HYDROSAR – WEATHER-RELATED HAZARD INFORMATION FROM SAR

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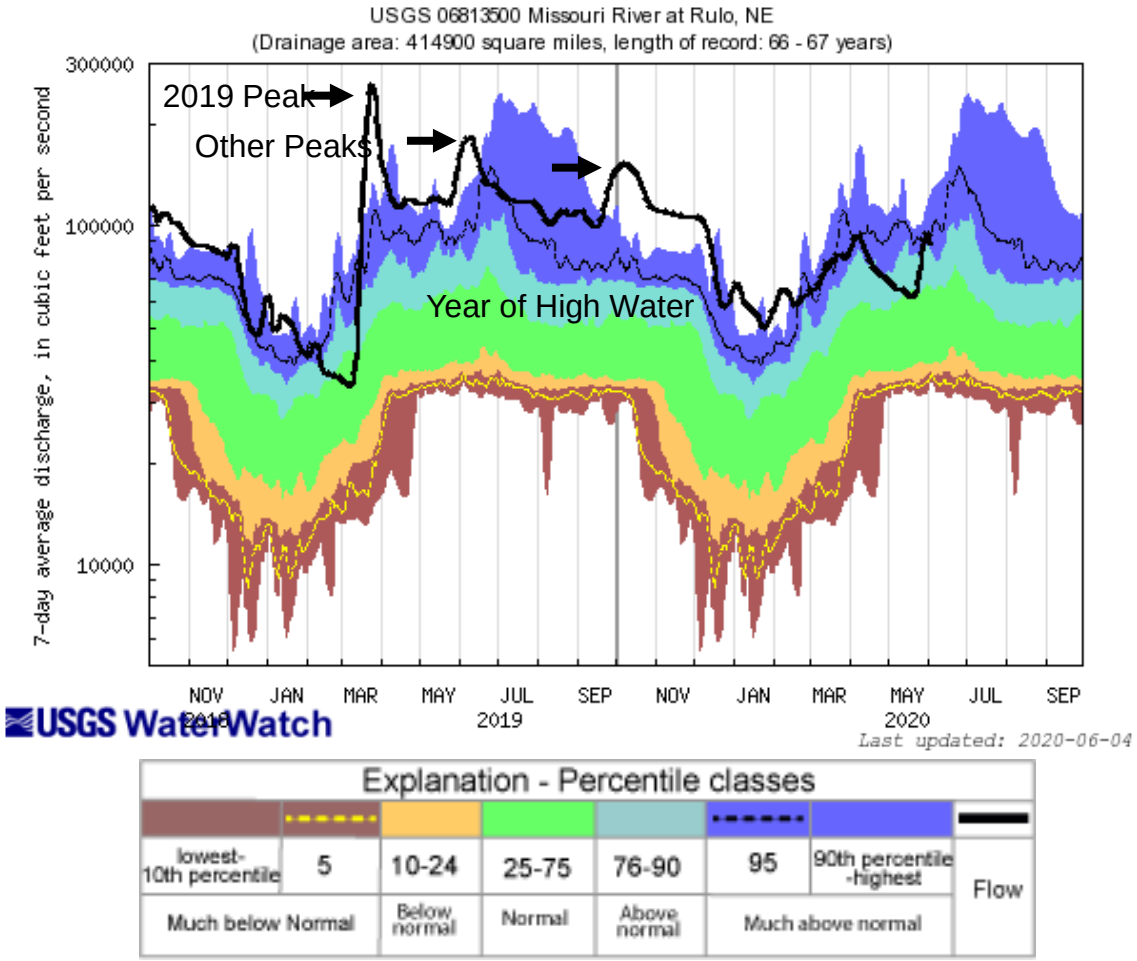
Lecture 4: Cal/Val Results of Flood Extent Algorithm

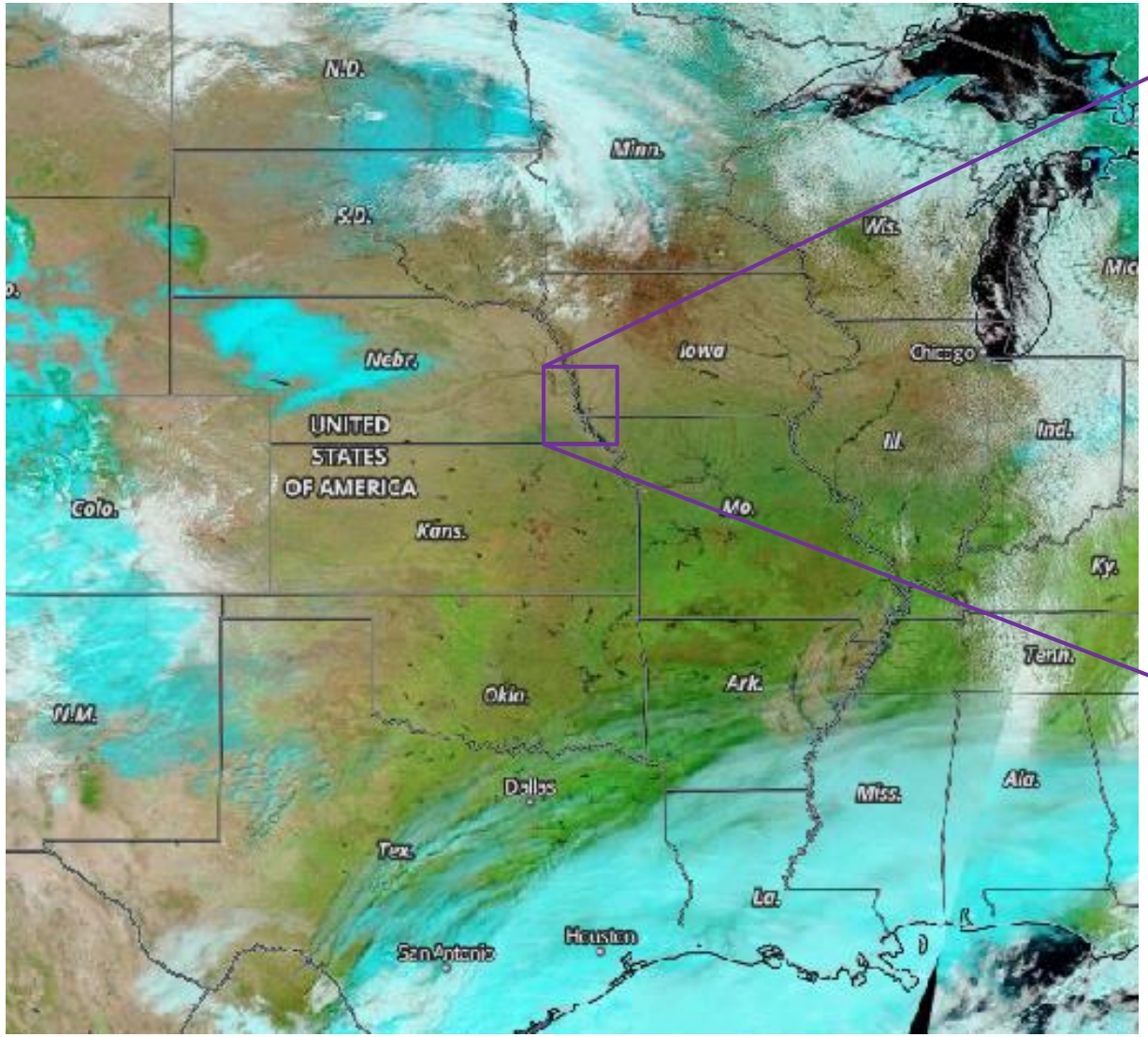
COMPARISON NEAR-SIMULTANEOUS OPTICAL IMAGERY – MISSOURI RIVER, NEBRASKA

Record-Setting Flood Event – Missouri River 2019

- Precursors
  - Below average temperatures in February
  - Significant snowfall, depth and coverage
  - Major winter storm leads to additional snowfall then rapid warming, rainfall, and snow melt across much of northeastern Nebraska
  - Cold winter weather and frozen ground limits infiltration, increases runoff and streamflow, develops ice jams, and extensive flooding
- Impacts
  - Extensive flooding begins in northeastern Nebraska, followed downstream with record-setting streamflows along the Missouri River
  - Record-setting damage in Nebraska and downstream states and continued seasonal and heavy rainfall events create a prolonged season of flooding with recurring events throughout 2019.



Study Domain – SE Nebraska

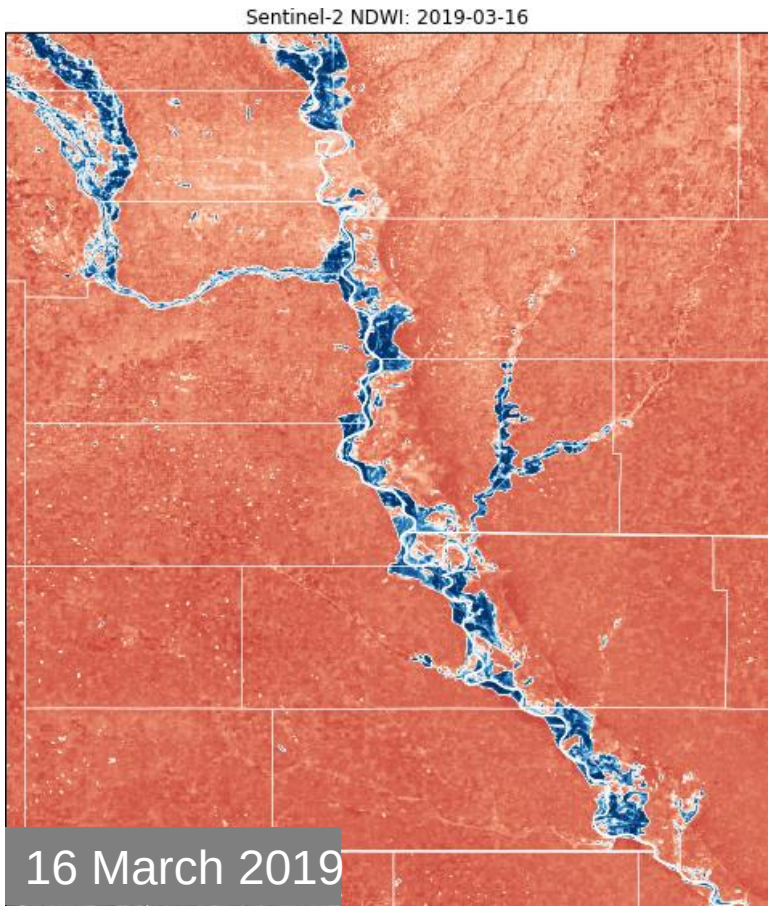


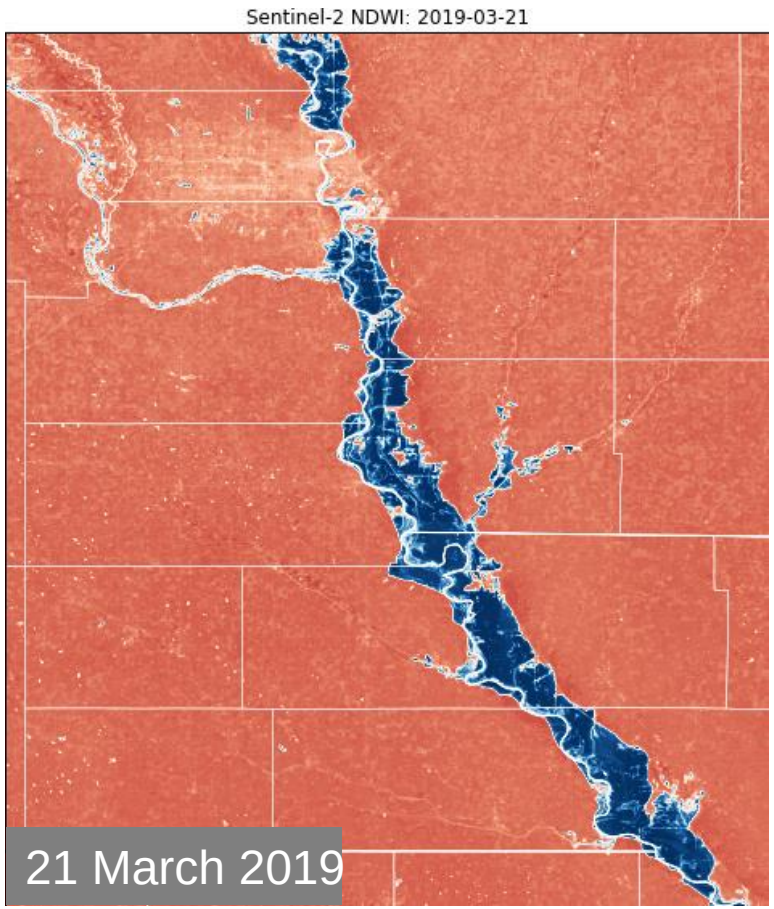
https://go.nasa.gov/2LA13sk

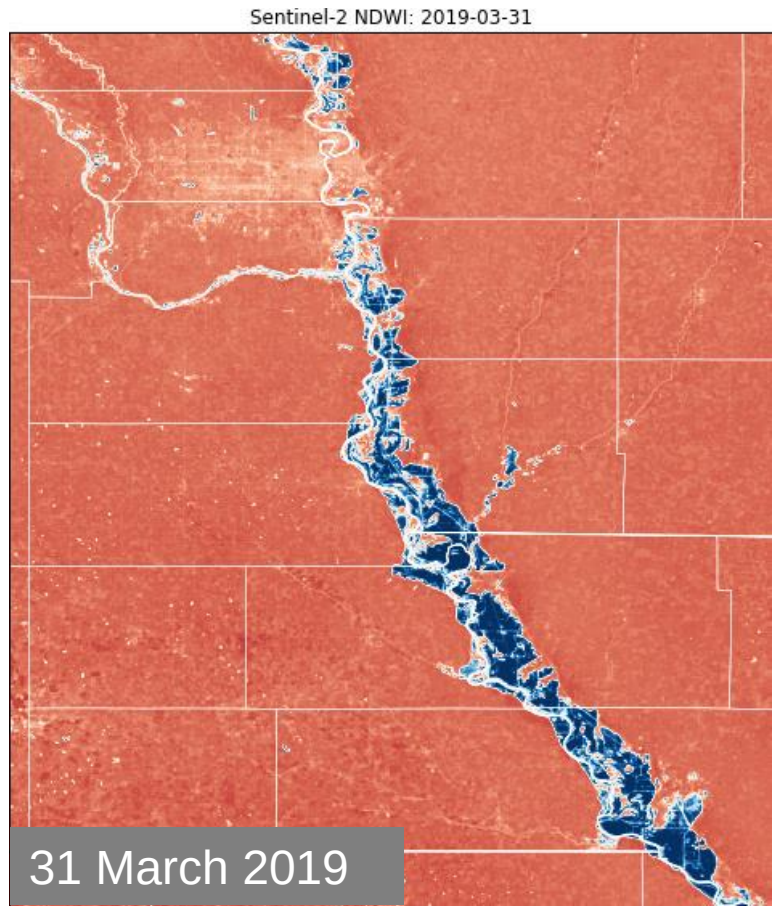
Study Period: 1 March – 1 Oct 2019

- Both Sentinel 1 and clear Sentinel 2 passes used

Early Evolution of the Flood



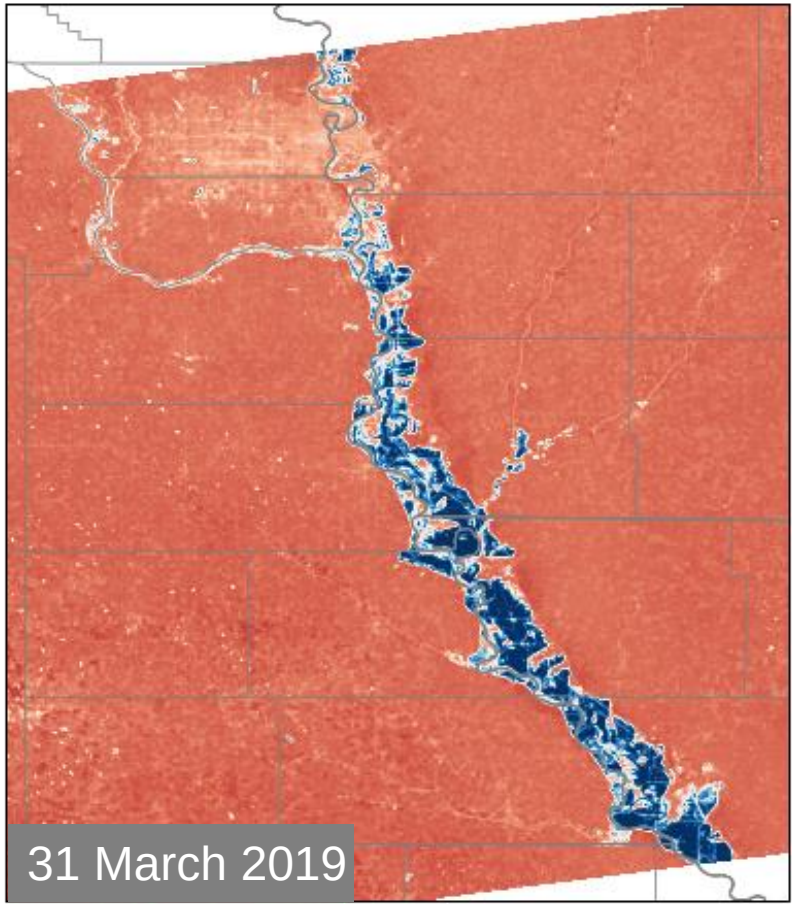




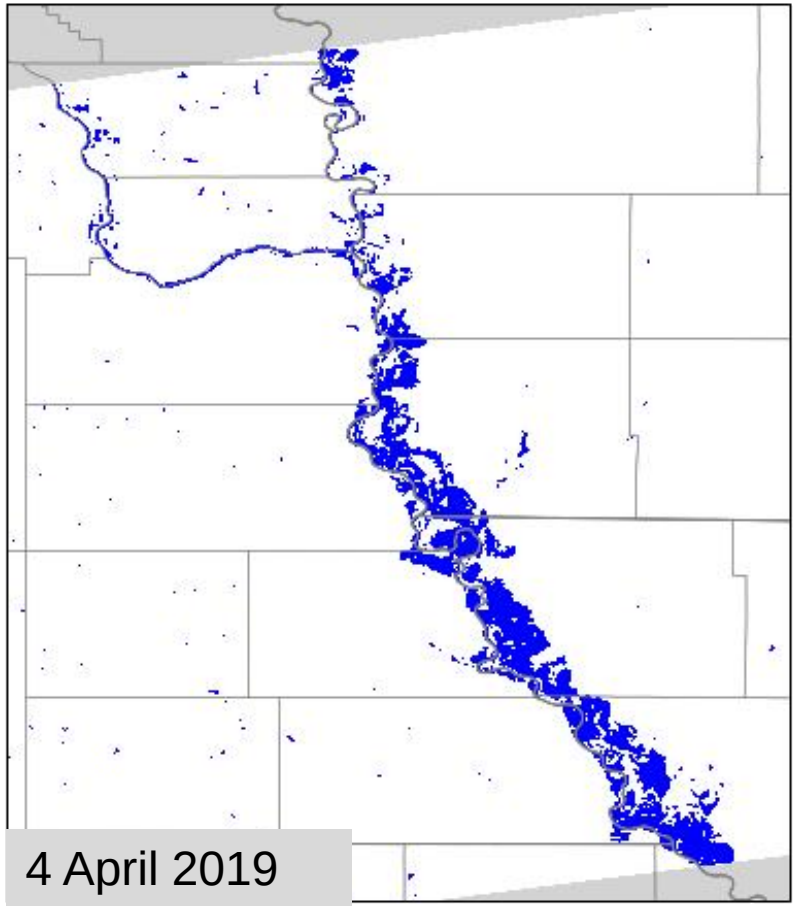
Comparing Sentinel-1 and Sentinel-2

Sentinel-2 False Color 2019-03-31

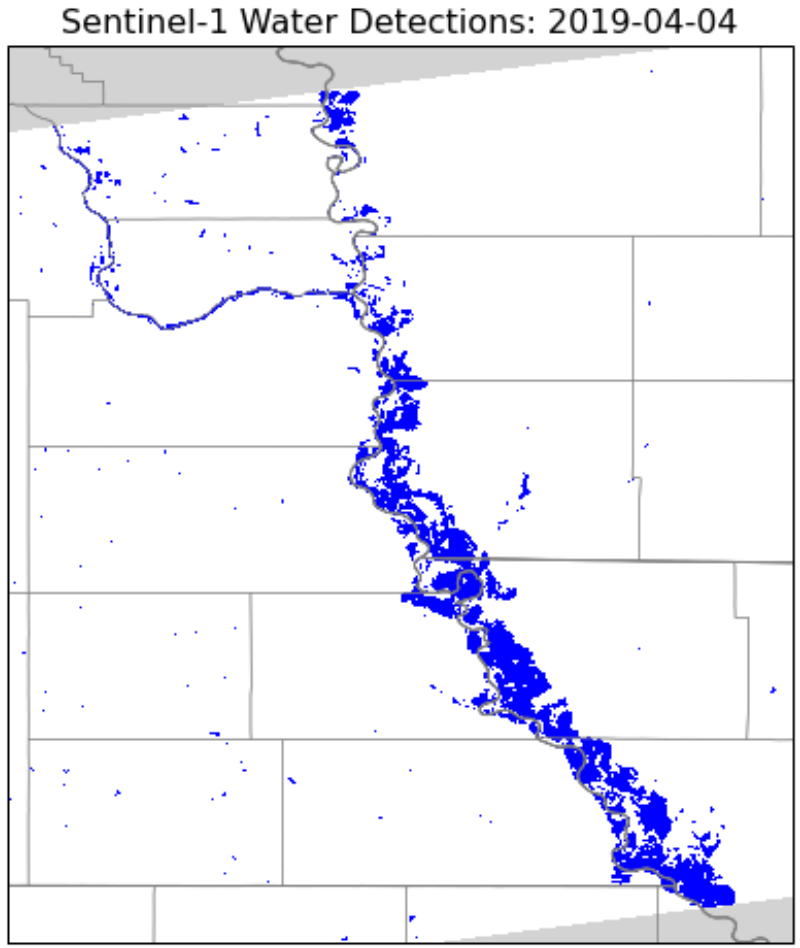
Sentinel-2 mNDWI



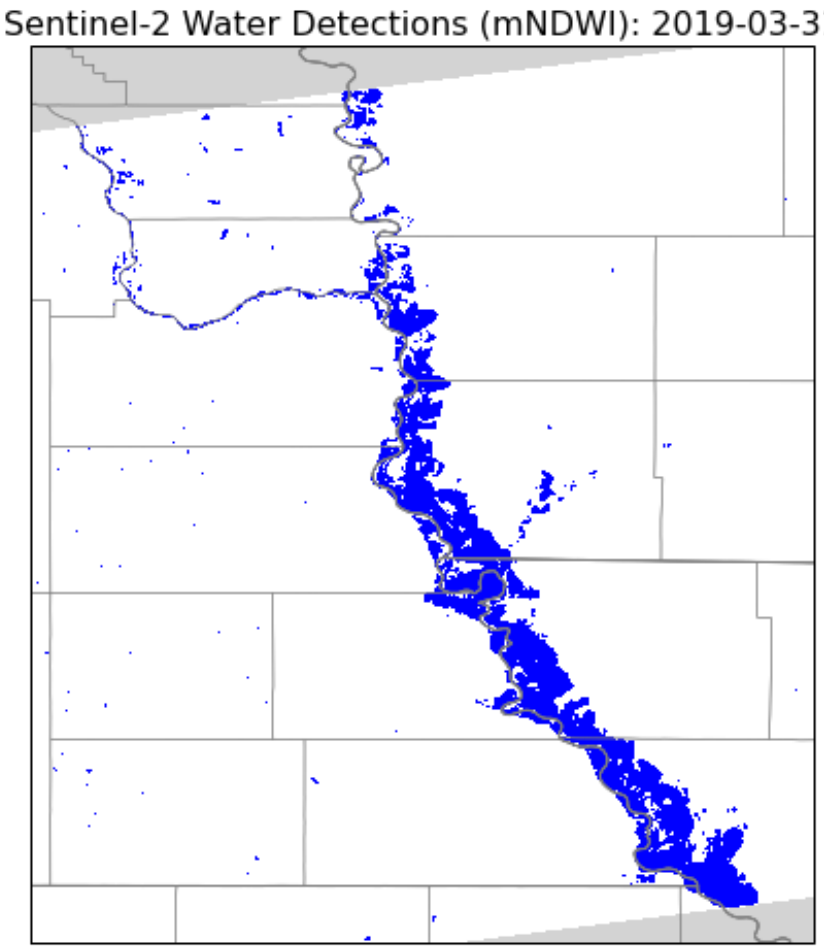
Sentinel-1 Water Detections: 2019-04-04



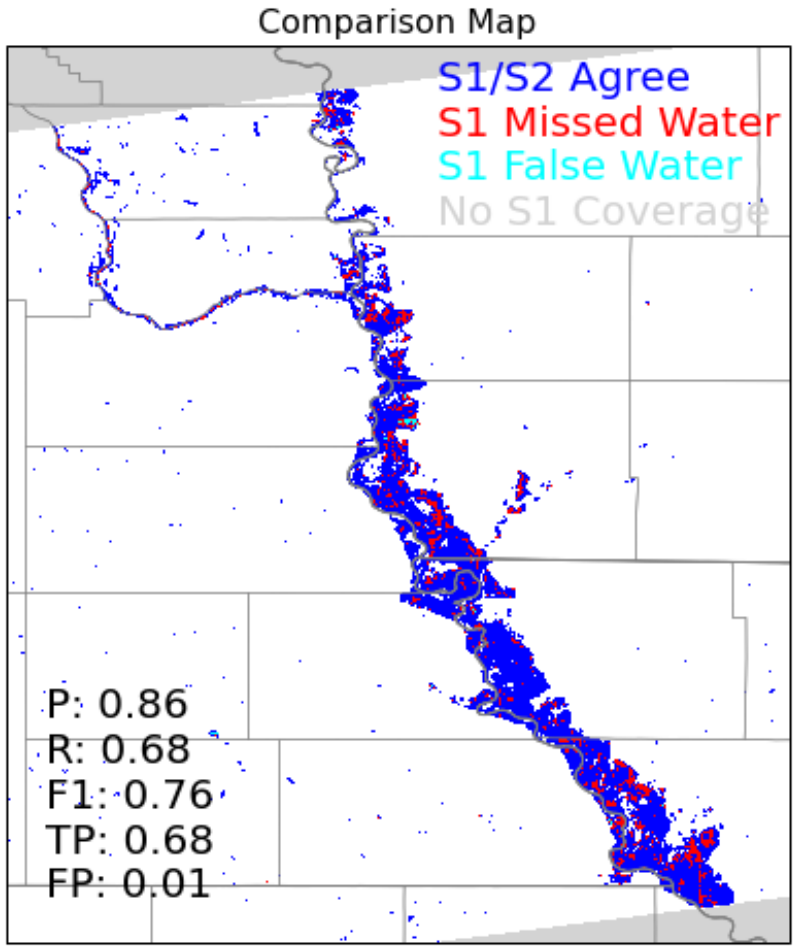
Comparing Sentinel-1 and Sentinel-2



31 March 2019



31 March 2019

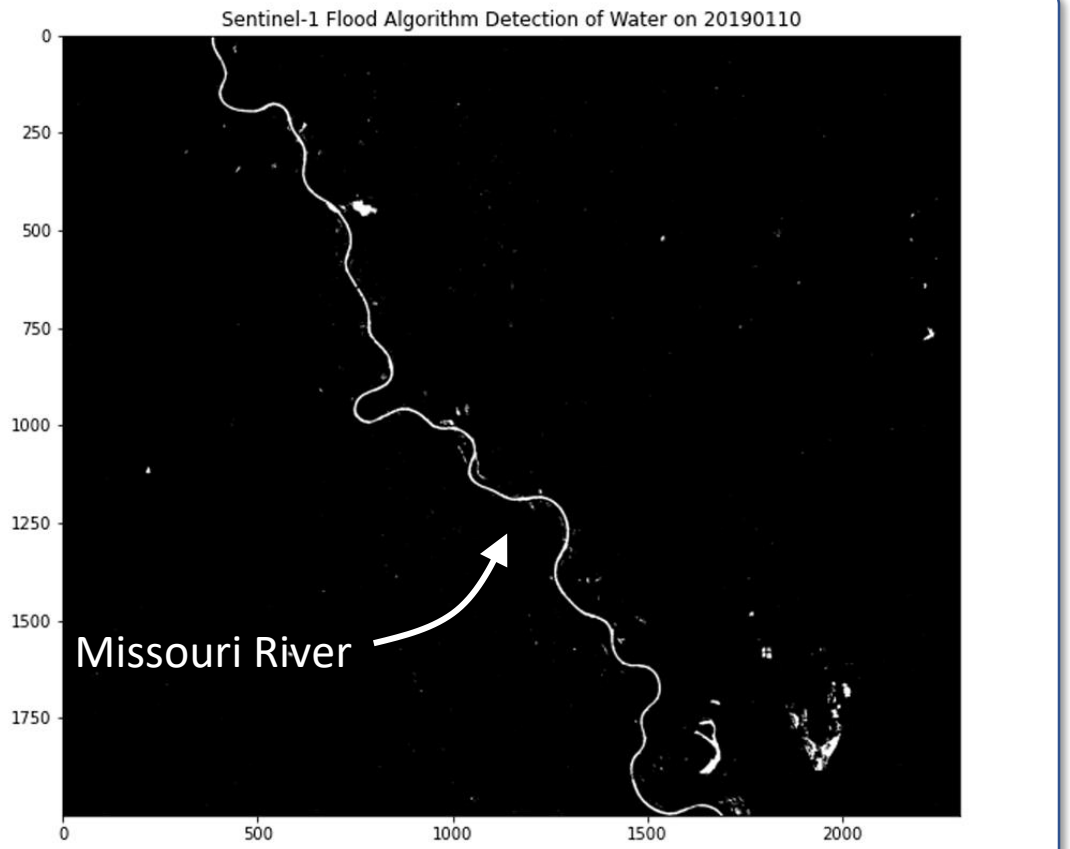


4 April 2019

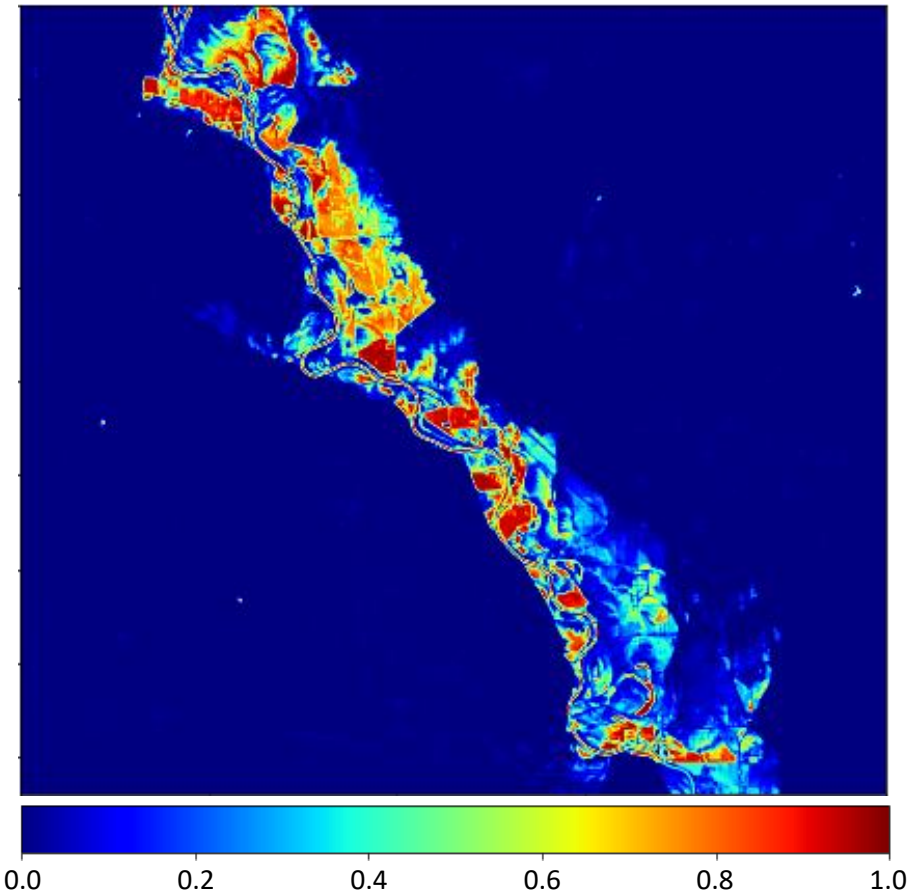
Surface Mapping Product

Performance Assessment

- **Combining Sentinel-1 & Sentinel-2 for High-Frequency Flood Monitoring; Nebraska 2019**

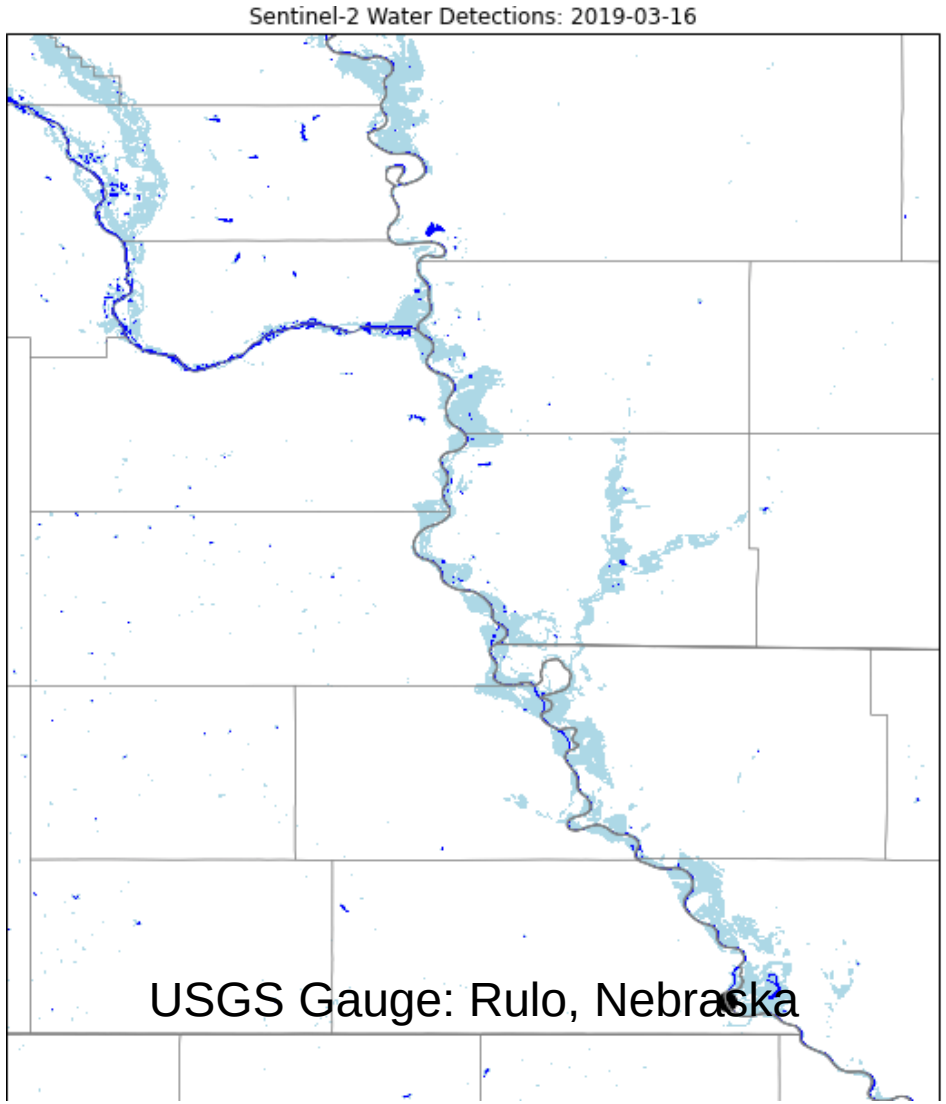


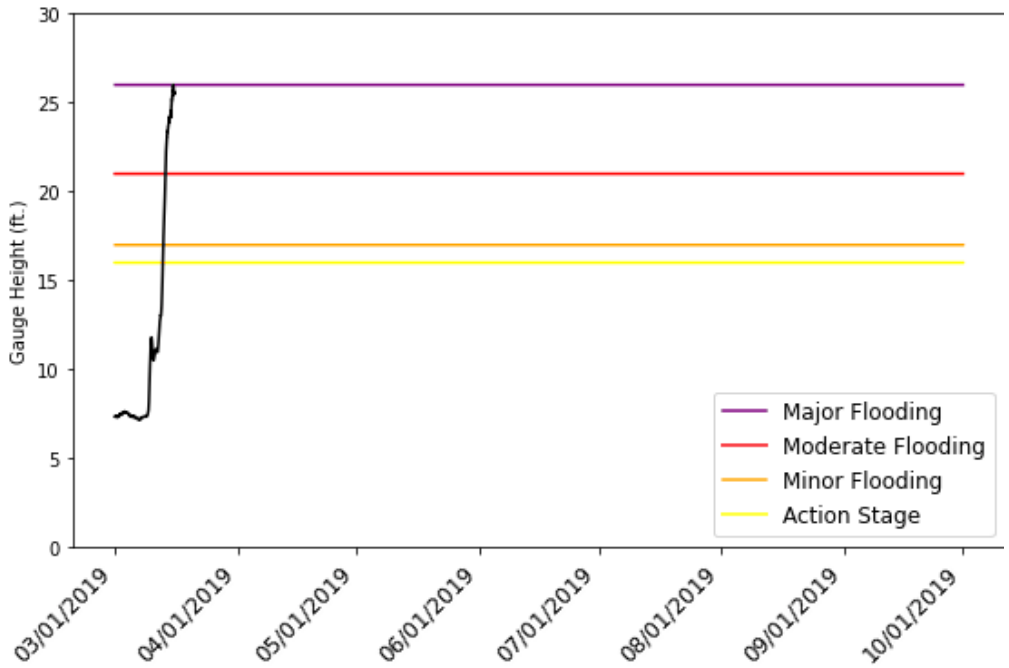
Joint Flood Mapping Time Series: 03/16 – 10/13/2019



Fraction of Inundated Time Steps [N=28 Scenes]

Time Series of Flood Detections

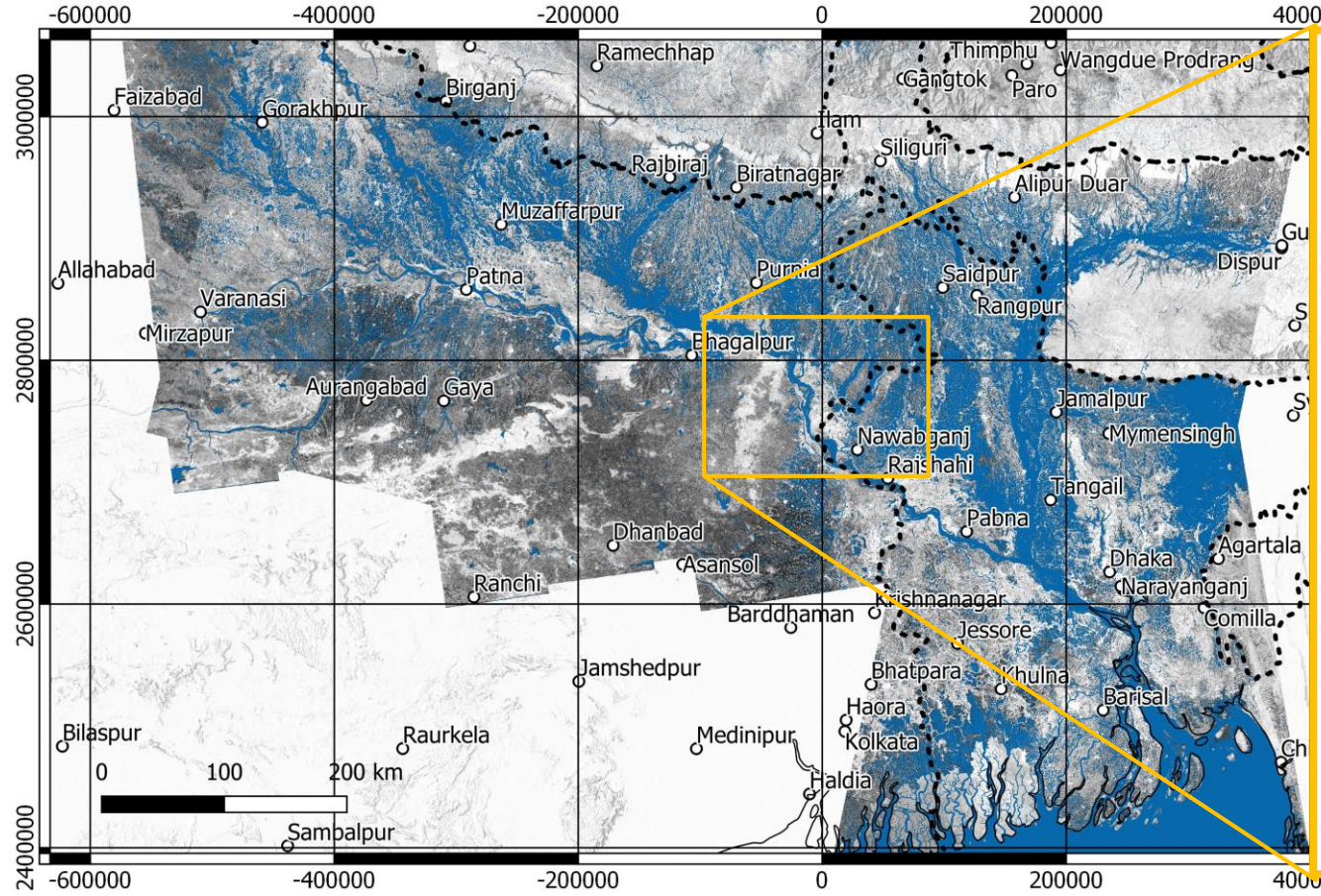


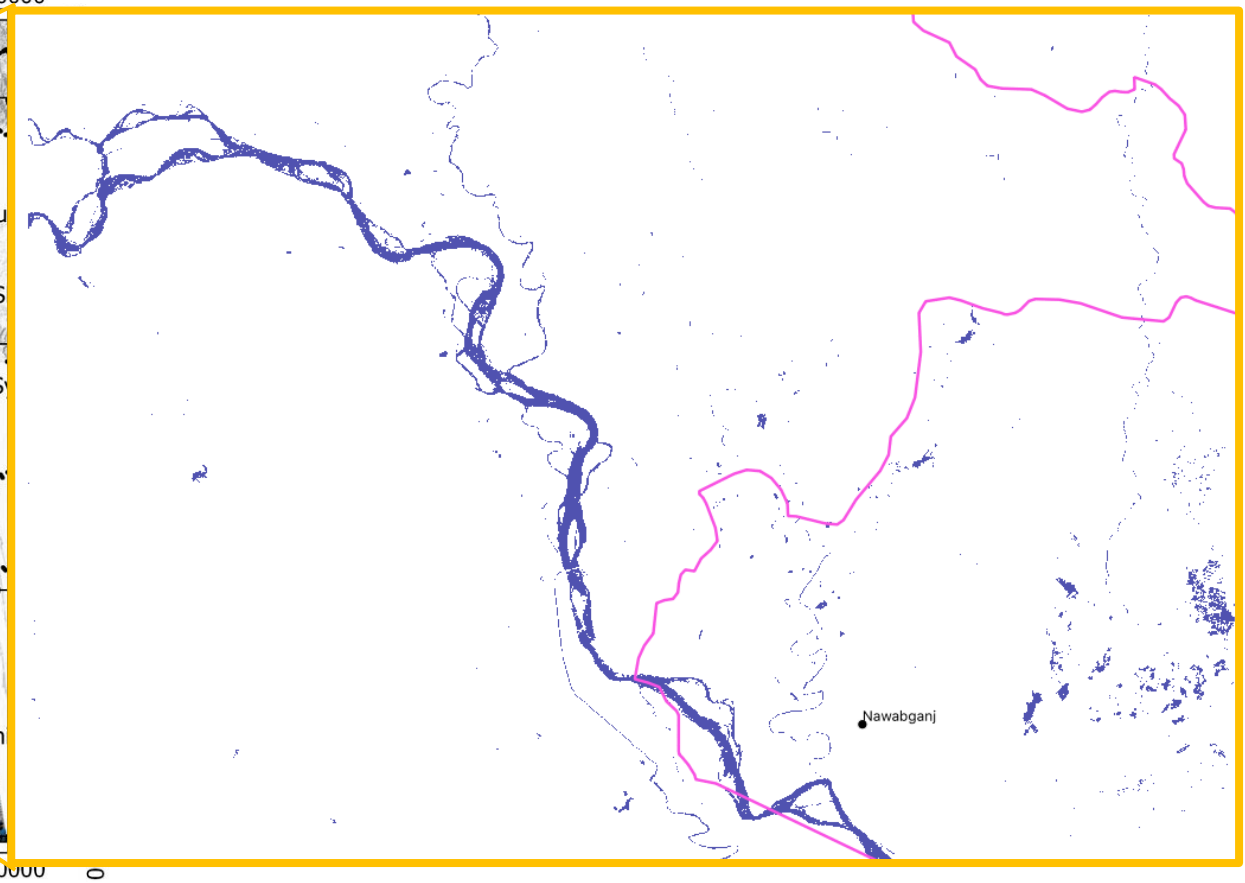


COMPARISON NEAR-SIMULTANEOUS OPTICAL IMAGERY – MONSOON FLOODING – JULY 2020

Subdomain of the Flood Event

Study period: 1 June 2020 – 14 August 2020



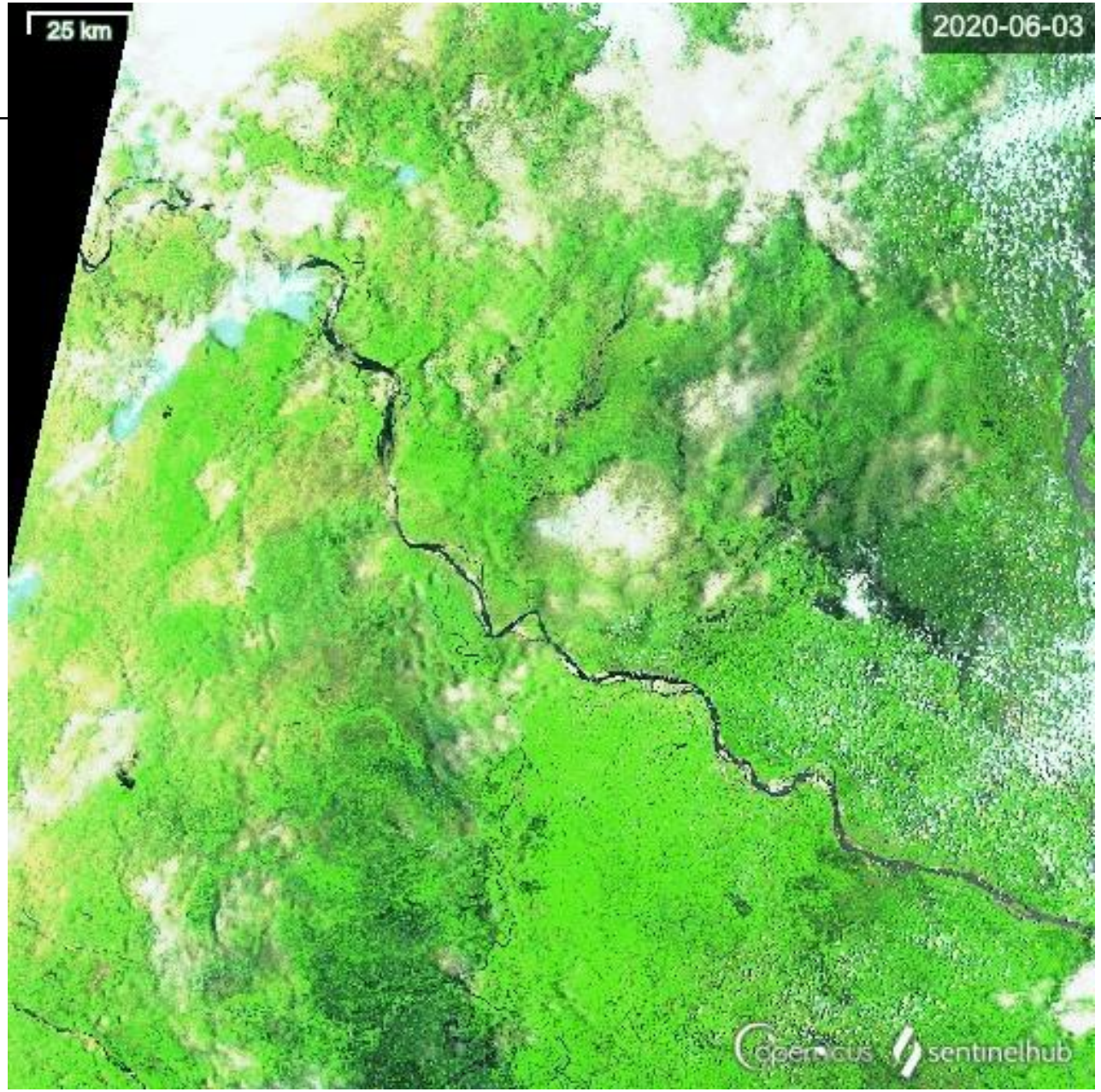


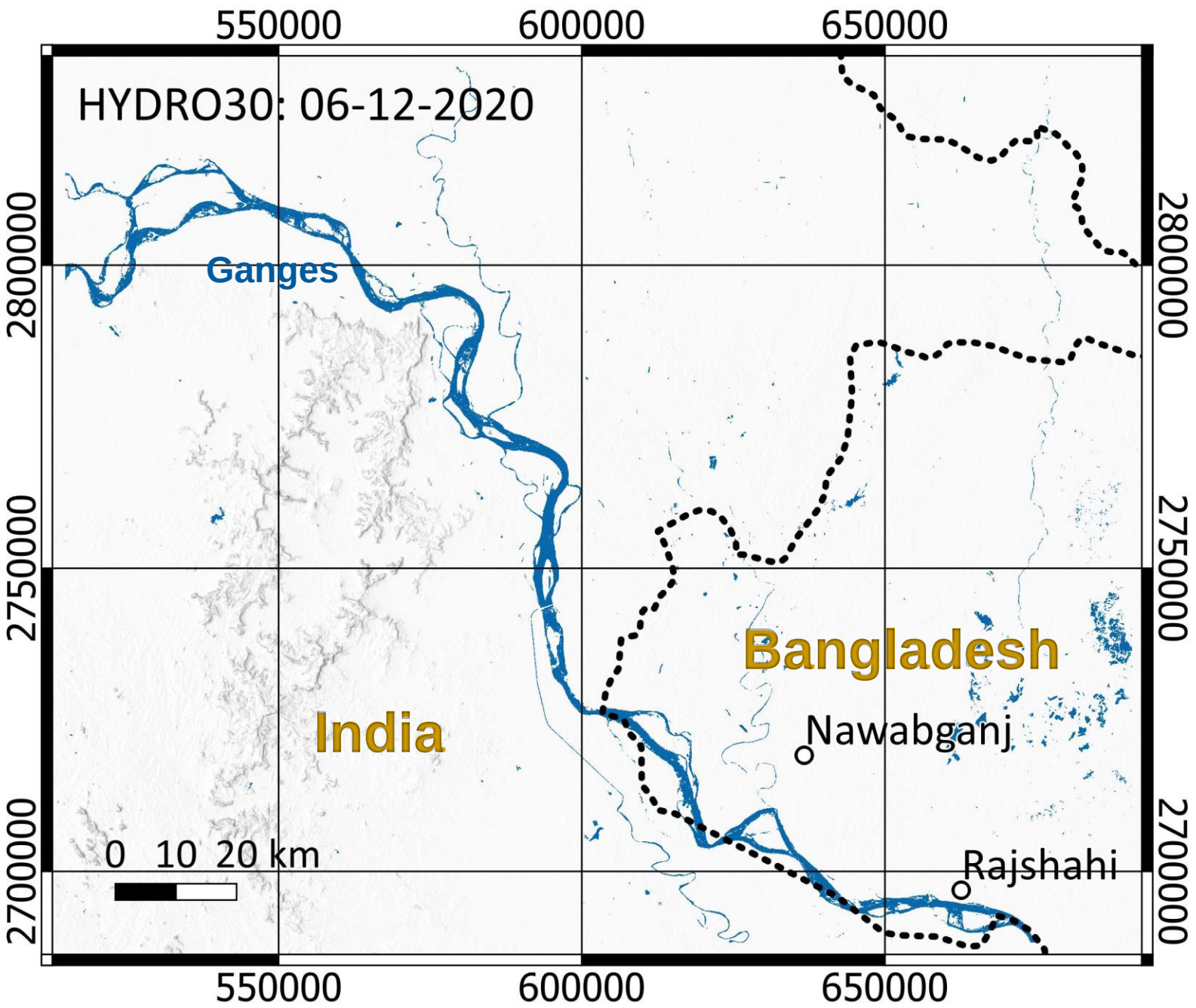
Animation dates: 12 June 2020 – 14 August 2020

Why SAR?

S2 animation from 1 June through 1 September 2020

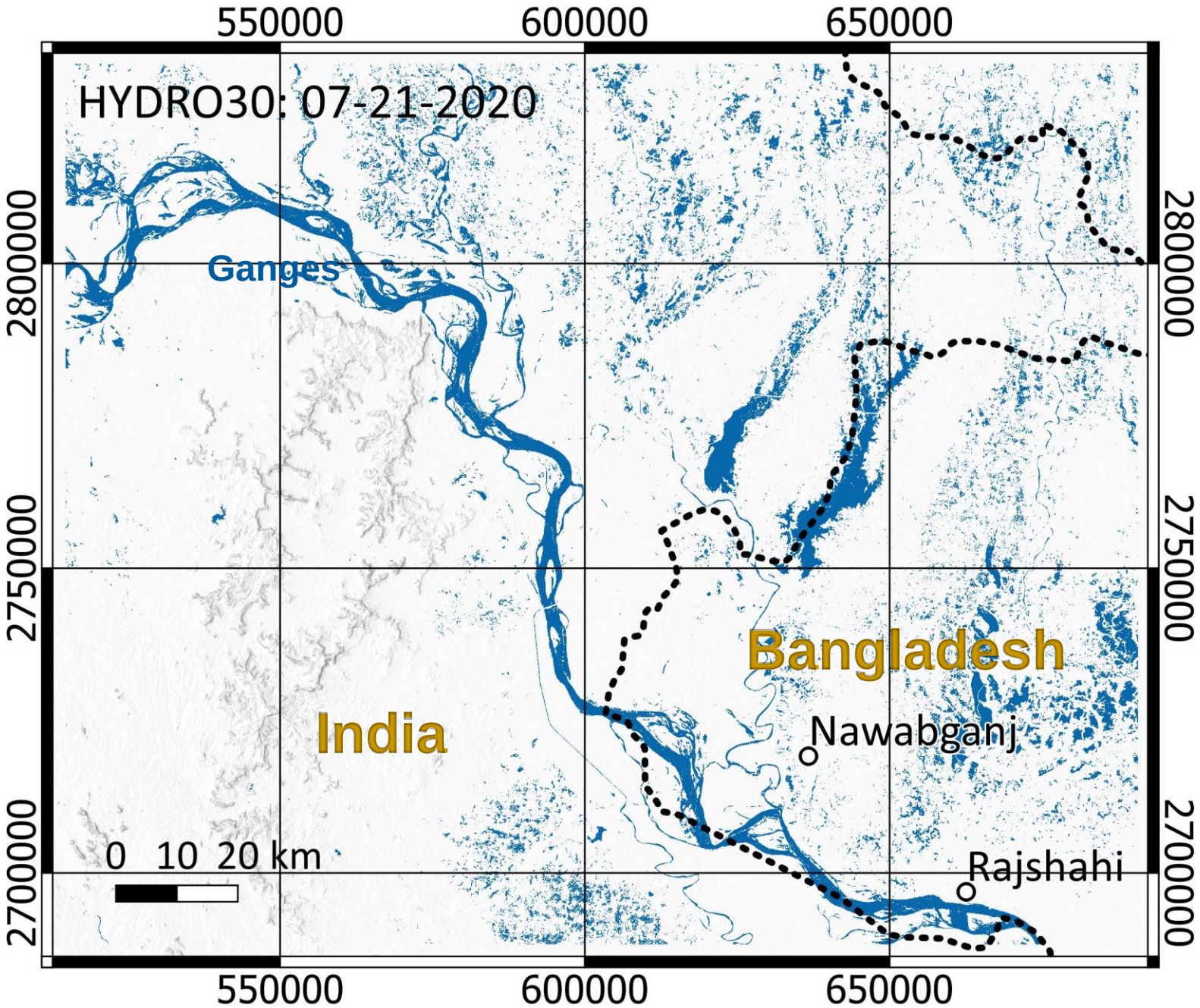
- Very few clear days across the domain
- Cloud cover regardless how thin interferes with surface water extent derivation from the infrared bands
- Comparisons shown later are qualitative due cloud cover
- Ancillary data resources will be necessary for a quantitative analysis of the surface water extents and change detection methodologies





12 June 2020

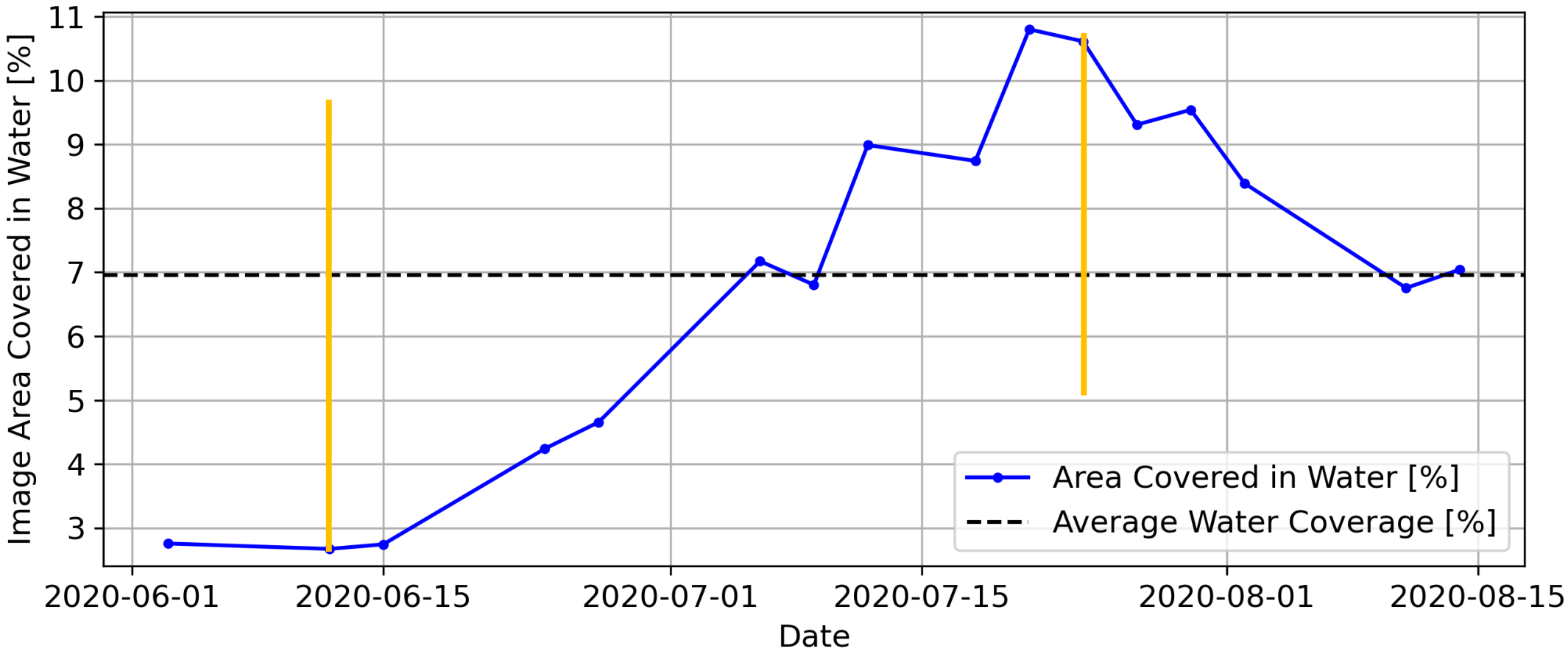
- Pre-event levels of the surface water extents as seen by Sentinel-1 SAR instrument



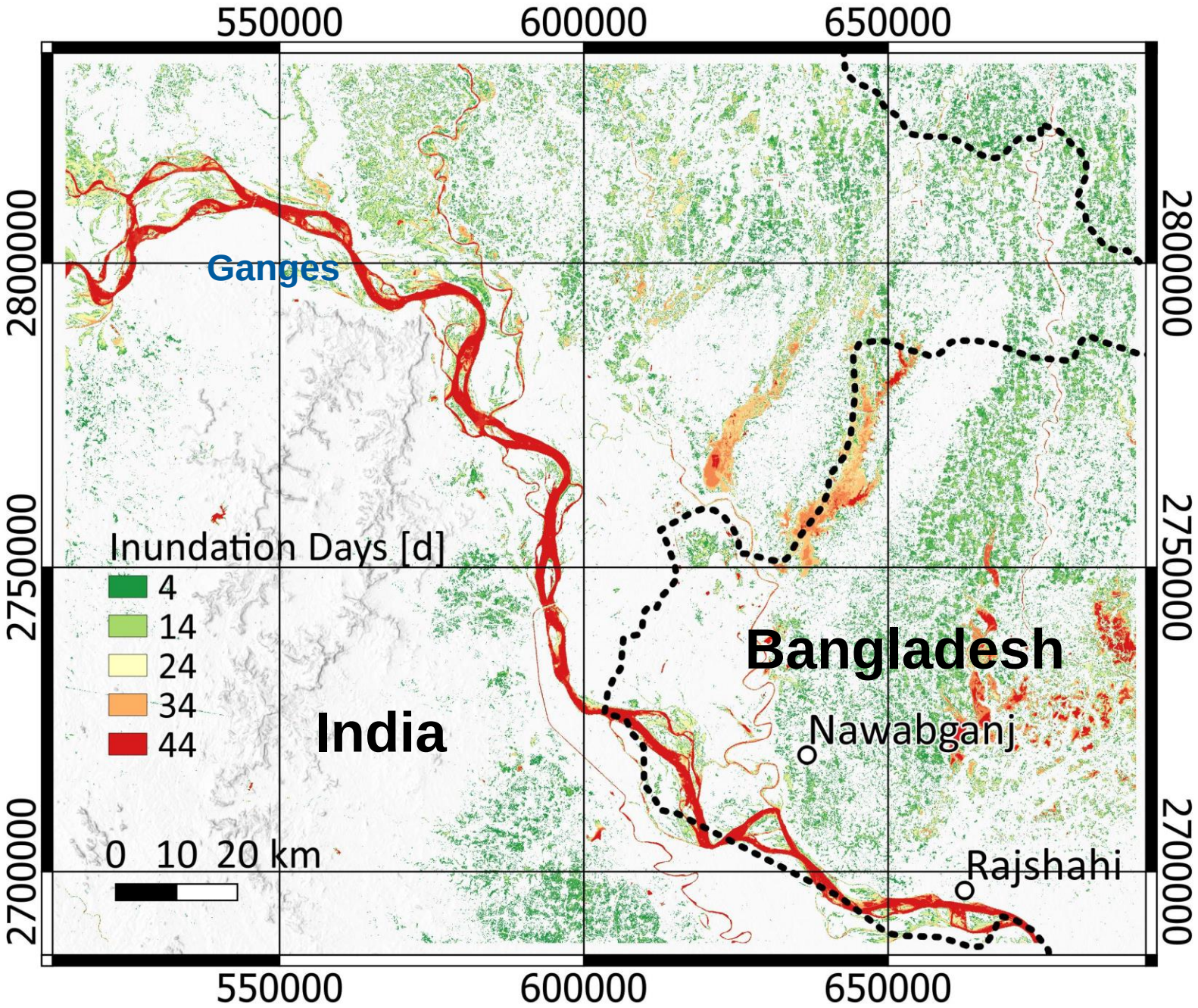
21 July 2020

- Wide-spread surface water extent detections across the domain as seen by Sentinel-1 SAR instrument

Area covered in surface water



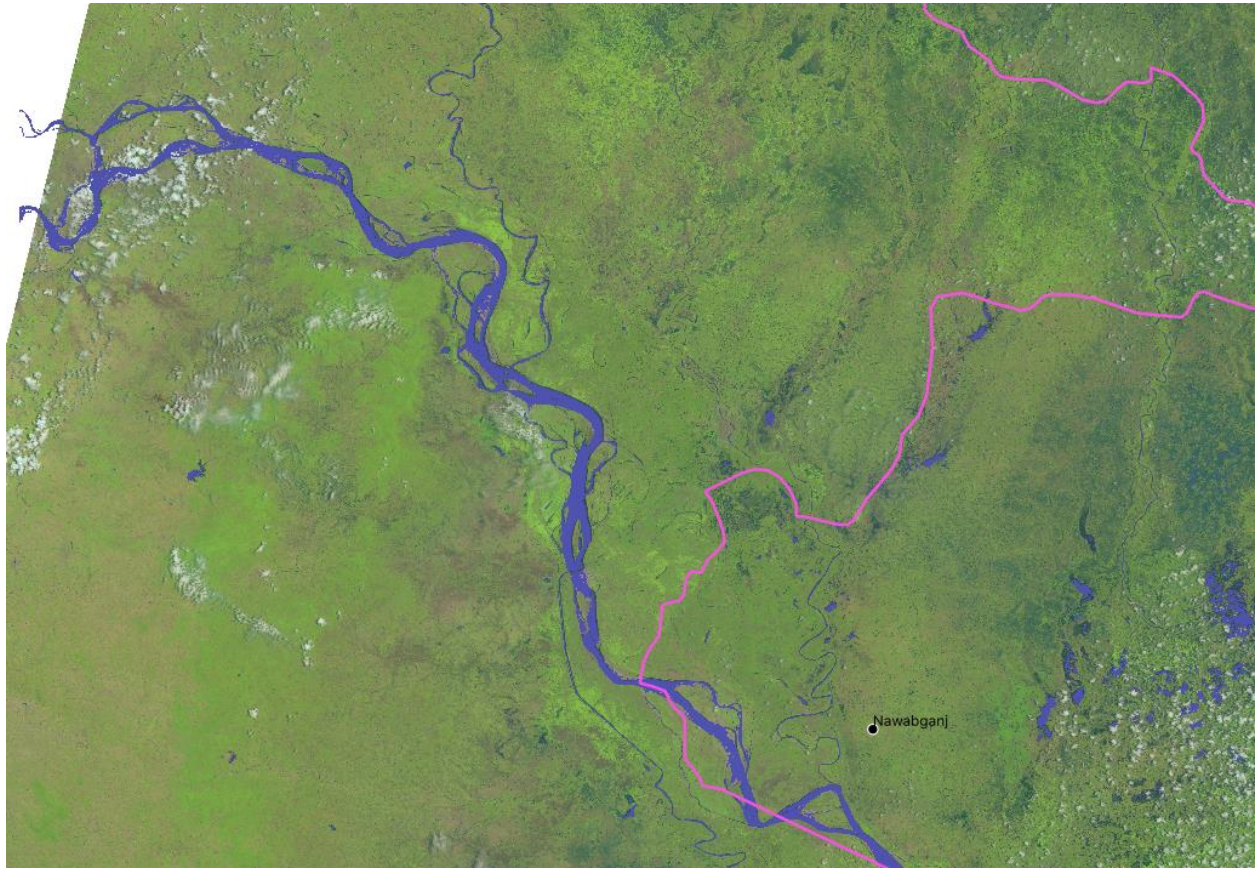
Orange lines correspond with dates of low and high-water extents shown in previous slides

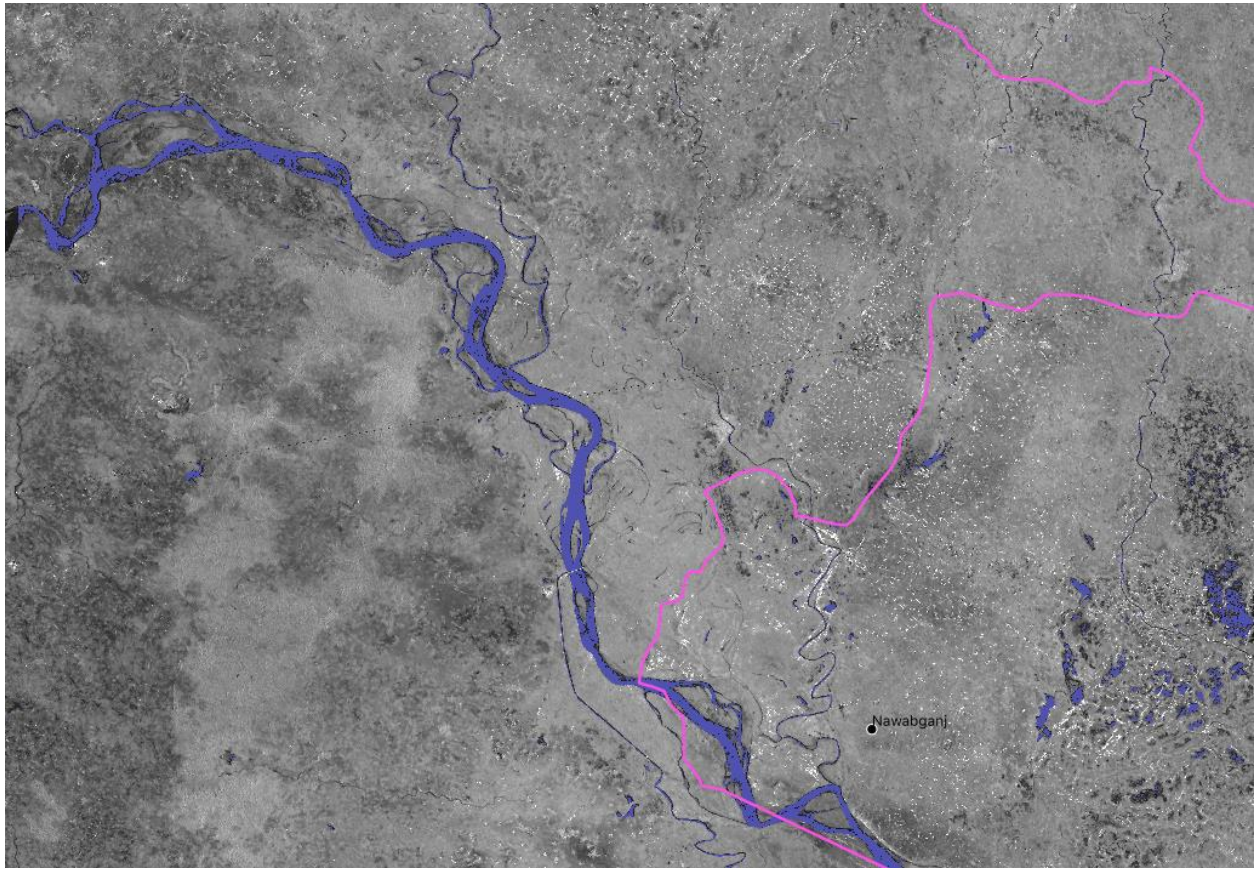


Number of days a pixel was flagged as water over the study period.

- Given the variation of time between overpasses, this chart is an approximate length of time water is detected at a pixel

Comparison S1/S2 – Pre-event, 8/12 June 2020



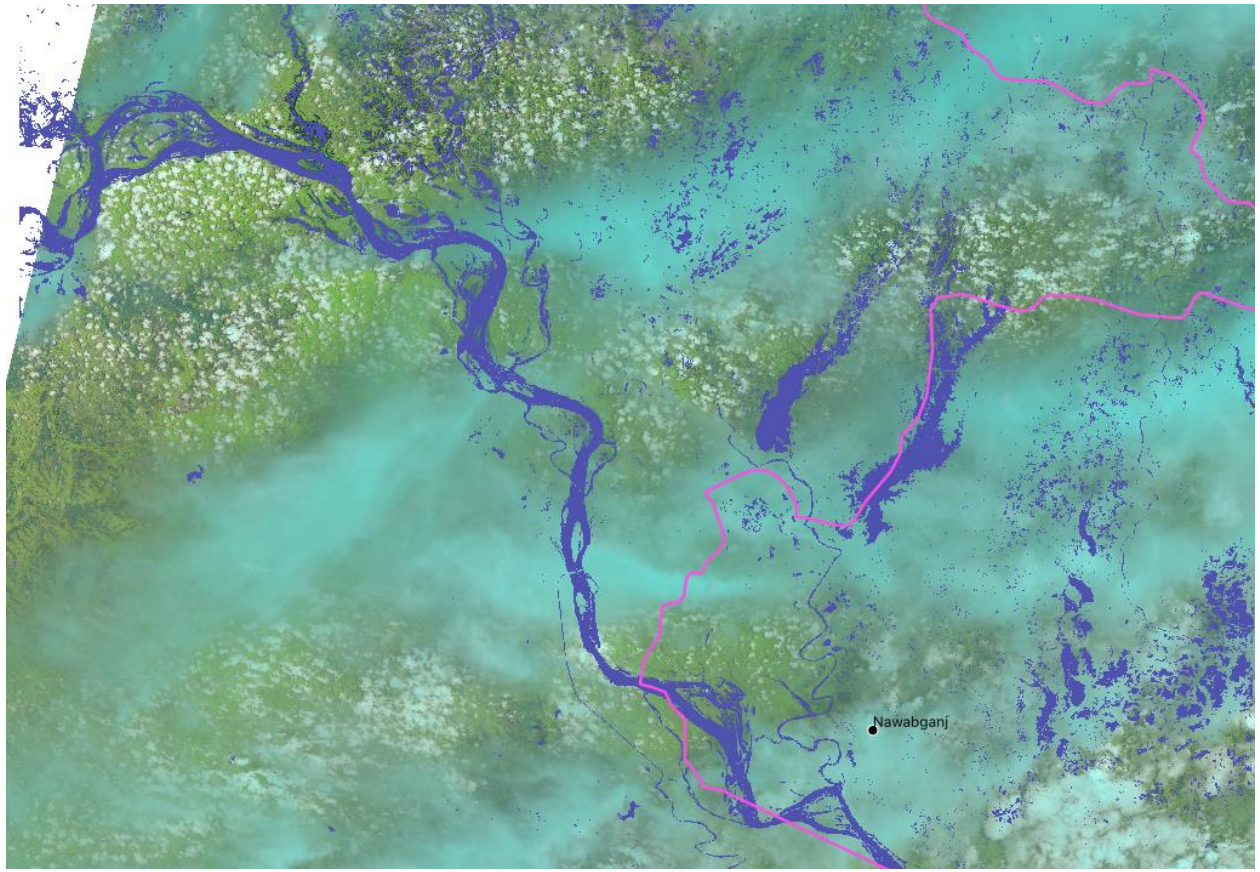


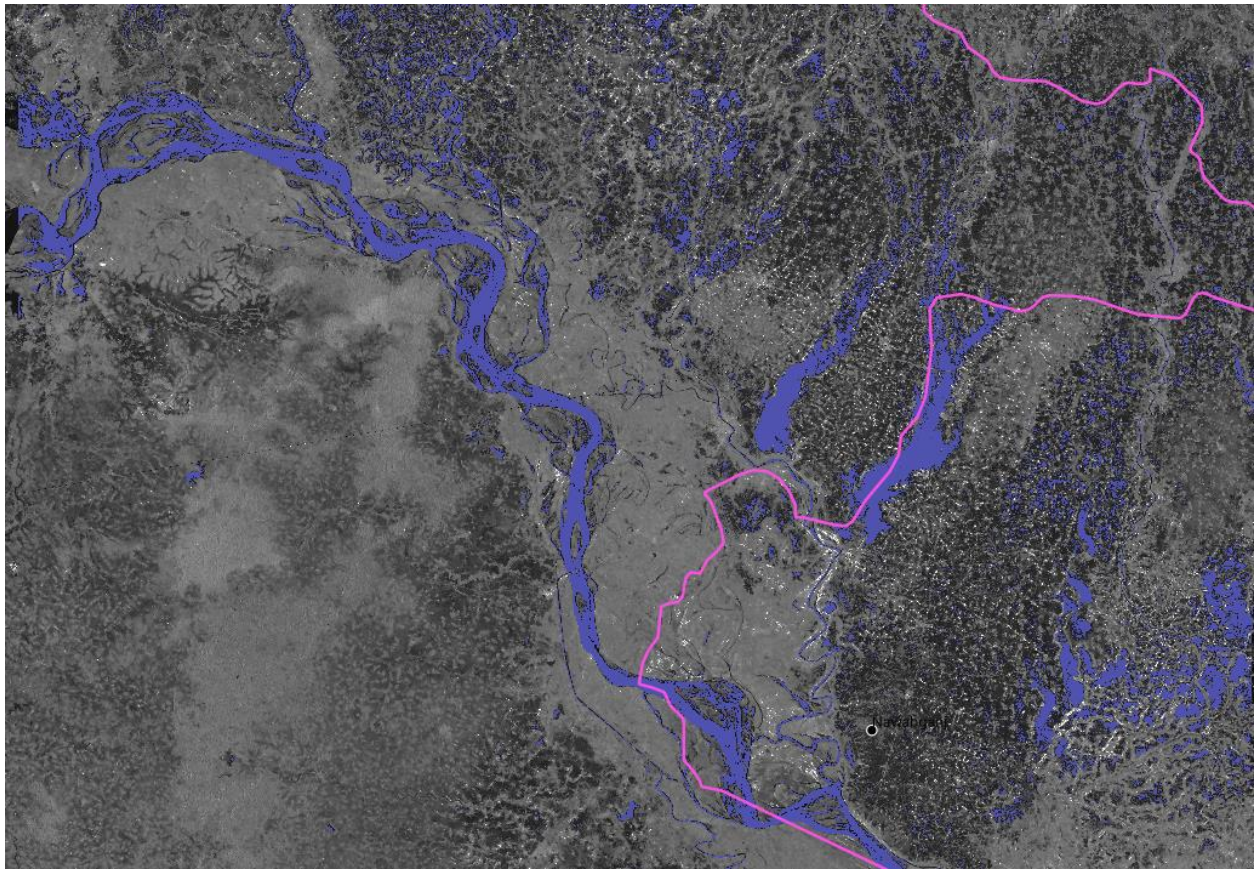
Sentinel 2A Natural Color RGB 8 June @ 043711 UTC

Sentinel 1 VH-Amplitude 12 June @ 121257 UTC

With Surface water masks

Comparison S1/S2 – 18 July 2020



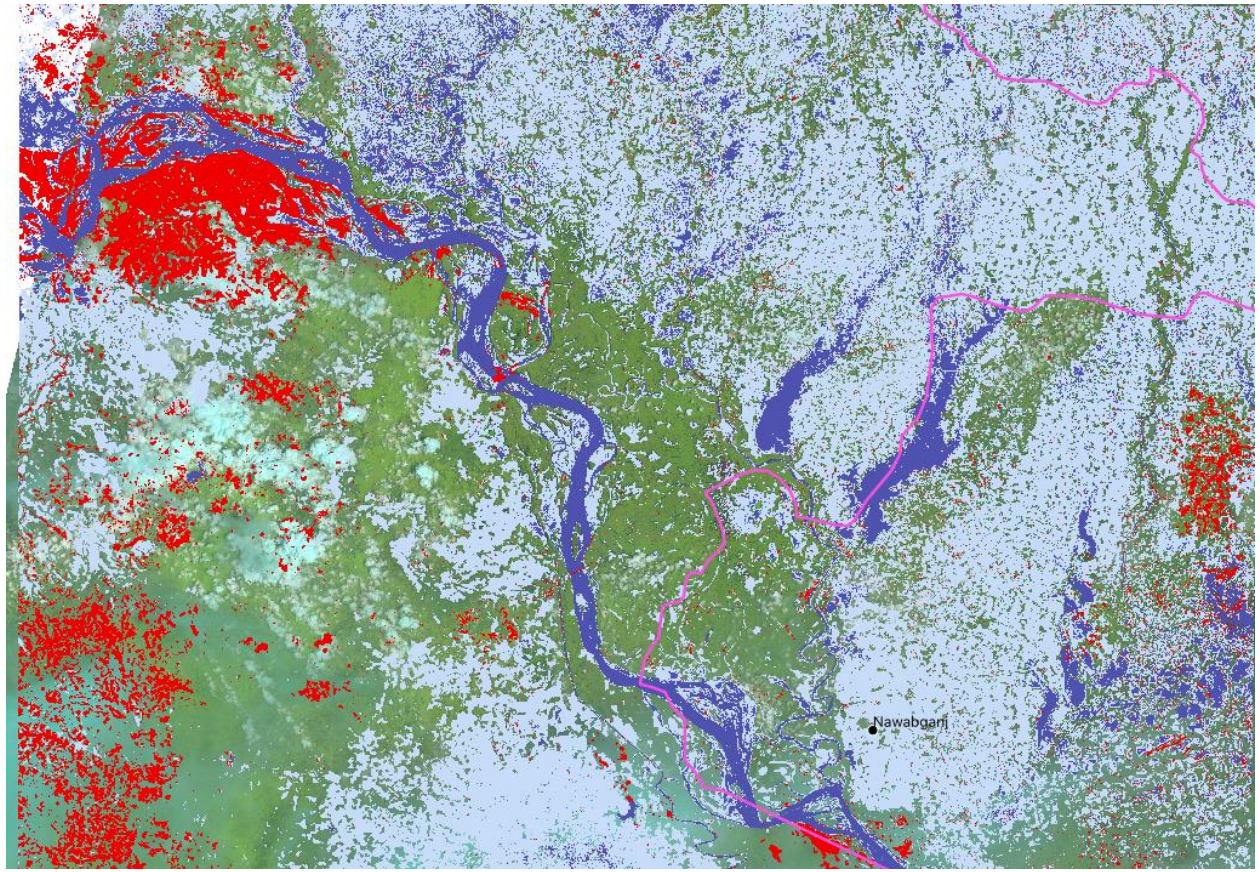


Sentinel 2A Natural Color RGB @ 043711 UTC

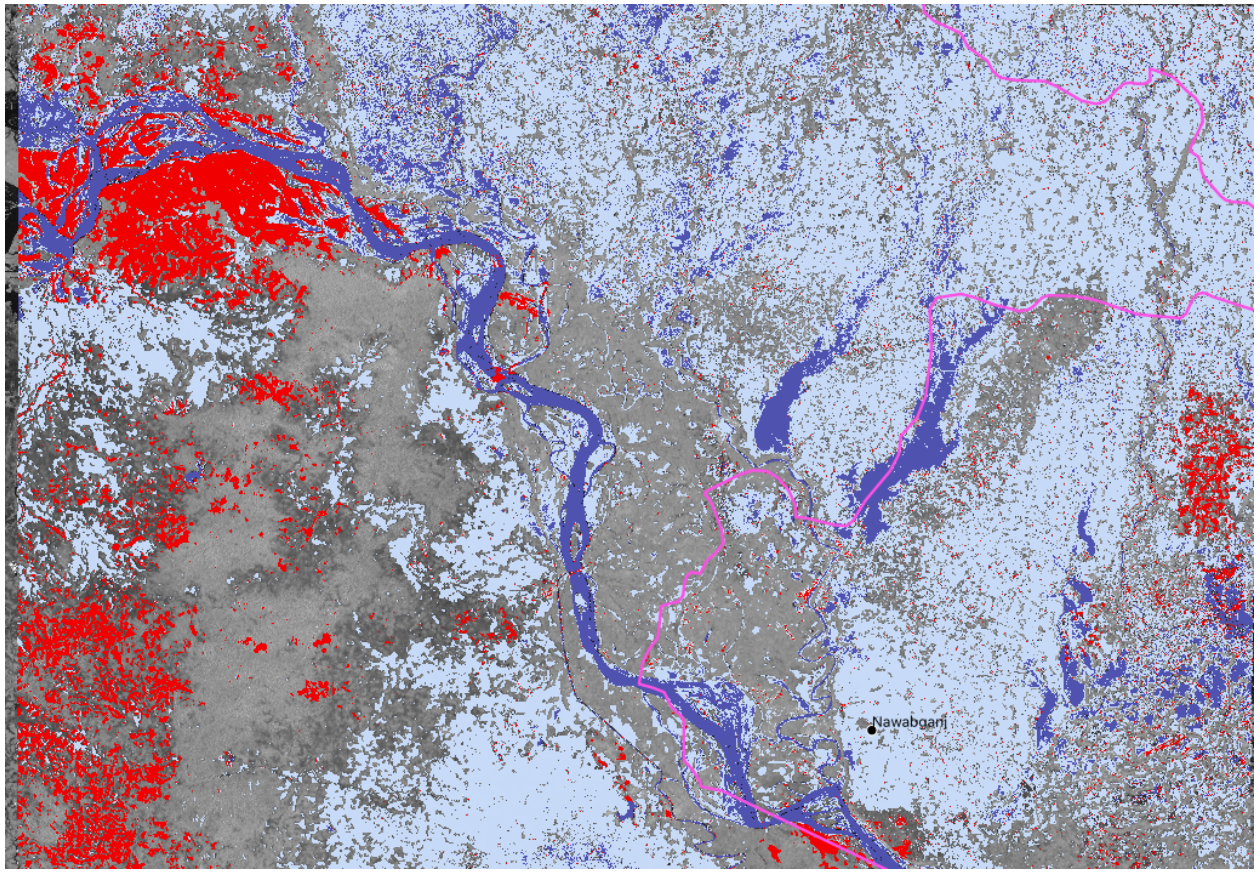
Sentinel 1 VH-Amplitude @ 121259 UTC

Change Detection Retrieval compared with 12 June 2020

Comparisons S1/S2 – 2 August 2020



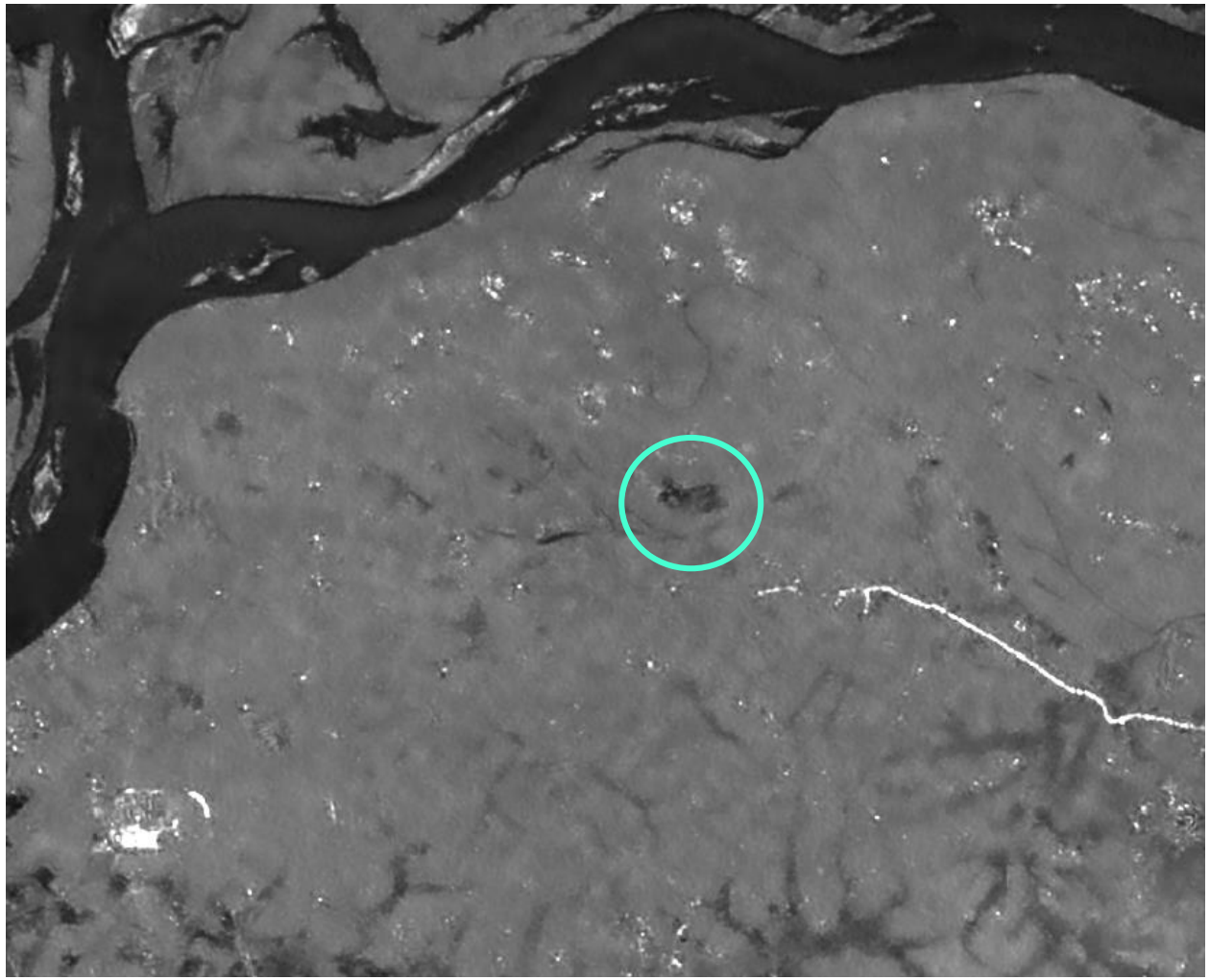
Sentinel 2A Natural Color RGB @ 043709 UTC



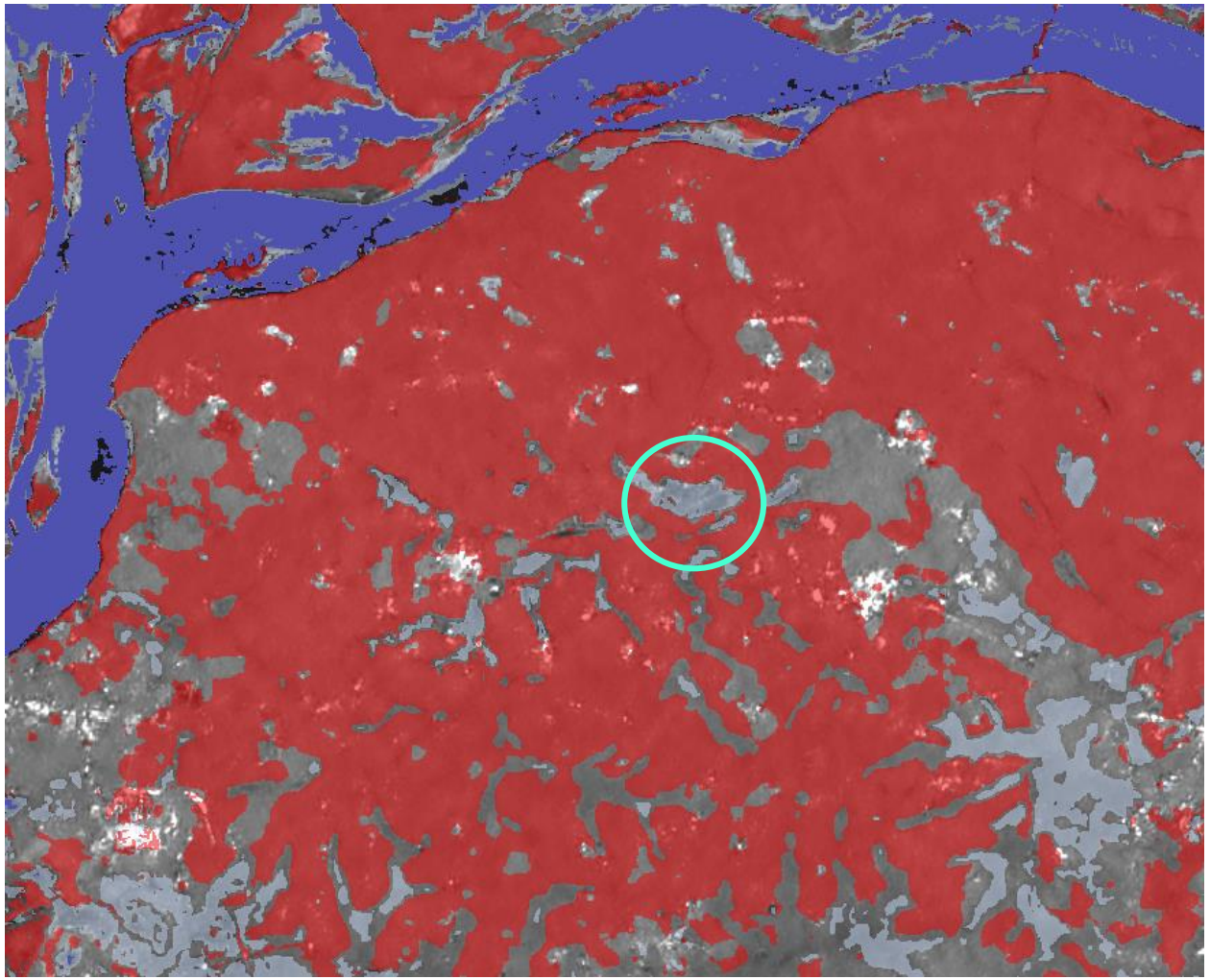
Sentinel 1 VH-Amplitude @ 000333 UTC

Change Detection Retrieval compared with 12 June 2020

Open Water versus Inundated Vegetation



VV Amplitude image – 12 June 2020

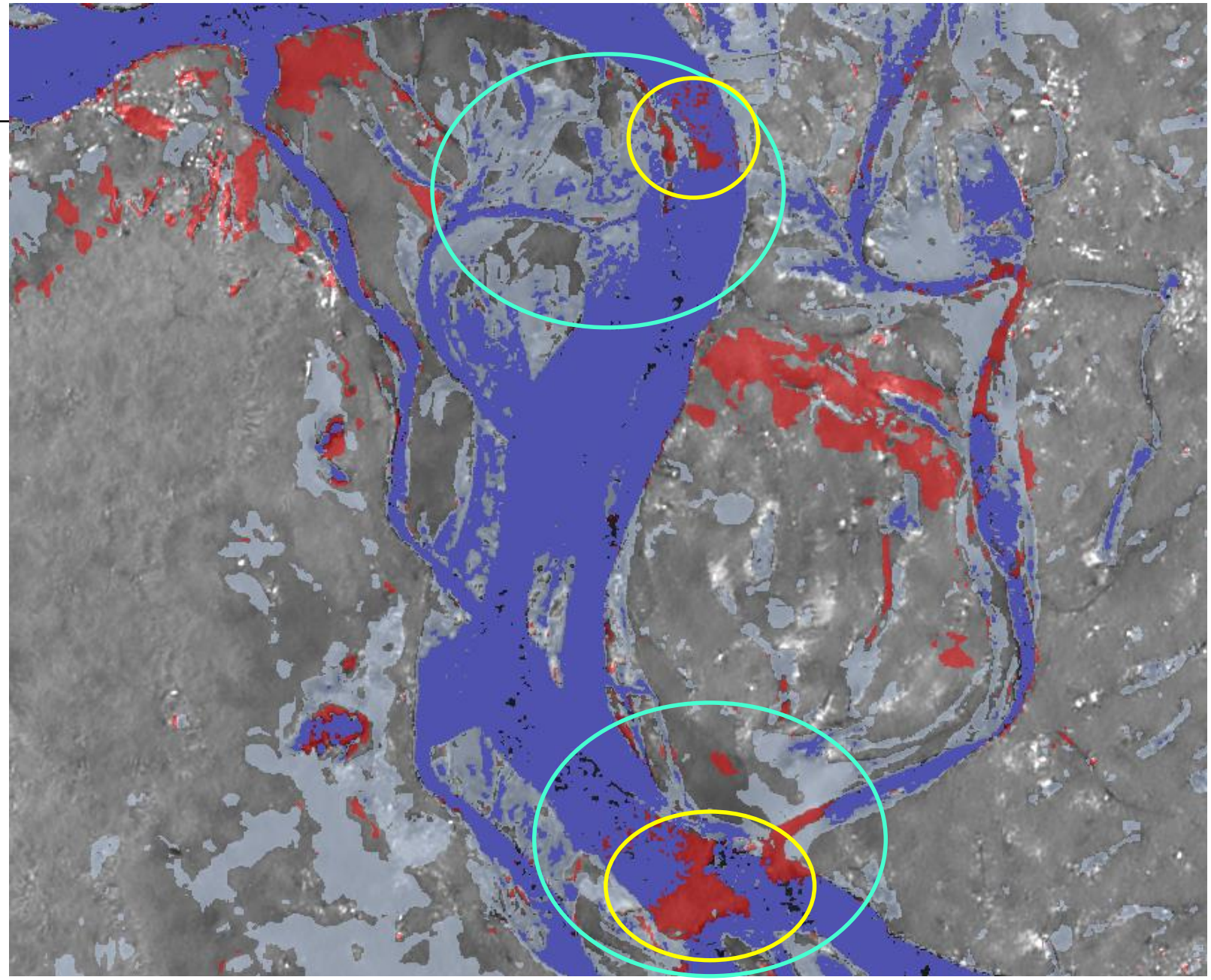


VV Amplitude image – 2 August 2020

Weather affects

2 August 2020 - VV Amplitude

- Surface water extents show a ‘gap’ in retrieval
- Bit of haze is apparent in the SAR image
- Combining the surface water extent algorithm along with the change detection retrieval results in higher probability of detection of the surface water
  - Need to continue testing to better understand how to automate the correct signal – brighten (red) or darken (blue)



Summary

- SAR-based retrievals of flood extents provides substantially more information over the period than optical alone
- Optimal conditions would allow for both optical- and SAR-based retrievals to be used together
- For days that had same-day collections, qualitative analysis showed good agreement of water extent areas

- Next steps
  - Identify additional sources of validation/verification information (ground stations, local reports) especially for the inundated vegetation areas not easily detectable from satellite sources
  - Identify additional satellite resources (Planet, Landsat 8) for additional looks across the domain

- What ideas come to mind across the HKH domain?

QUESTIONS?

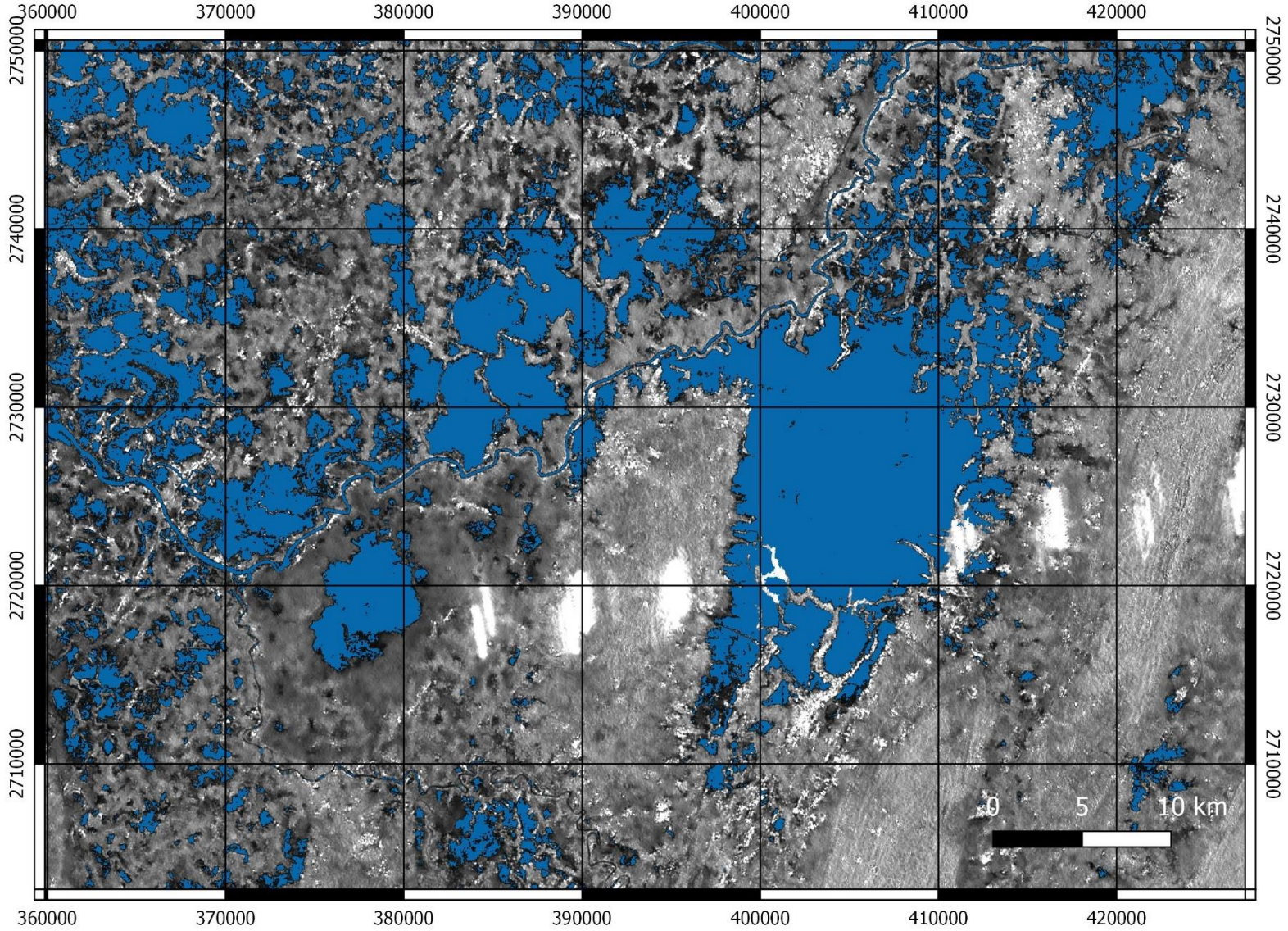
BACK-UP SLIDES

Surface Mapping Product

Performance Assessment

- **Flood mapping Performance**
  - Site: Bangladesh flood 2017

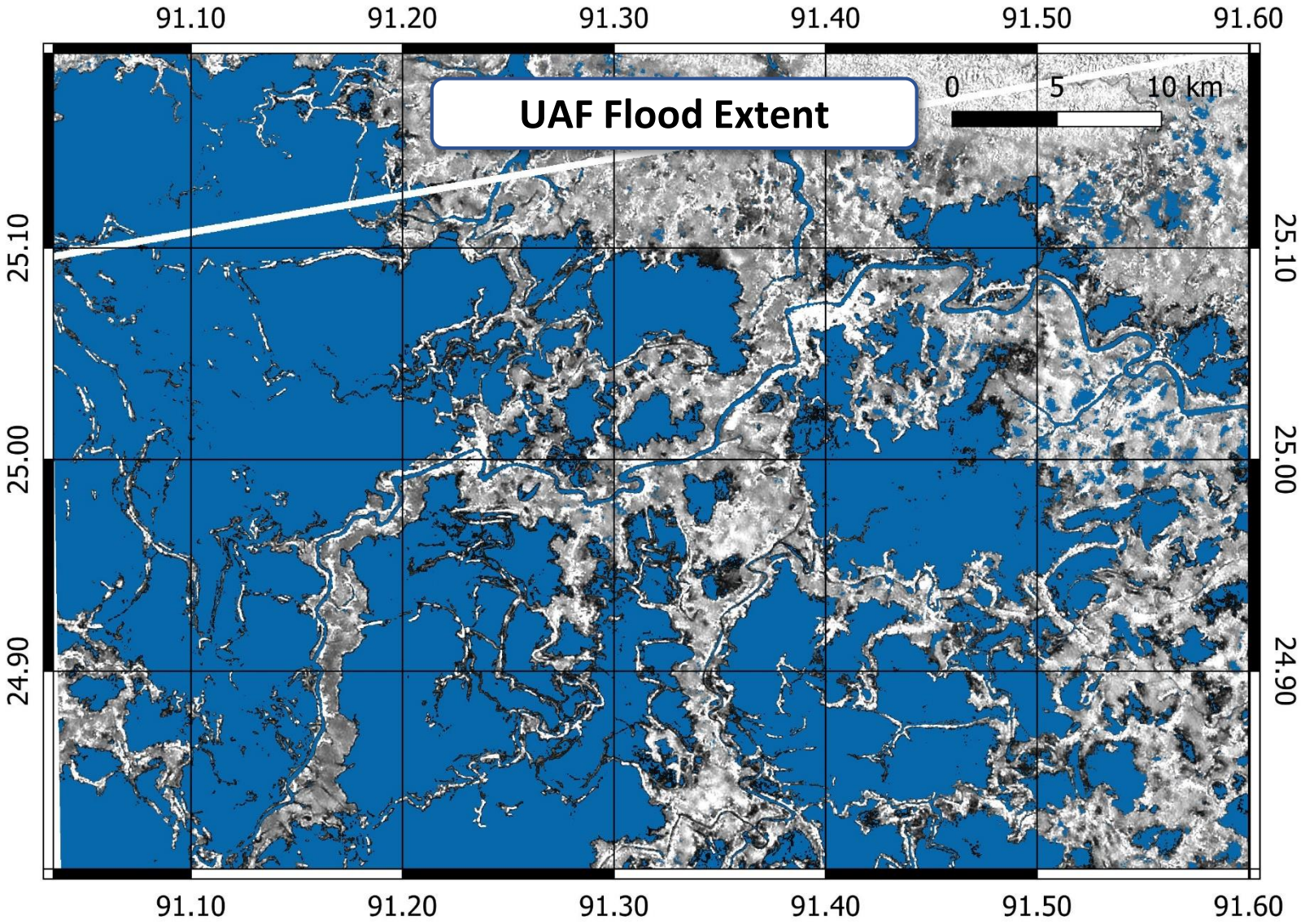
- **Example**
  - April 07, 2017
  - UAF Flood mapping Product (beta)



Surface Mapping Product

Performance Assessment

- **Flood mapping Performance**
  - Site: Bangladesh flood 2017

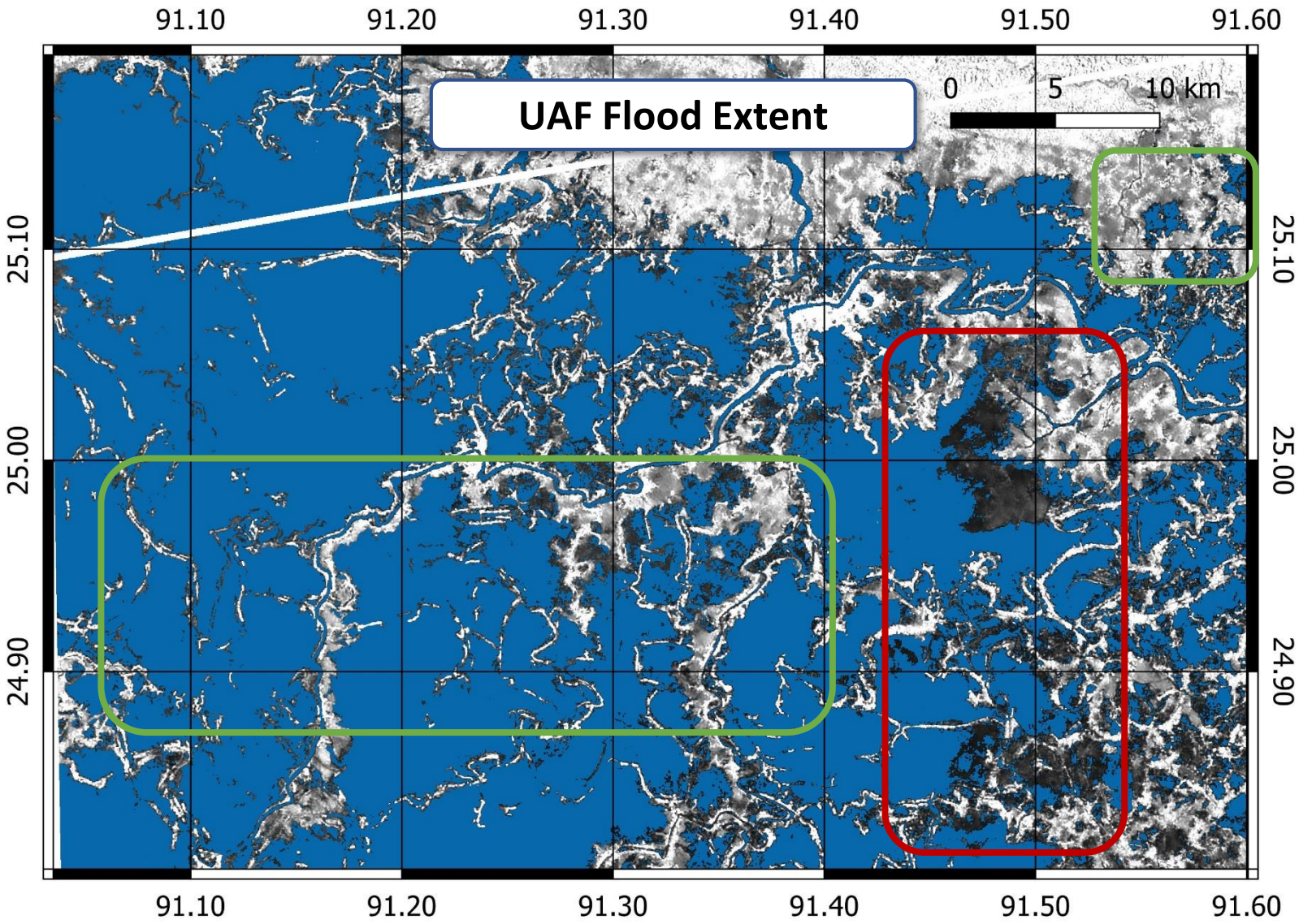


- **Comparison to Reference Data**
  - Source ICIMOD
  - Date Range: April 2017

Surface Mapping Product

Performance Assessment

- **Flood mapping Performance**
  - Site: Bangladesh flood 2017



- **Comparison to Reference Data**
  - Source ICIMOD
  - Date Range: June 2017