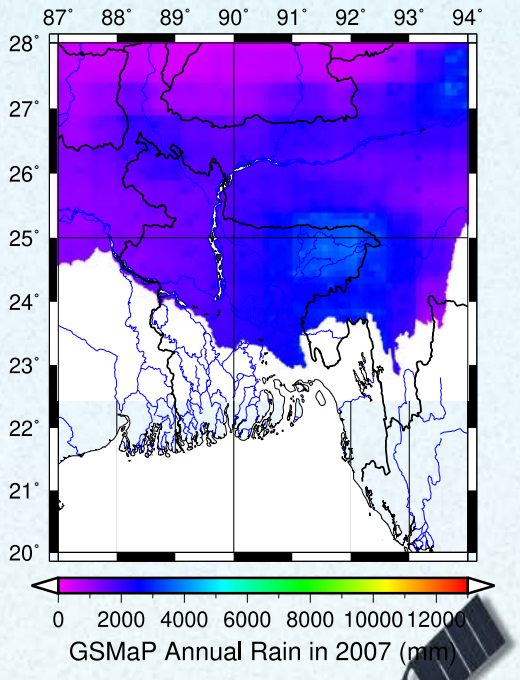


Annual Rainfall
(GSMaP)

2004



Annual Rainfall
(Grand rain gage)



Annual Rainfall
(GSMaP)

2007

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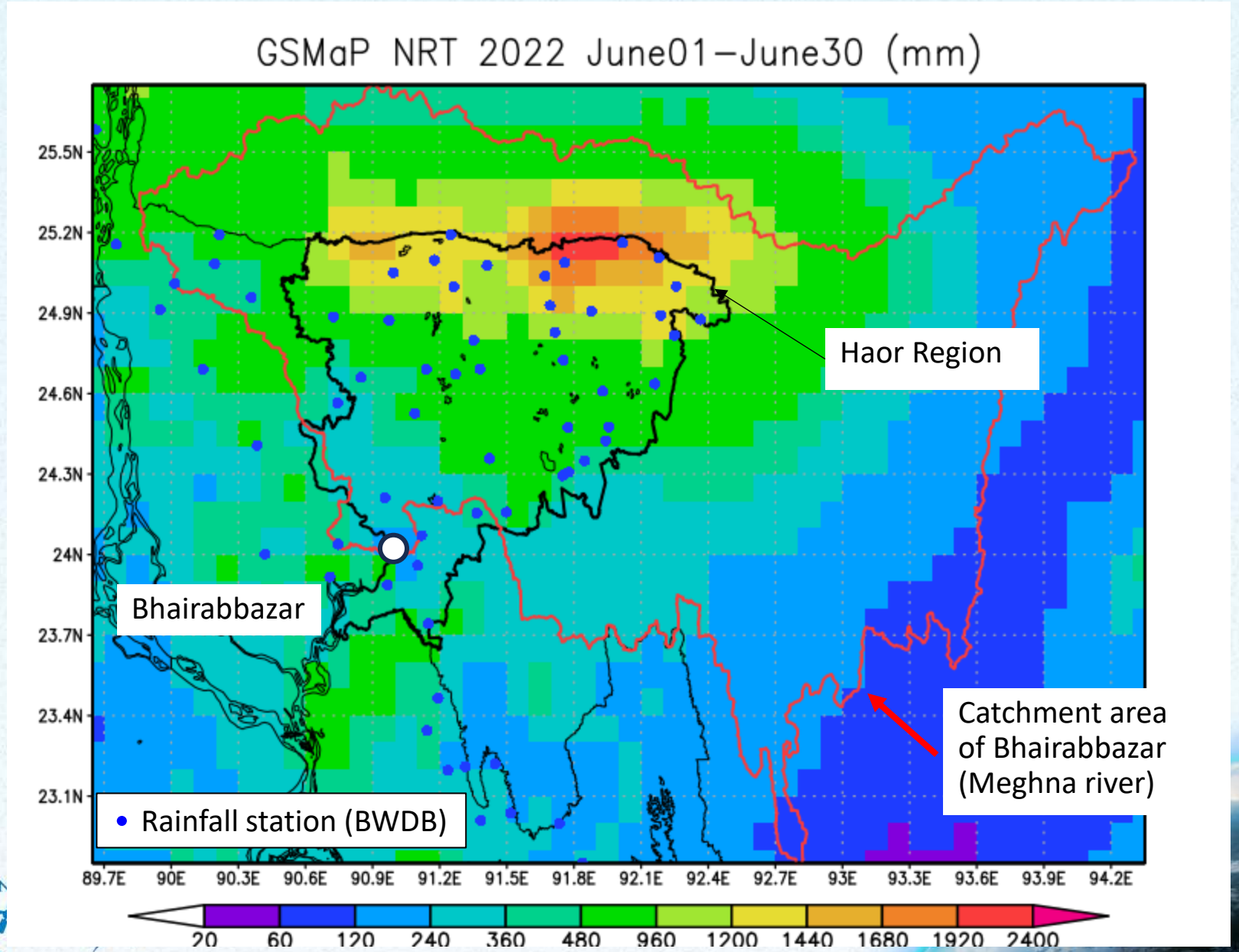
Heavy rainfall outside observation network



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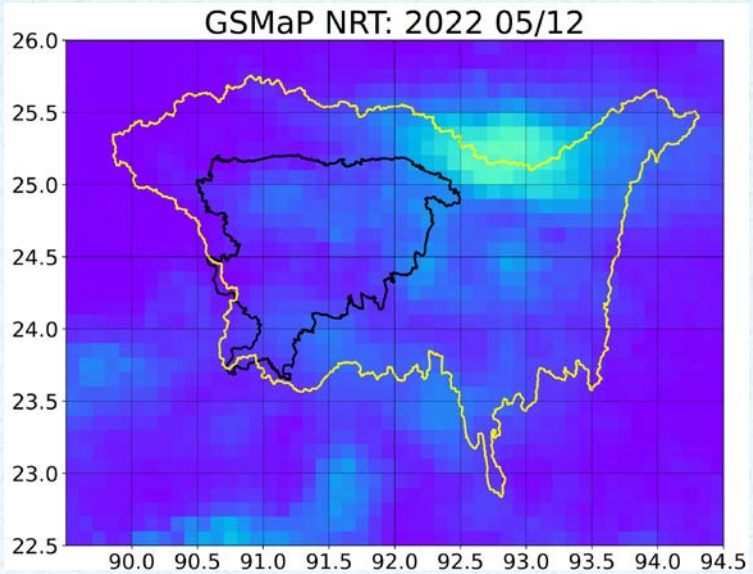
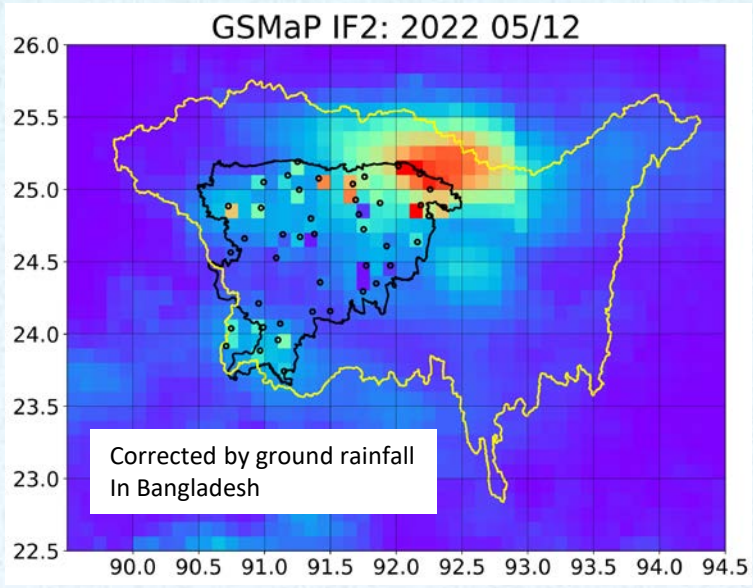
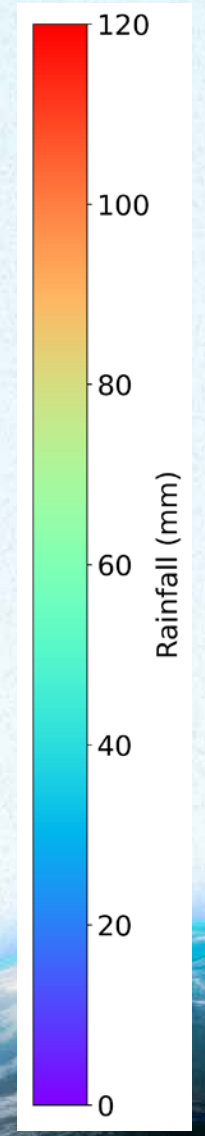
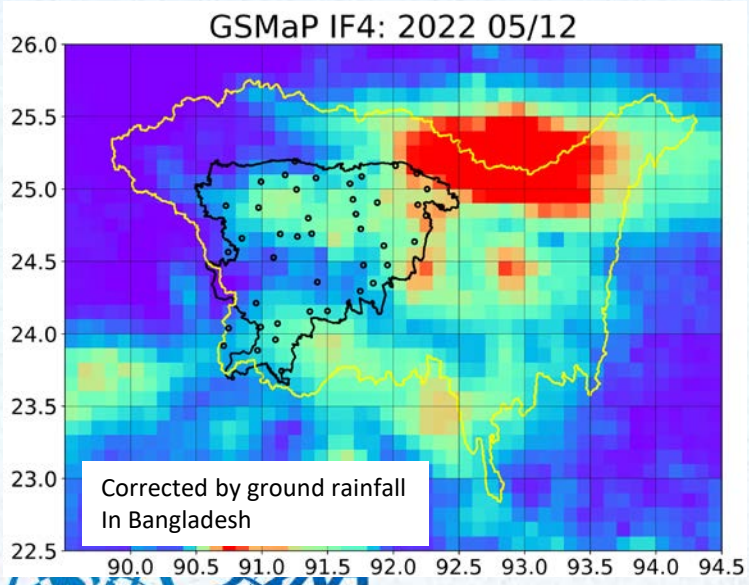
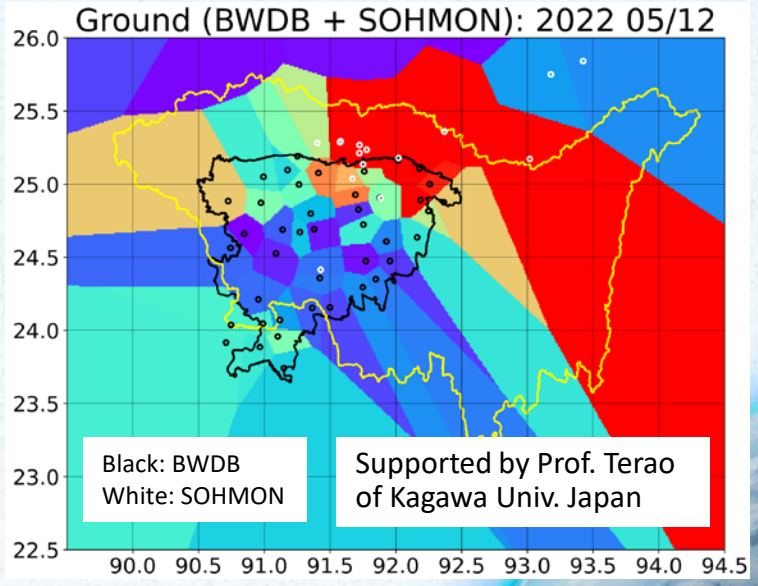
Daily rainfall (12 May 2022)











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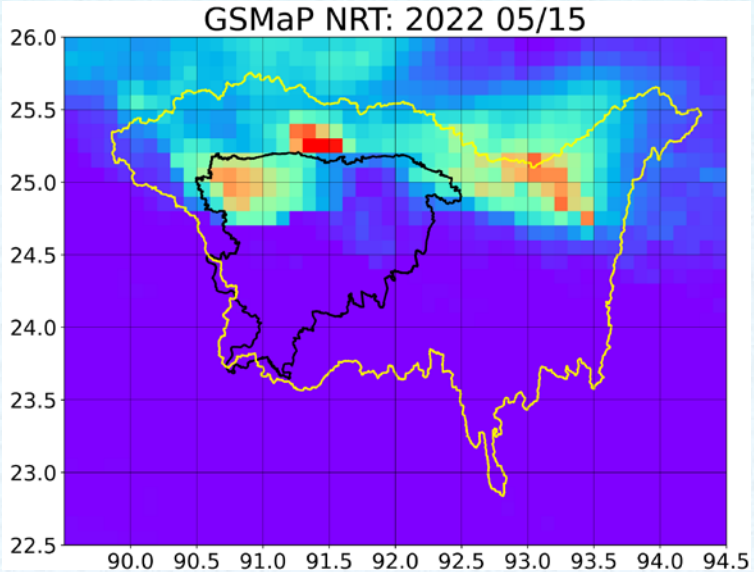
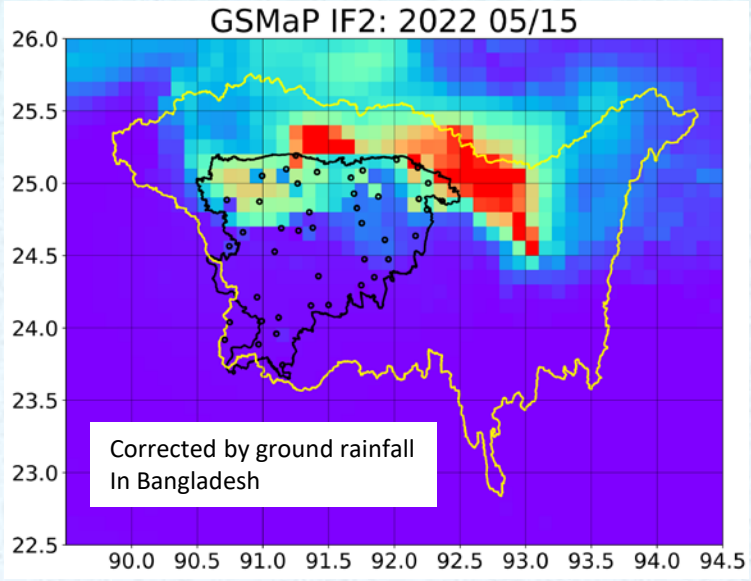
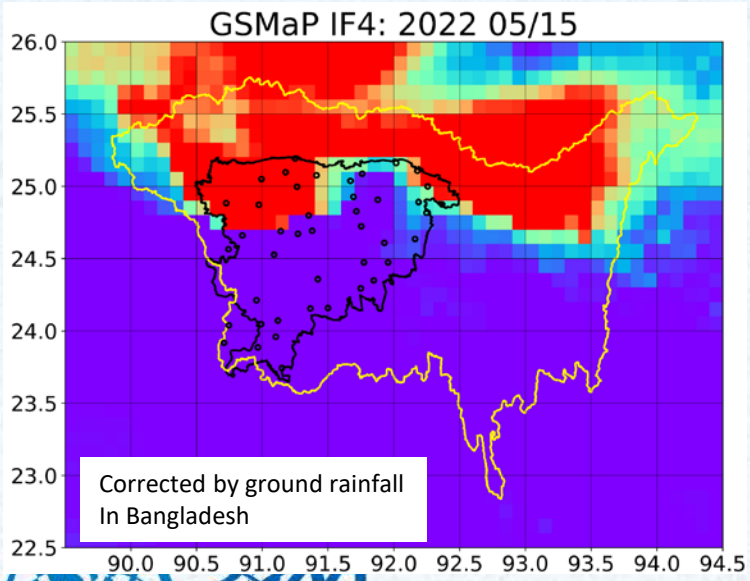
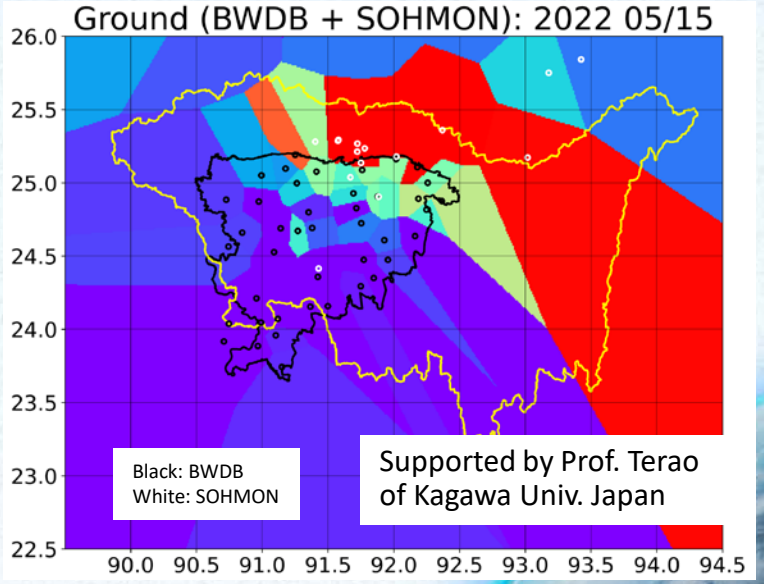
"Data was provided by the Bangladesh / Northeastern India Meteorological Data Archive from the web site at http://rfweb.ed.kagawa-u.ac.jp/dav/gbm_jp/data/DATABASE/".

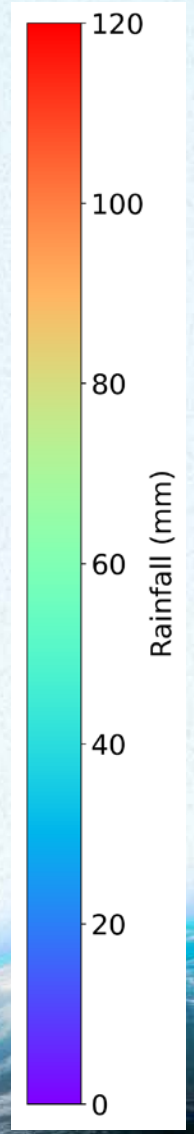
Daily rainfall (15 May 2022)











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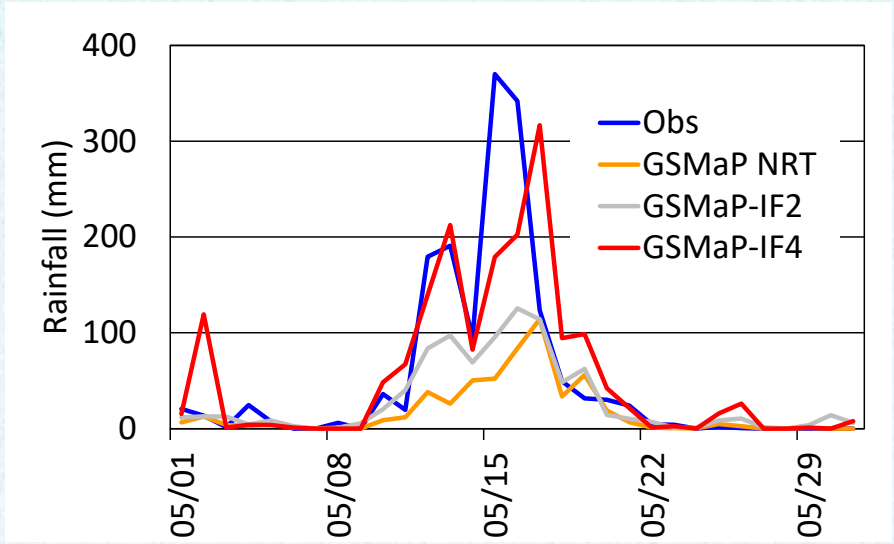
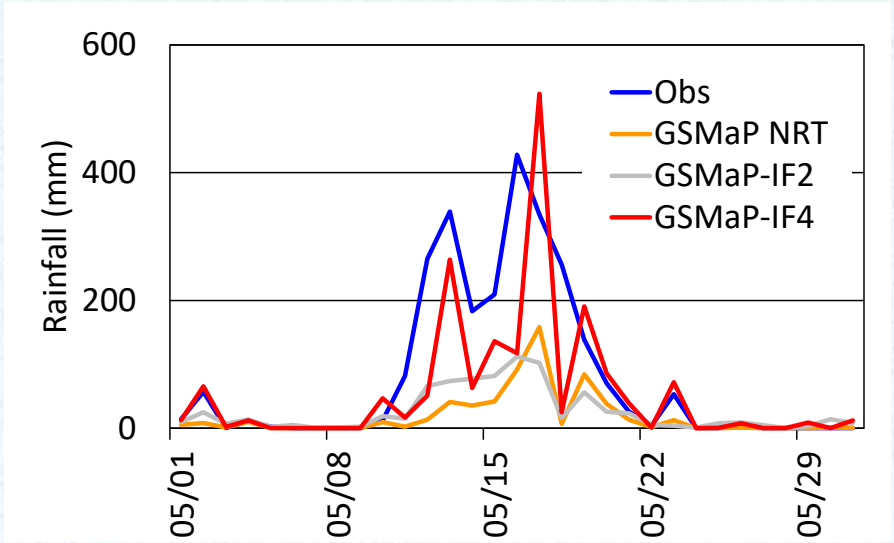
"Data was provided by the Bangladesh / Northeastern India Meteorological Data Archive from the web site at http://rfweb.ed.kagawa-u.ac.jp/dav/gbm_jp/data/DATABASE/".

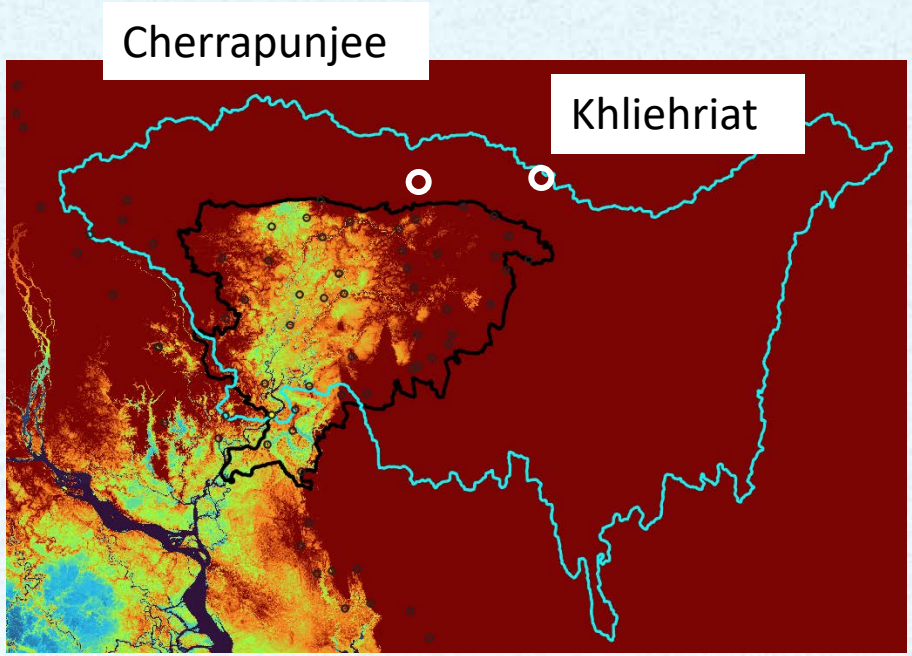
Comparison to observed rainfall outside observation network

Khliehriat



Cherrapunjee





Supported by Prof. Terao of Kagawa Univ. Japan

"Data was provided by the Bangladesh / Northeastern India Meteorological Data Archive from the web site at http://rfweb.ed.kagawa-u.ac.jp/dav/gbm_jp/data/DATABASE/".

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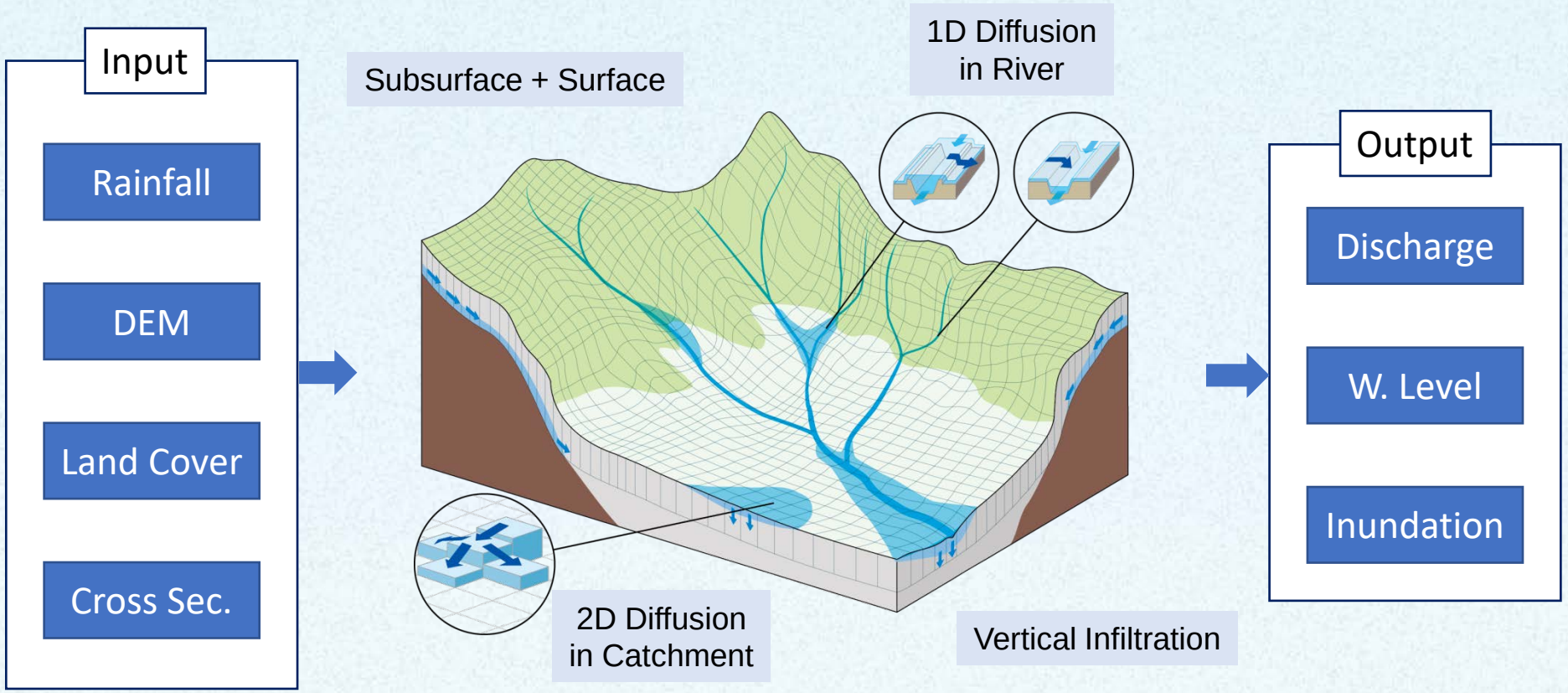
Rainfall-Runoff-Inundation (RRI) Model



- Two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously
- The model deals with slopes and river channels separately
- At a grid cell in which a river channel is located, the model assumes that both slope and river are positioned within the same grid cell

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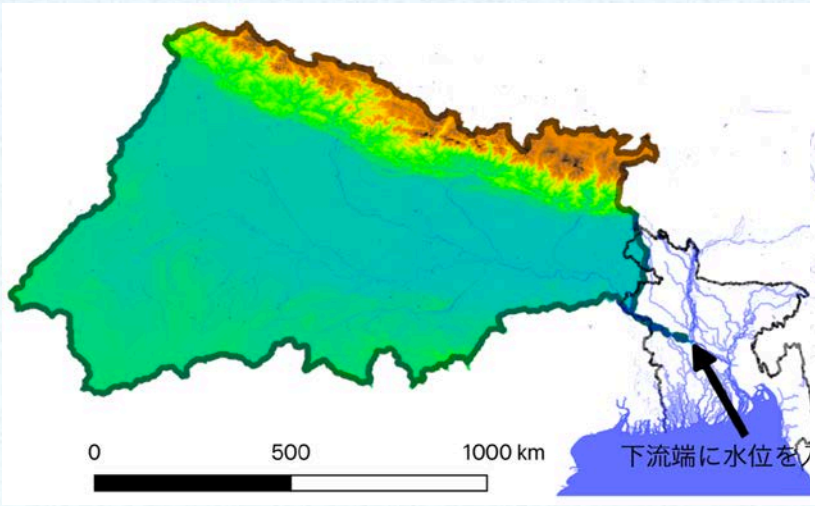
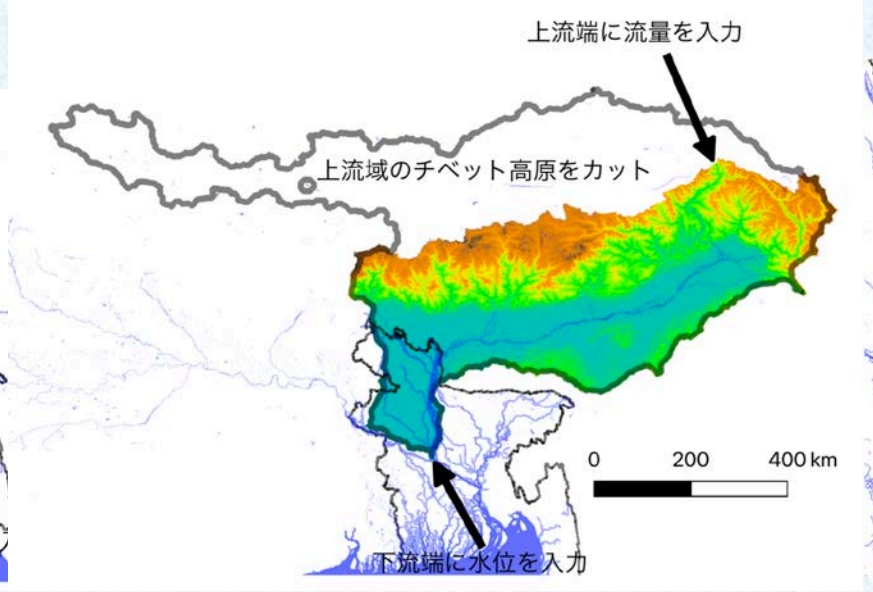
Sayama, T. et al.: Rainfall-Runoff-Inundation Analysis of Pakistan Flood 2010 at the Kabul River Basin, *Hydrological Sciences Journal*, 57(2), pp. 298-312, 2012.

Comparison with ground rainfall data

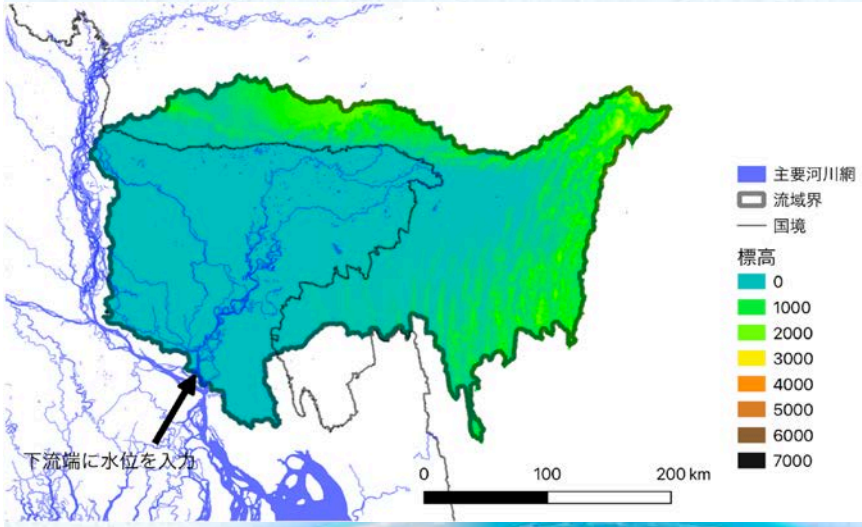
モデル番号	流域	計算面積	グリッドサイズ	標高データ	降雨分布
G001	Ganges	942,913 km^2	60 秒 (896×544)	HydroSHEDS	GSMaP
B001	Brahmaputra	539,085 km^2	30 秒 (1184×734)	HydroSHEDS	GSMaP
M001	Meghna	85,214 km^2	15 秒 (1154×720)	HydroSHEDS	GSMaP



Ganges model



Brahmaputra model



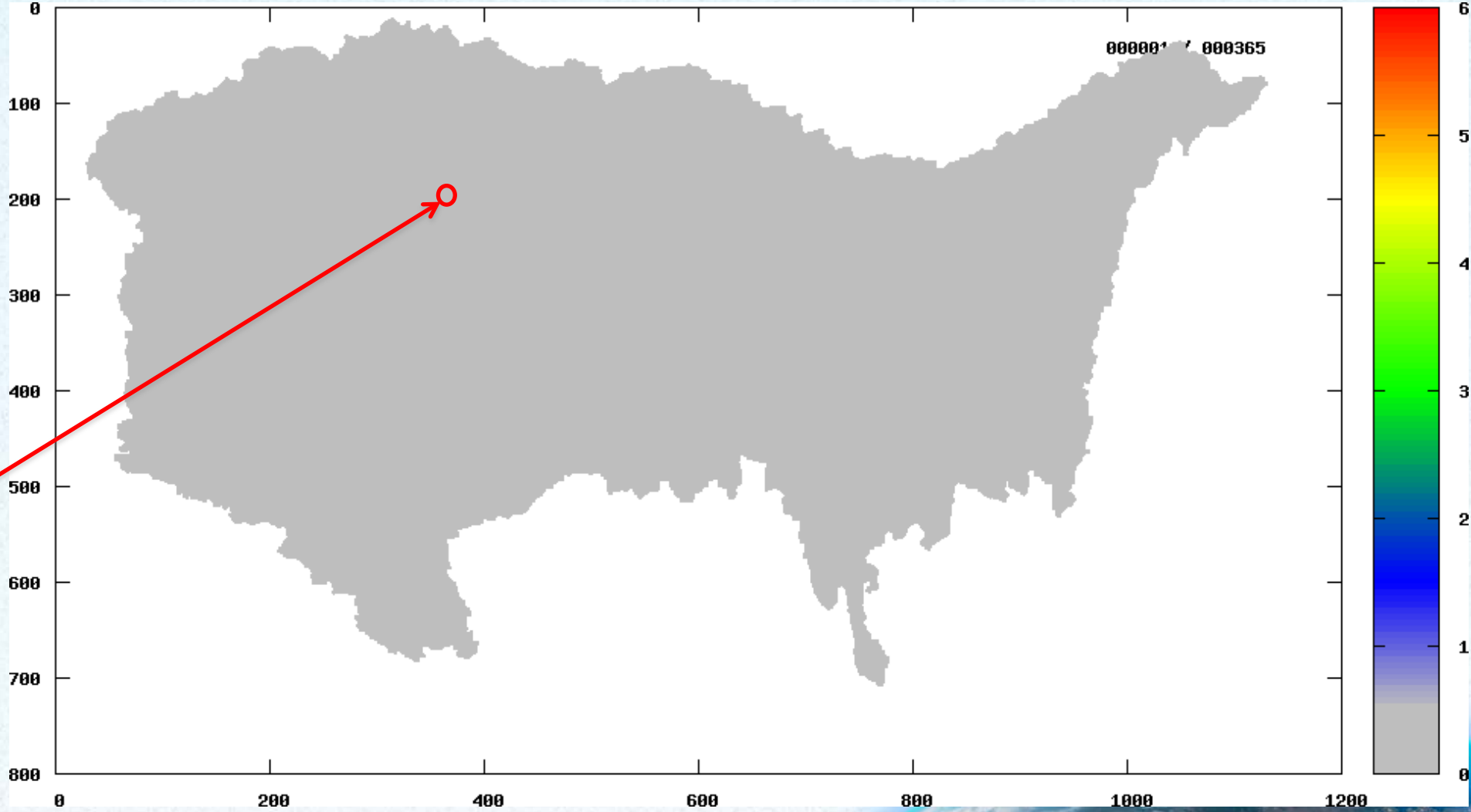
Meghna model

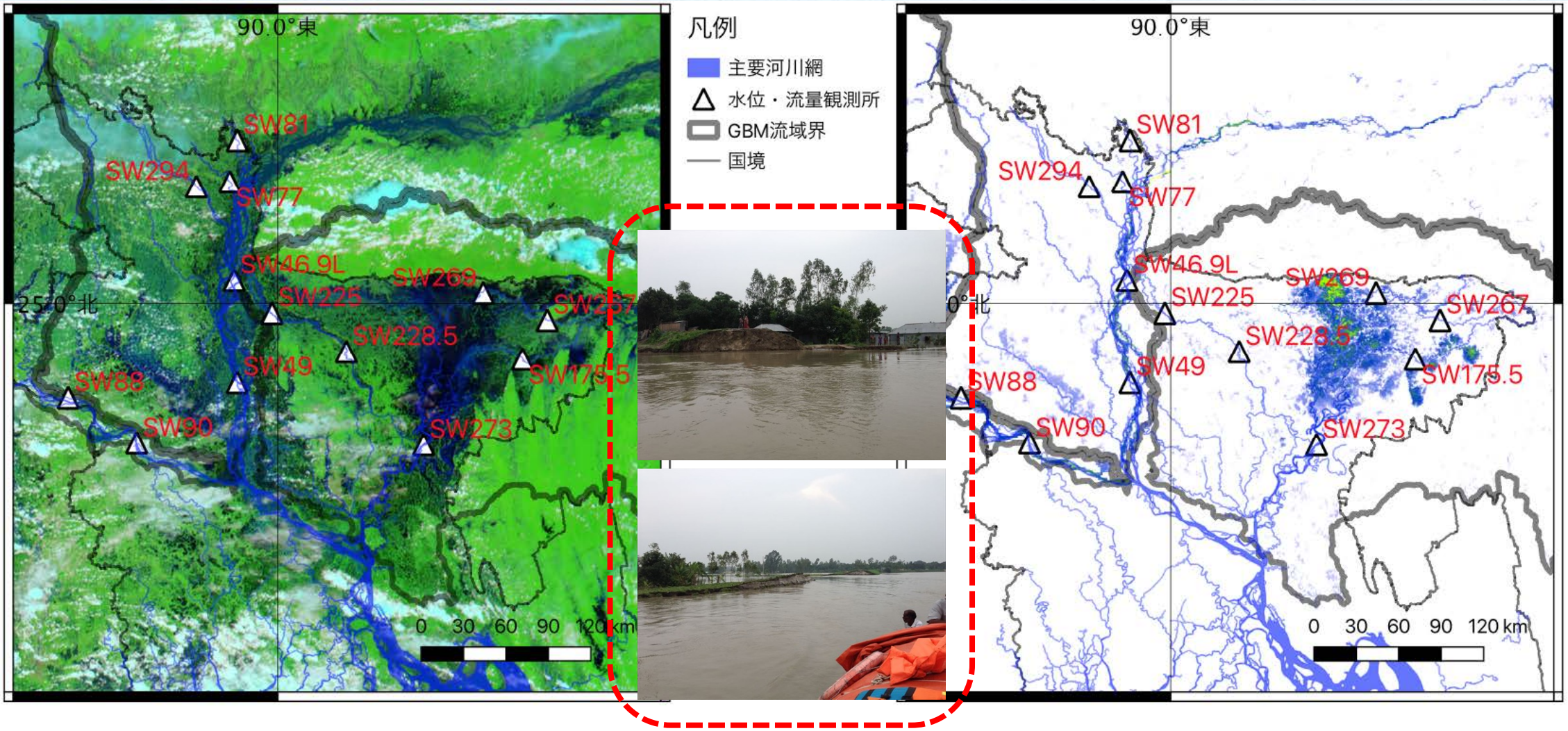
Flood inundation in the Meghna River basin - Assimulation of inundation in the Haor area (one year in 2007).

Haor (A = 8,600 Km2)

Dry Season

Rainy Season

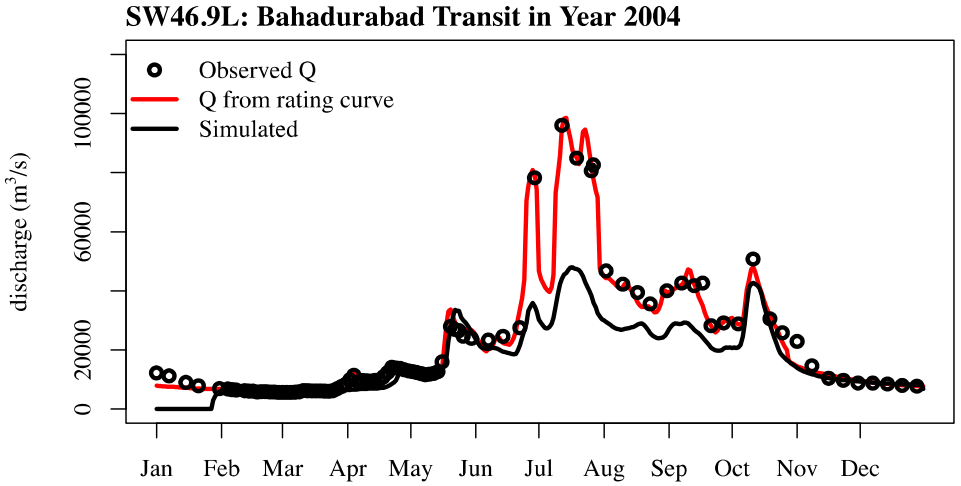




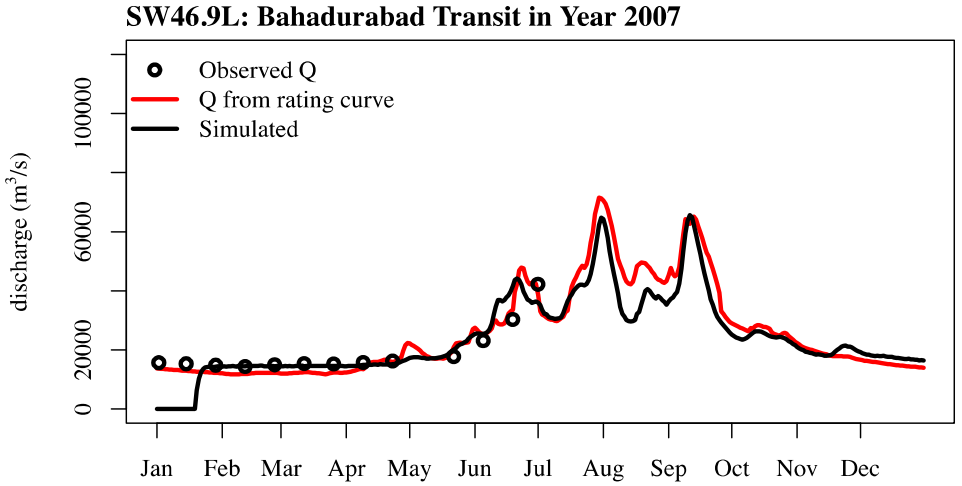
Inundation Area by MODIS satellite data.

Simulation result by RRI

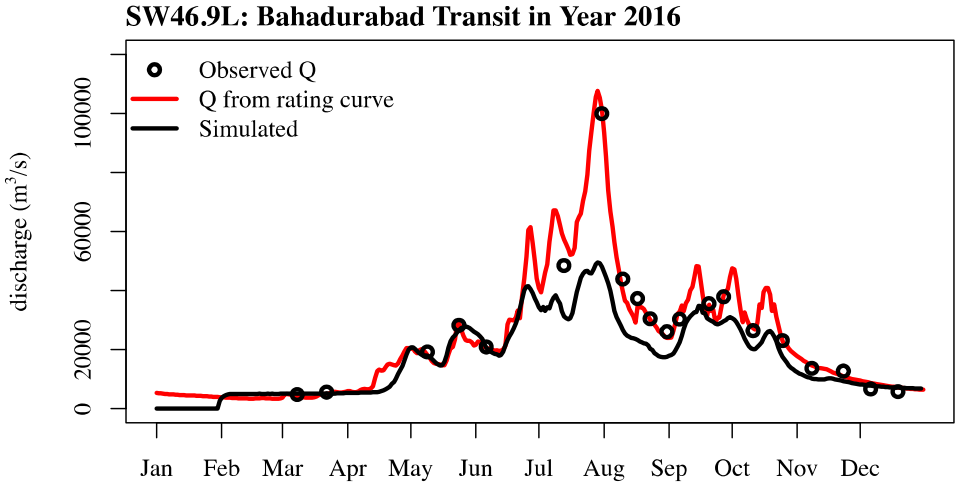
Simulation result of Brahmaptra model（Discharge）



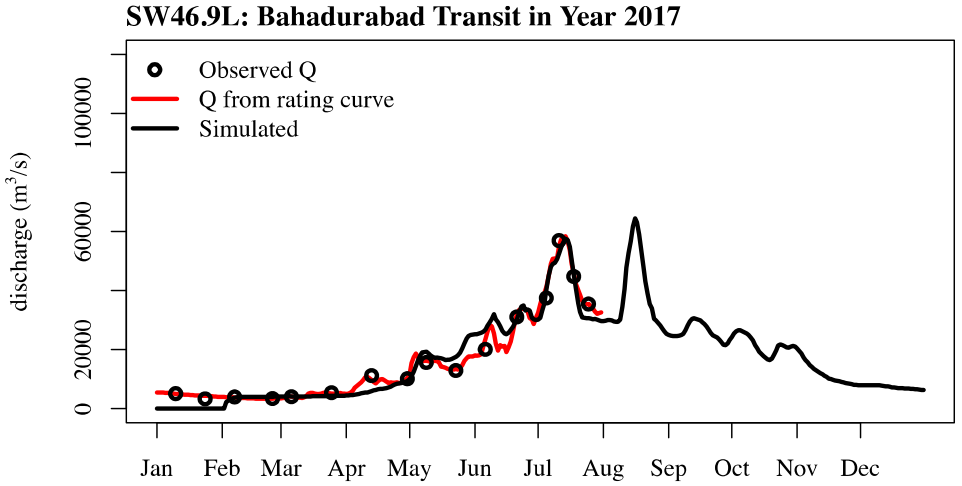
(a) SW46.9L in 2004



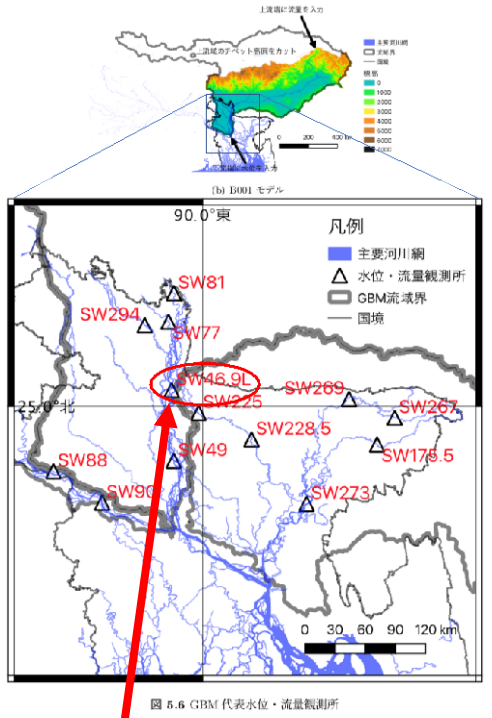
(b) SW46.9L in 2007



(c) SW46.9L in 2016



(d) SW46.9L in 2017



Location

SW46.9L
Bahadrabad

Conclusion

- Rainfall information outside of observation network is important for flood management at transboundary basin.
- GSMAP is very useful data for real-time flood forecasting or inundation assimulation.
- GSMAP-IF is effective in improving the accuracy of flood forecasts in areas where ground observation density is sparse.
- GSMaP-IF provides several correction methods. Users need to consider which method is suitable for their target basin.

Philippine Space Agency