National Aeronautics and Space Administration

Postdoc Research

High-cadence River Width Measurements from the OPERA Dynamic Surface Water Extent Product

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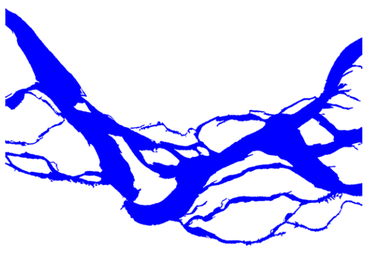
Background

Water stress is one trigger to conflict. Bringing in satellite-derived river information enables the assessment of basin conditions anywhere in the world even where no *in-situ* information is available.

Approach

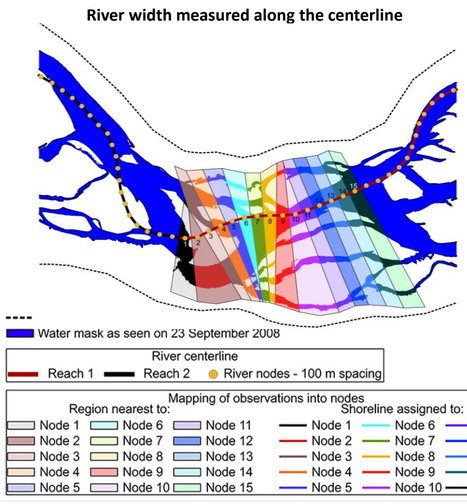
Satellite-derived Water Mask



The Water Mask is a raster derived from the OPERA Dynamic Surface Water eXtent (DSWx) product showing the presence of water in the area of interest at the time of satellite image capture.

River Processor

River width measured along the centerline



OPERA Dynamic Surface Water Extent:

- **Initially Sentinel-2 and Landsat-8 satellites with upcoming addition of Sentinel-1.**
- **Expected inclusion of NISAR and SWOT.**

→ **Snapshot of River Width in Time**

Pekel Probability Maps

[Maps how often a pixel was classified as water covered in Landsat images collected between 1984 and 2020]

- **High probability ⇨ "always" inundated ⇨ low stage**
- **Low probability ⇨ "rarely" inundated ⇨ high stage**

→ **Benchmark for interpreting OPERA river widths**

River Processor: How is River Width calculated?

Map pixels to closest river node.

River node: equally spaced points on river centerline

$$Effective\ Width\ at\ Node = \frac{Area\ of\ Voronoi\ Polygon}{Node\ Spacing}$$

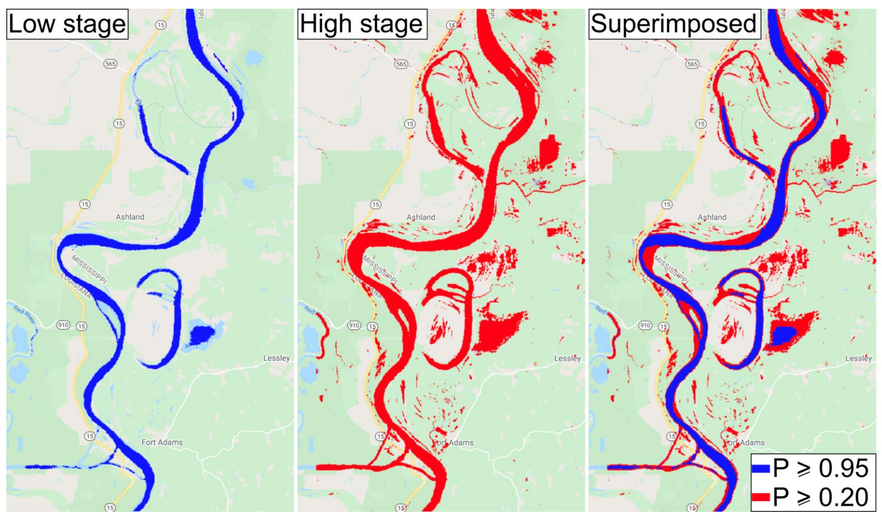
→ **River Basin Diagnostics**

Significance of Results to NASA/JPL

This work advances the mission of NASA by supporting sustainable water and natural resources management decisions.

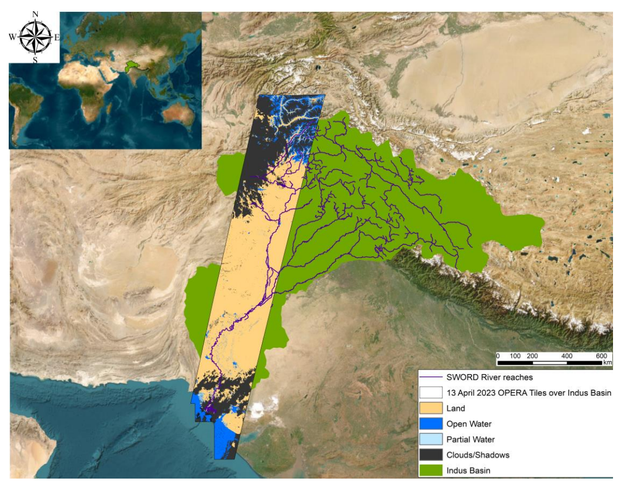
FUTURE WORK

- Use of Pekel probability (P) maps to benchmark widths for classification of new widths

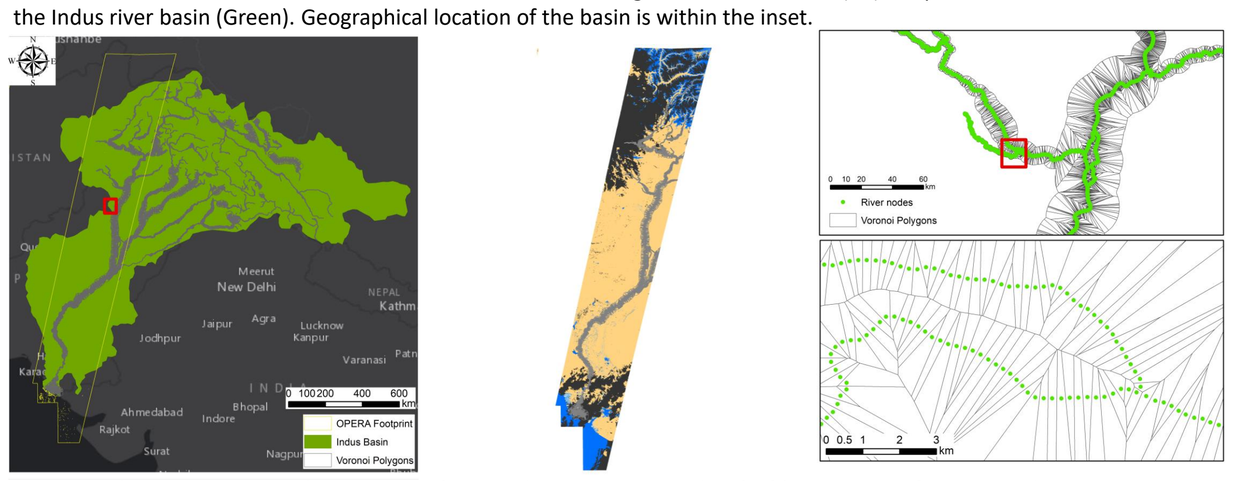


Example open water masks produced for the Mississippi River northwest of Baton Rouge under Low Stage conditions –probability of inundation ≥ 0.95 (in blue); High Stage conditions – probability of inundation ≥ 0.20 (in red); Superposition – highlighting the differences between the two masks.

Results

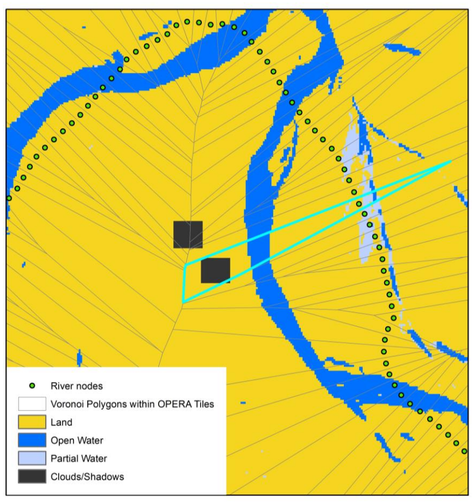


(Above Left) – NASA's EOSDIS Worldview Interactive User Interface for dynamic querying of OPERA data. This can be used to determine both image availability at a specific geographical location and trends of image availability over time before using the "OPERA Tile Downloader" for downloading imagery. (Above Right) - Study Area: OPERA tiles collected on the 13 April 2023 over the Indus River were chosen for width extraction using the River Processor (RP). Map illustrates OPERA tiles over the Indus river basin (Green). Geographical location of the basin is within the inset.



Creation of Voronoi Polygons for mapping of water observations to nodes: (Left) – Creation of Voronoi Polygons. SWORD (SWOT River Database) river centerline nodes (SWORD node product) are used to create polygons; (Middle) –Voronoi Polygons clipped to the set of OPERA image tiles; (Right) – Zoomed in views of Voronoi Polygons and SWORD nodes.

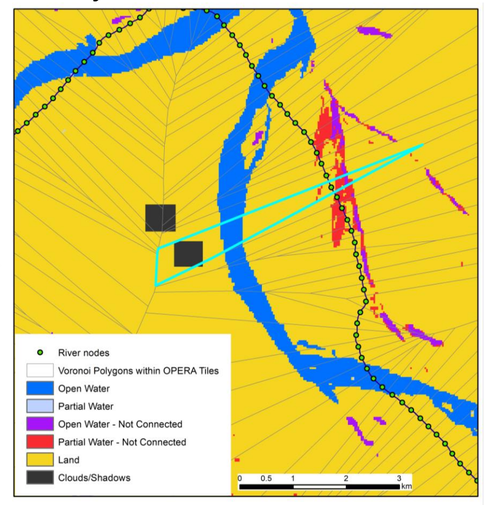
Adjacent Water bodies may bias widths

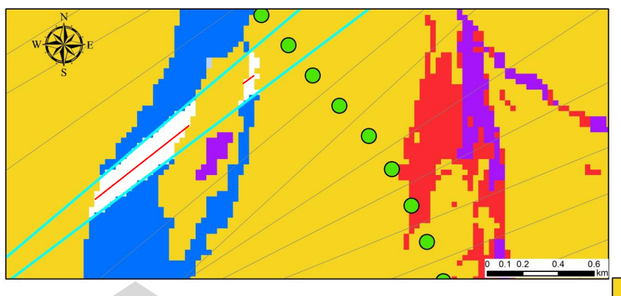


Connectivity algorithm identifies individual waterbodies.

Closest waterbody is kept for width computation (Open and partial water)

Adjacent Water bodies removed





Left: Performance Evaluation of the River Processor at an anabranching section of the Indus River. Preliminary width comparisons are made using manually digitized width values.

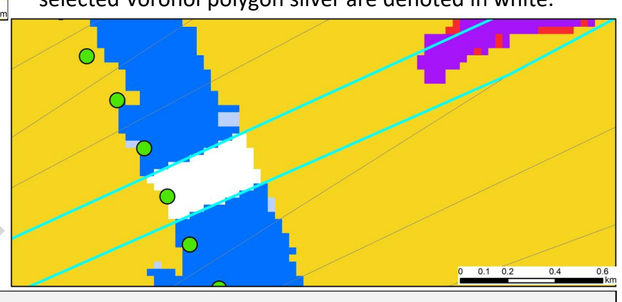
Partial and open water bodies adjacent but not connected to the main channel are represented in vermillion and purple hues. Pixels that were mapped to the node of the selected Voronoi polygon sliver are denoted in white.

River Processor: 644 m
Hand-measured: 696 m

Legend:
Cross-section
Pixels mapped to node

Right: Performance Evaluation of the River Processor at a single channel-section of the Indus River.

River Processor: 488 m
Hand-measured: 435 m



Publications and Acknowledgements:

Munasinghe, D.S.N., Frasson, R.P.M., Bonnema, M., Chan, S., Bekaert, D., Shiroma, G.H.X., and J.W. Jones, 2023. An Algorithm for Extraction of River Width from Harmonized Multi-Platform Spaceborne Sensors. In: CIROH (Cooperative Institute for Research to Operations in Hydrology) Training and Developers Conference, May 16-18, 2023. *(Poster)*

Munasinghe, D.S.N., Frasson, R.P.M., and C.H. David, 2022. Harmonizing multiplatform spaceborne water surface observations to support the US Army Corps of Engineers - Engineer Research and Development Center water intelligence assessments. In: NASA WWAO and Water Resources Meeting, October 04 - 07, 2022. *(Poster)*

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Clearance Number: CL#00-0000

Poster Number: PRD- E-036