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Water depth estimate and flood extent enhancement using GFM

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COPERNICUS EMERGENCY MANAGEMENT SERVICE

GloFas & GFM annual meeting
5-6 March 2024 – Online

GFM layers: water observations

Flood extent

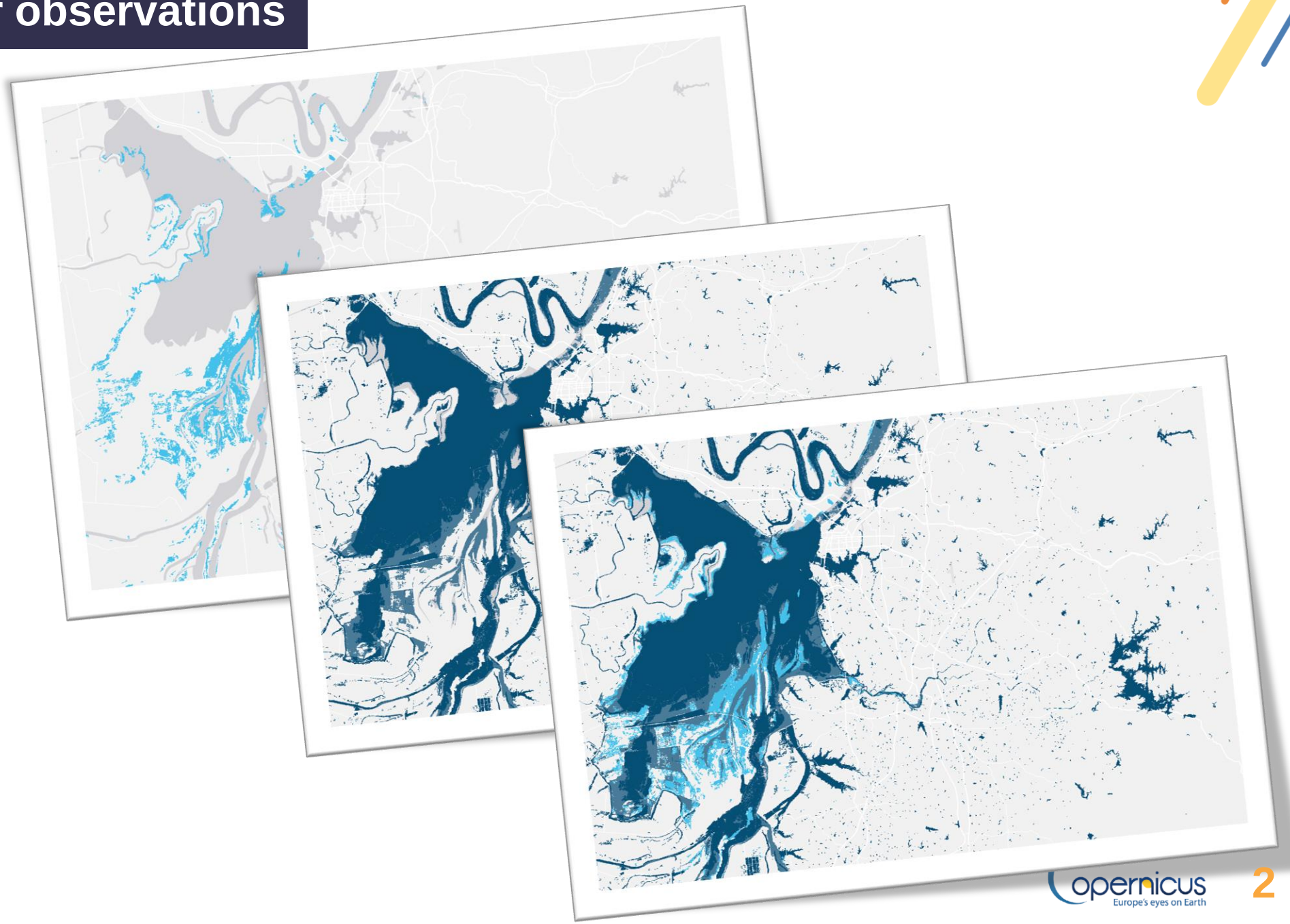
Ensemble flood extent

Water mask

Permanent & seasonal water

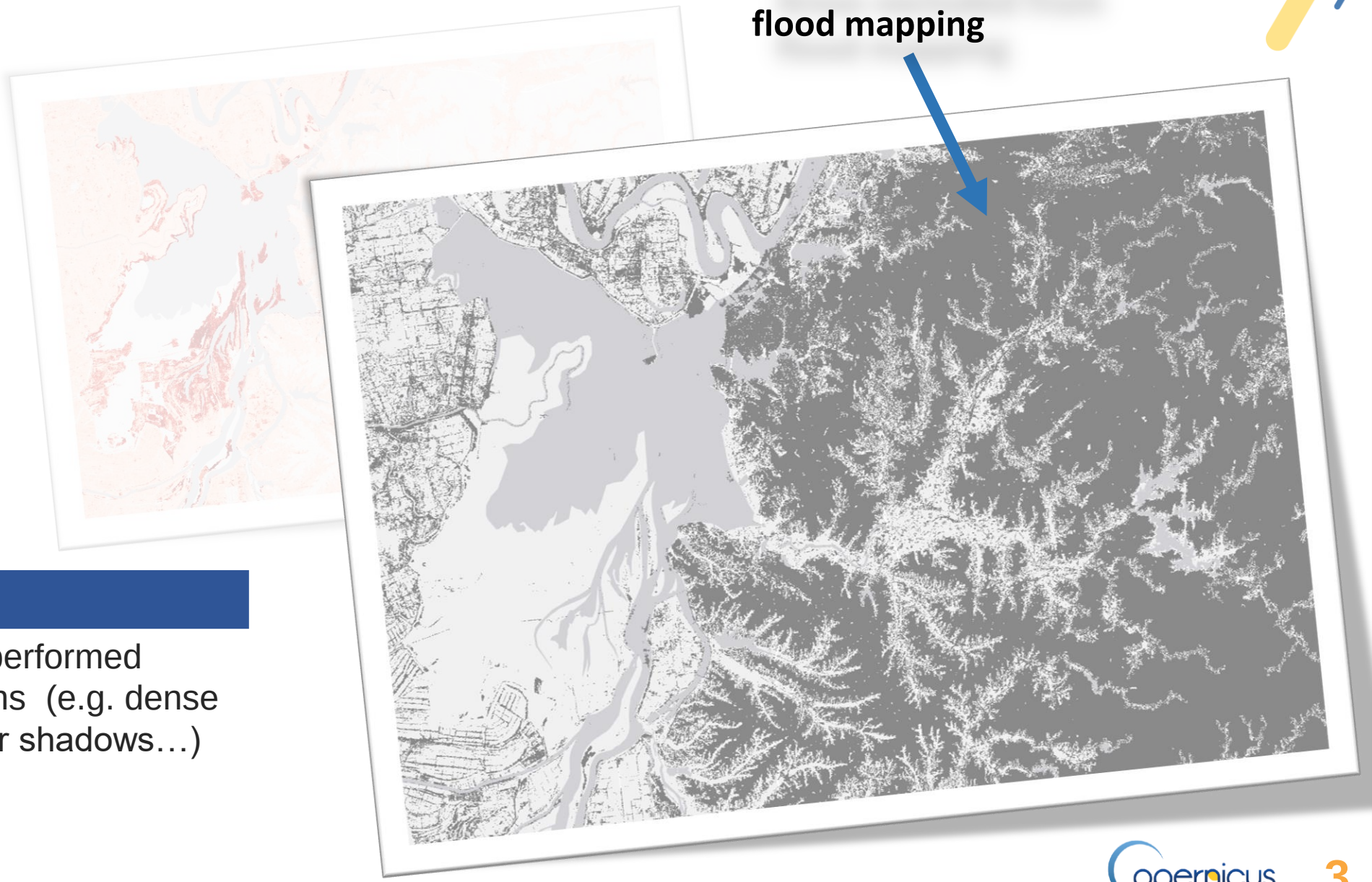
Water extent

Water extent = flood + water mask



GFM layers: additional information

Areas excluded from flood mapping



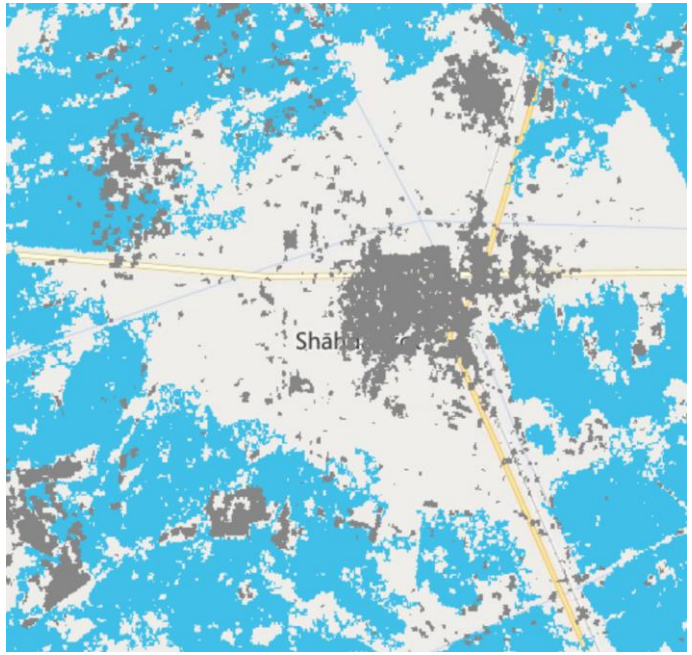
Likelihood values

Confidence in flood classification

Exclusion mask

Where flood mapping is **not** performed because of technical limitations (e.g. dense vegetation, urban fabric, radar shadows…)

Advances in Flood Mapping with GFM



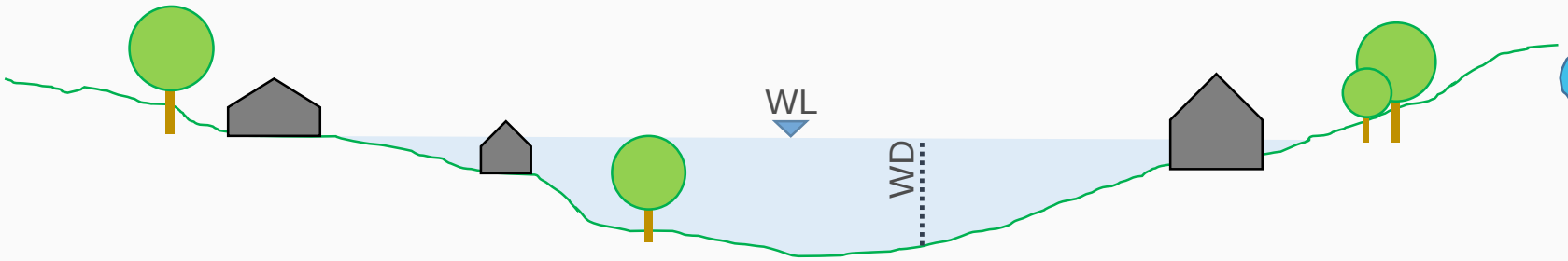
GFM is great but…

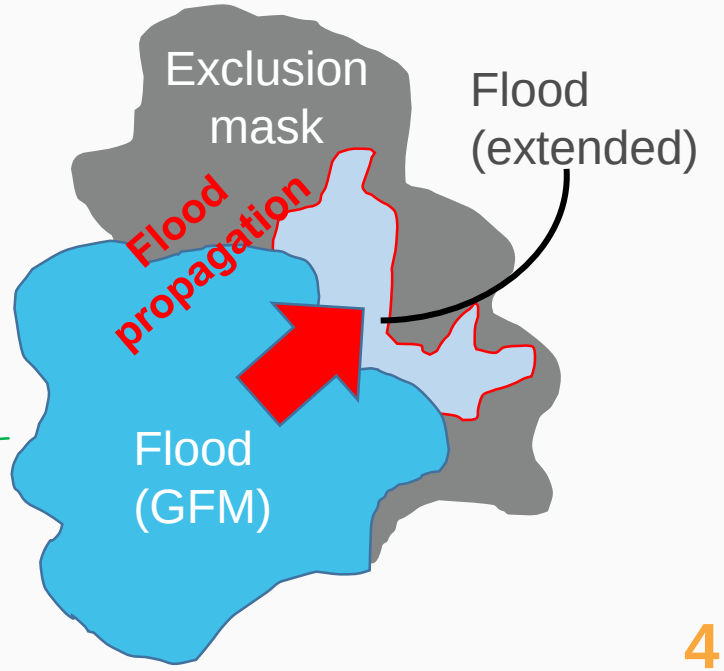
- Does **NOT** map floods in some conditions (*Exclusion Mask*)
- Provides flood extent but **no flood depth**

Goals

Combine GFM with topographic data (*DTM*) to…

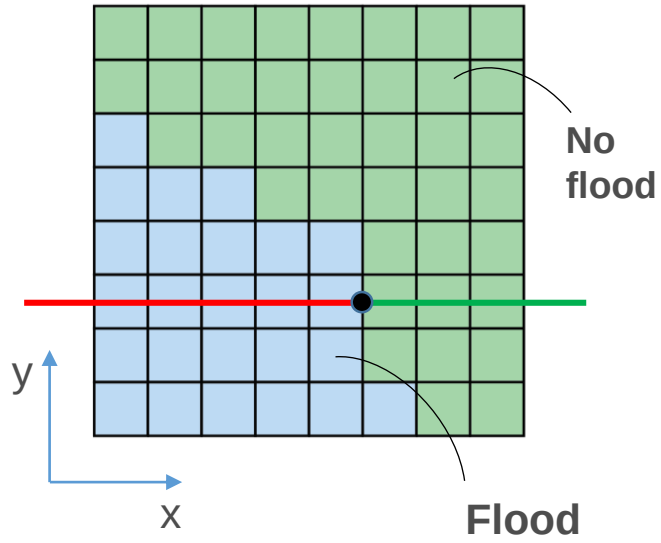
1. **Extend flood delineation** into excluded areas where flood water is expected due to lower altimetry.
2. **Estimate water levels (WL) and water depths (WD)**



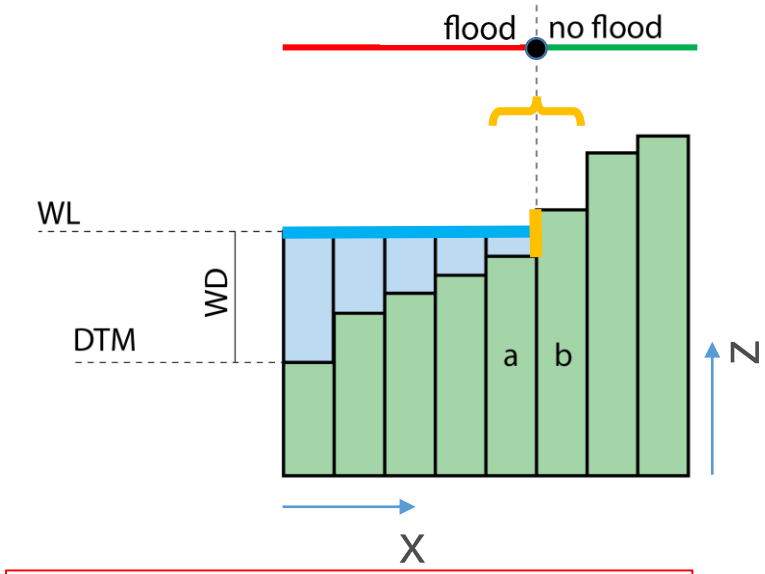


1. Water level estimate

The altimetry of the pixels along the border can be used to estimate the water level inside flooded areas



DTM



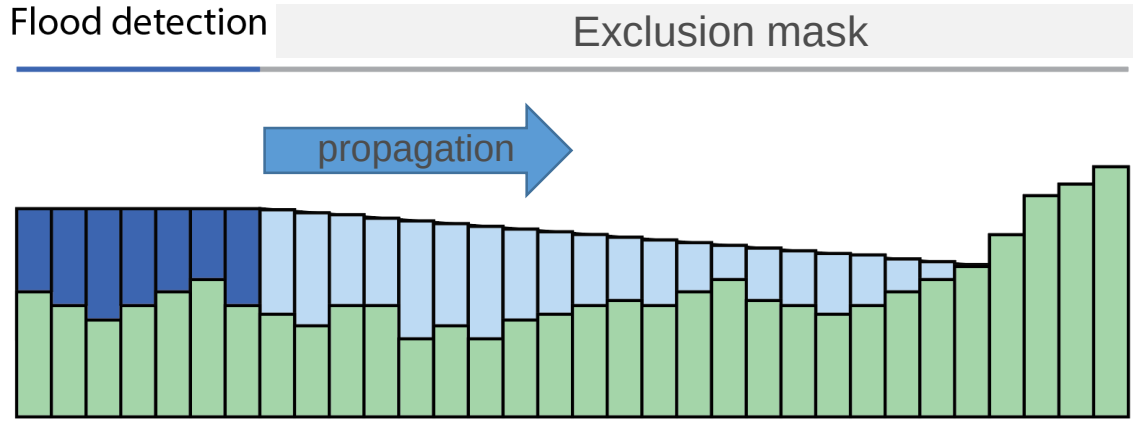
$$WL \in mean(DTM_a, DTM_b)$$

Steps:

1. All borders of flooded areas are identified
2. Borders shared with water bodies and excluded areas are removed
3. Elevation of the remaining borders is used to interpolate water levels

2. Flood propagation in the exclusion mask

Once water level is estimated, flooded areas are propagated into the exclusion mask

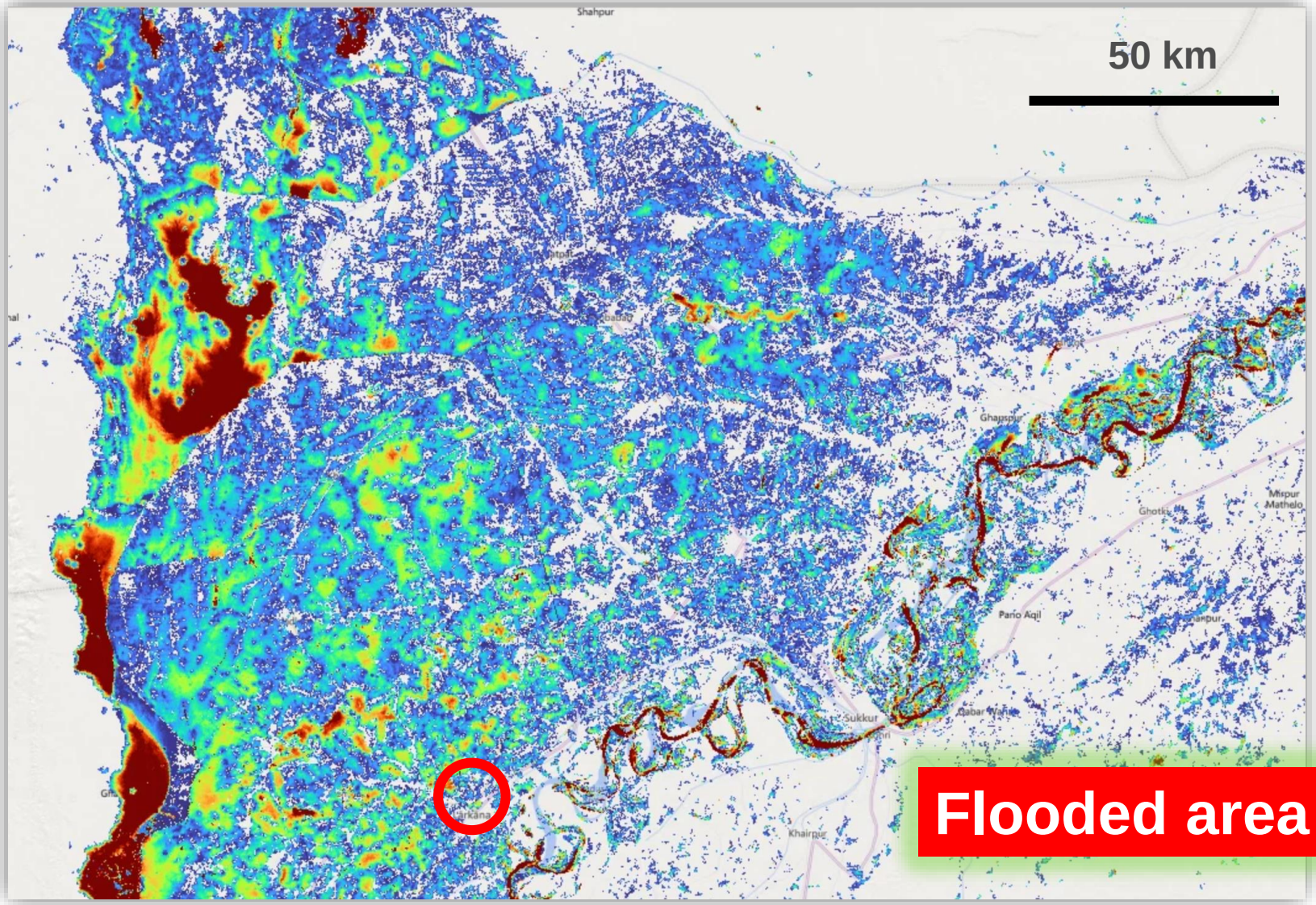


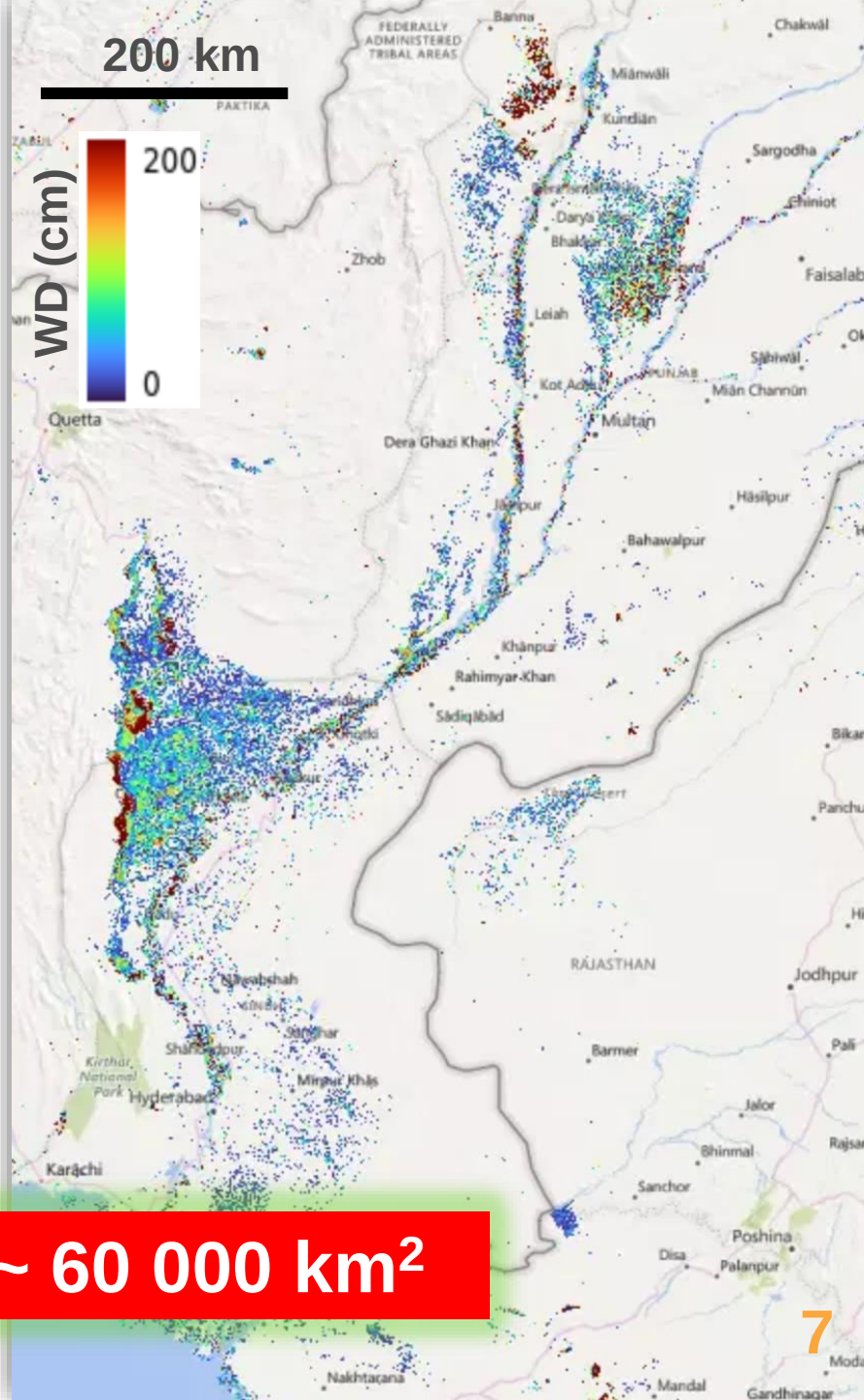
Conditions:

1. Propagation to neighboring excluded pixels where ***DTM < Water level***
2. Flood propagation up to a **maximum propagation distance (**which depends on the initial size of the area from where flood is propagating)

Water depth = Water level - DTM

Flood in Pakistan (August 2022)



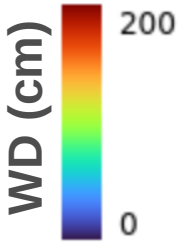


Flooded area ~ 60 000 km²

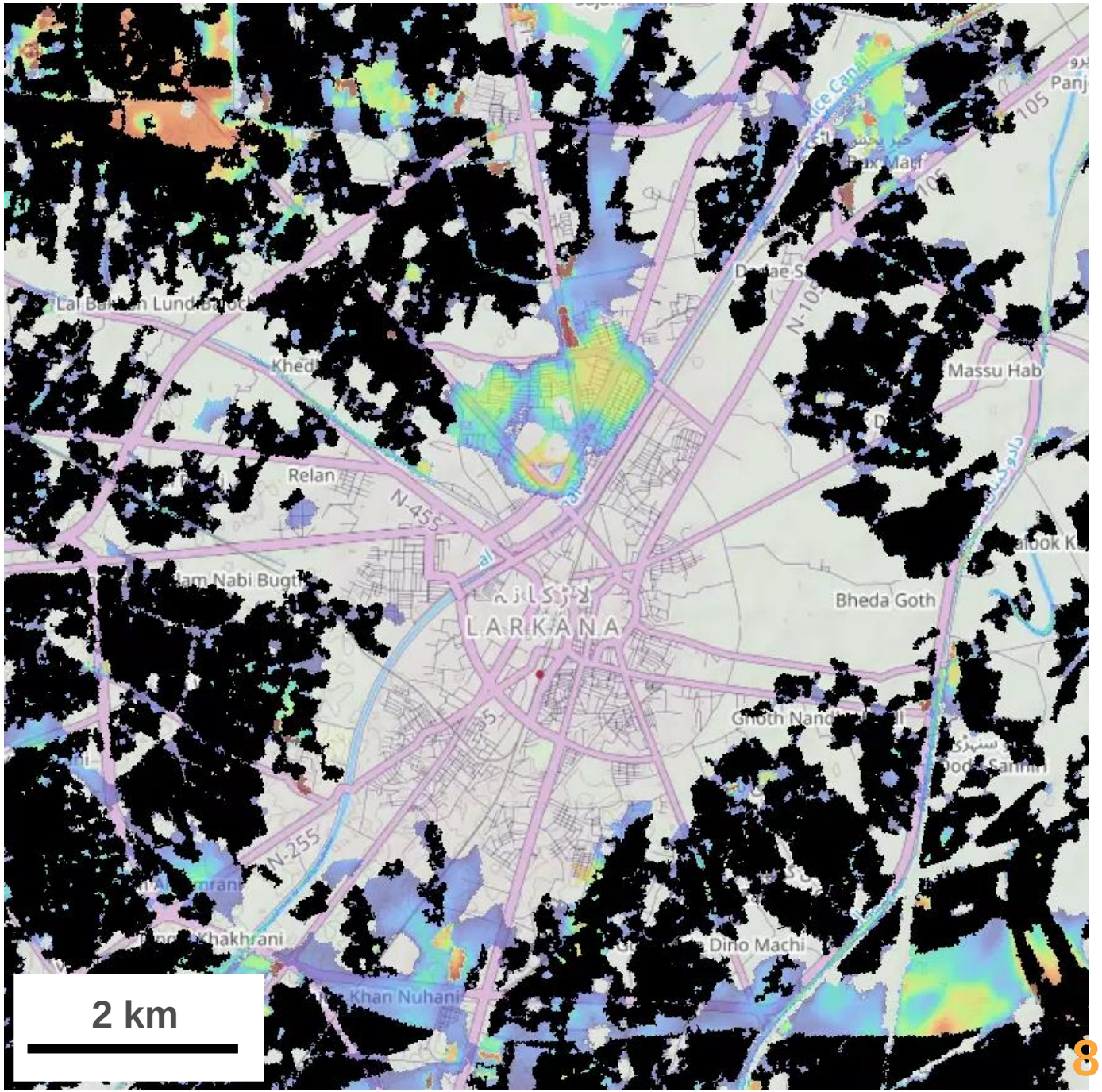
Flood in Pakistan

Initial GFM flood delineation

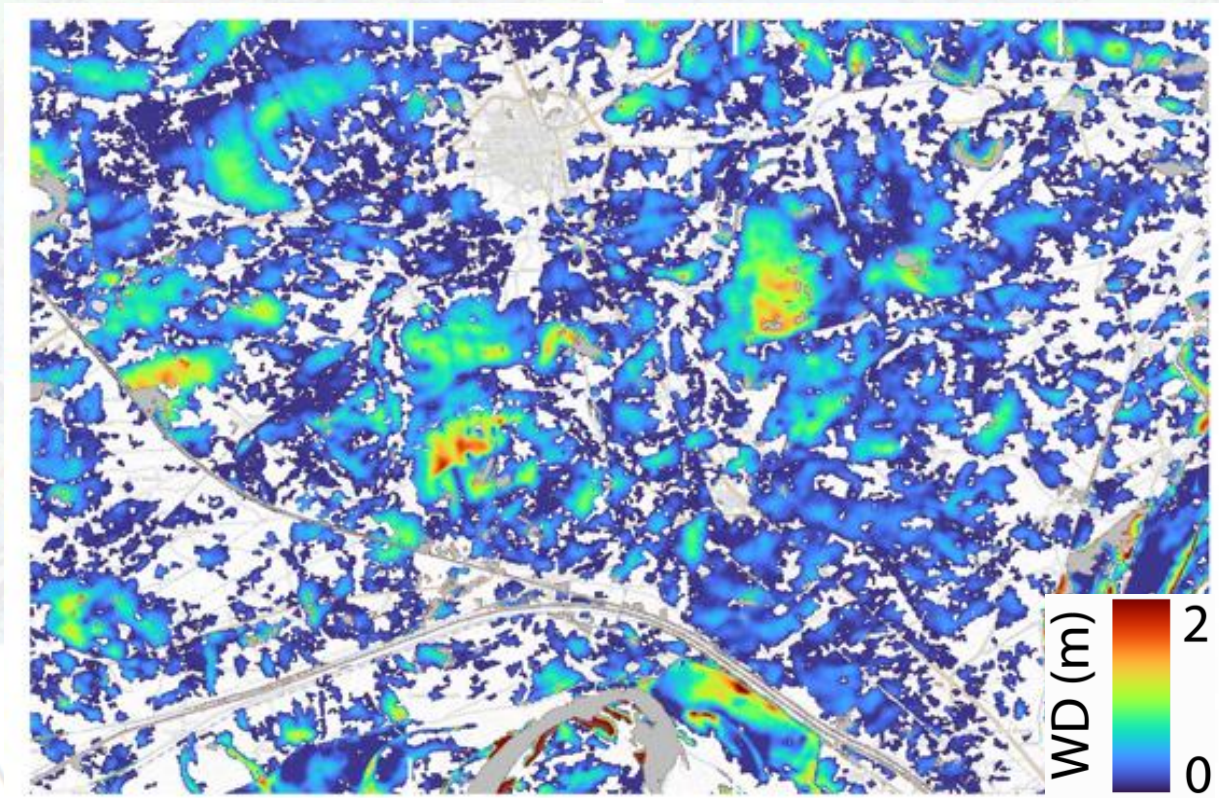
Extended flood delineation + Water depth estimate



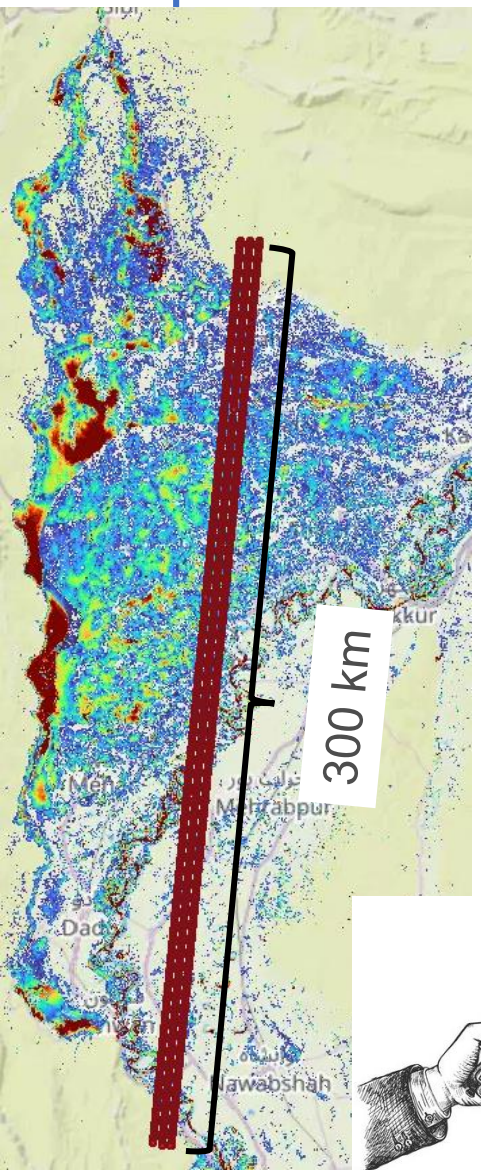
- ✓ Expansion of floods in urbanized areas (impacts expected)
- ✓ Reasonable water depth estimates



Performances – Flood classification results

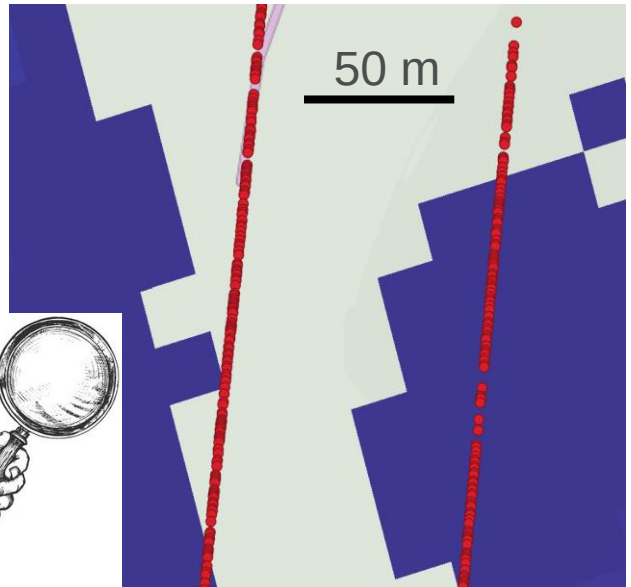


Performances – Water depth



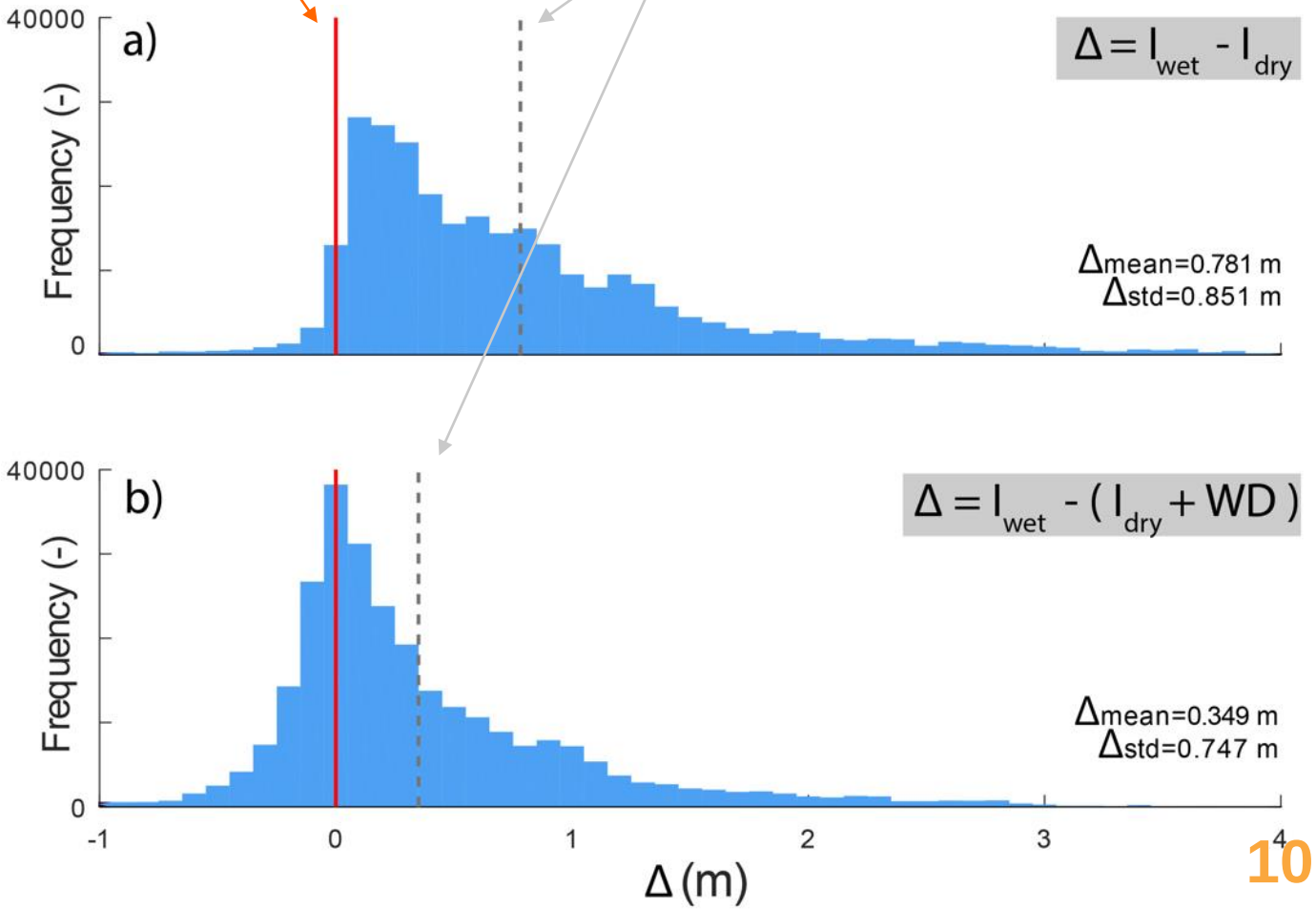
ICESat-2 :

- space borne lidar
- 90 days revisit time
- Accuracy: ~ 5 cm
- Data density: ~ 1 point/m



Error = 0
(ideal case)

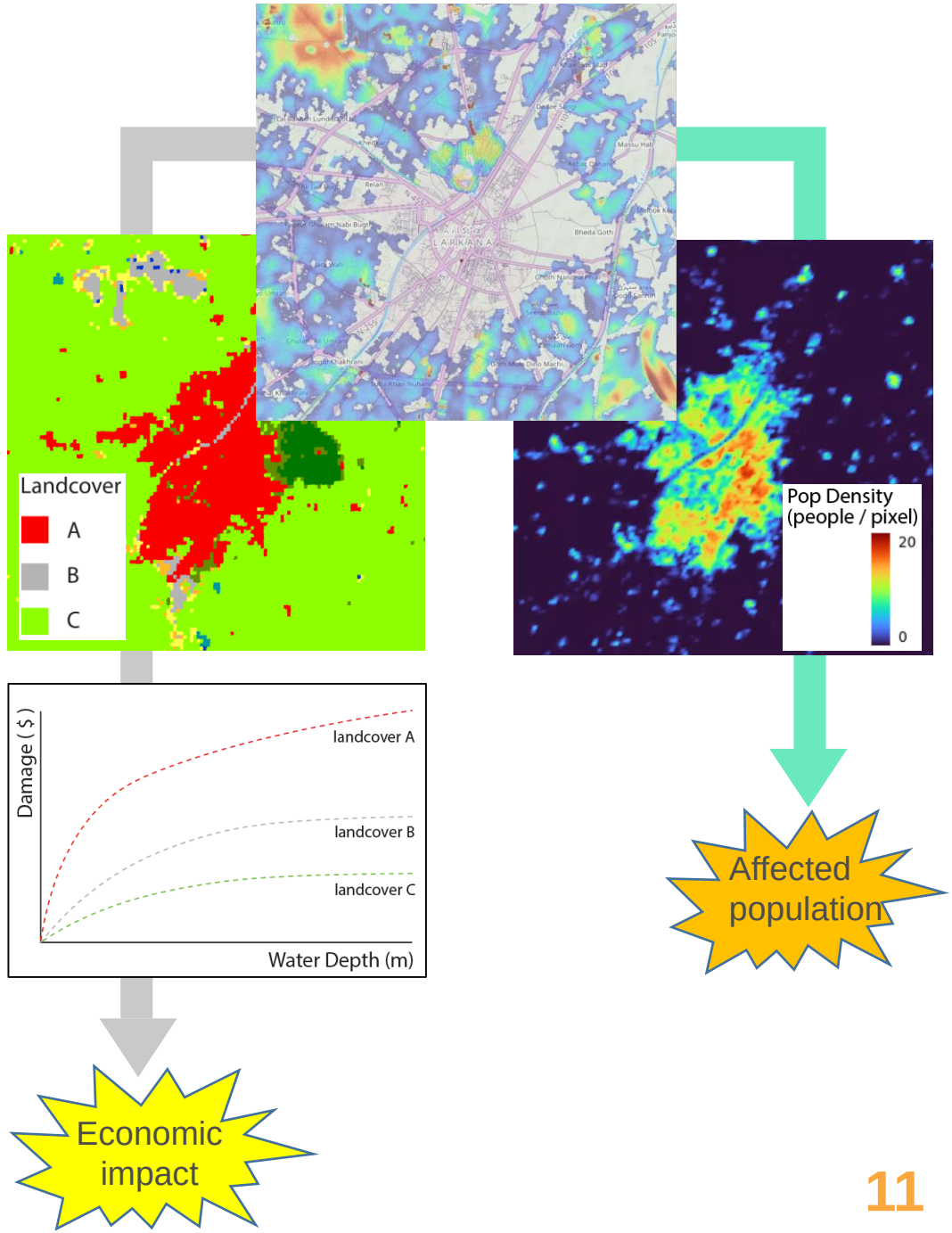
Bias is reduced when WD estimates are added on top of the non-flooded altimetry



Conclusions

Promising framework to enhance flood delineation (flood propagation + water depth estimation)

- On a large scale
- With minimum supervision
- Reasonable computational times



<u>Ongoing:</u>

1. Flood database (from 2015 onward)
2. Impact assessment (historical & real-time)

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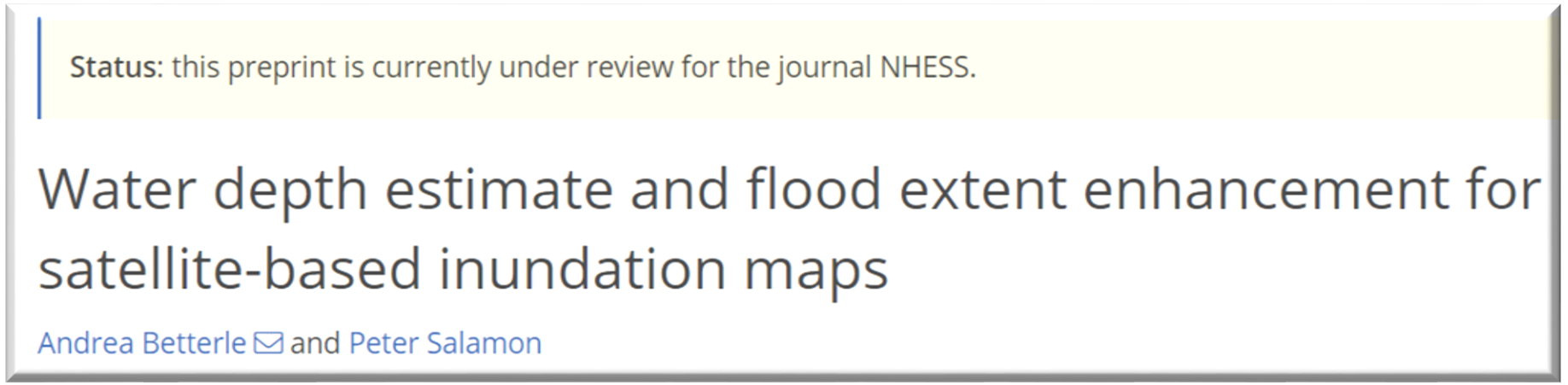

Status: this preprint is currently under review for the journal NHESS.

Water depth estimate and flood extent enhancement for satellite-based inundation maps

Andrea Betterle and Peter Salamon