Scenario DOCTORAL TRAINING PARTNERSHIP | UKRI Natural Environment Research Council | JBA trust | JBA consulting | Flood Foresight | University of Reading

Secondary forecast-based financing for flood impact mitigation using data assimilation

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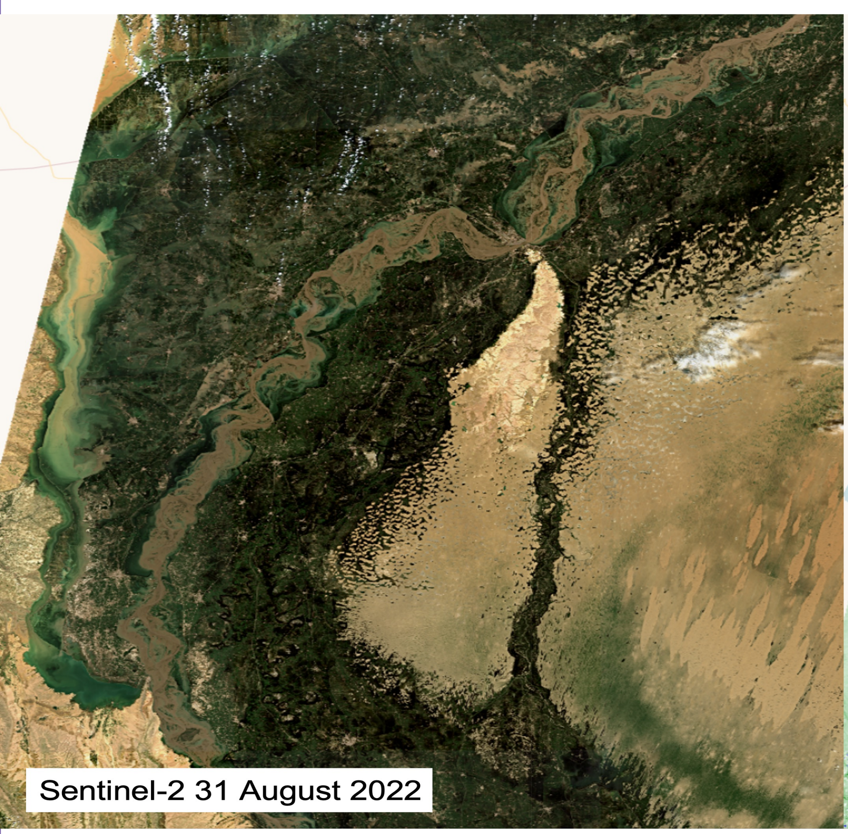
1. University of Reading 2. JBA Consulting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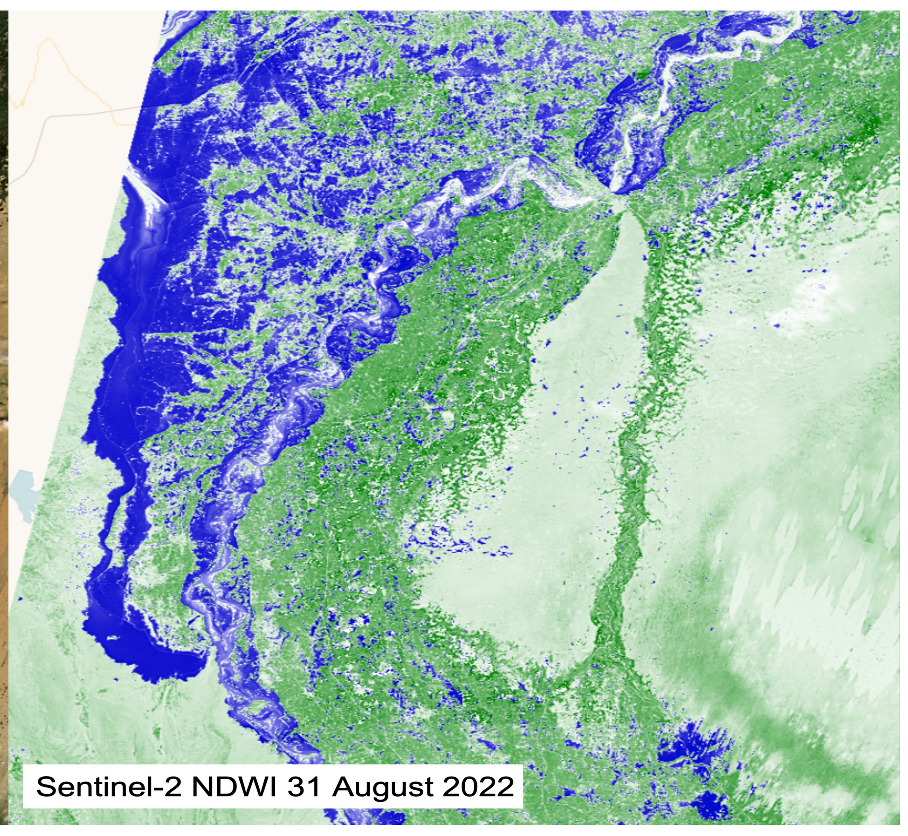
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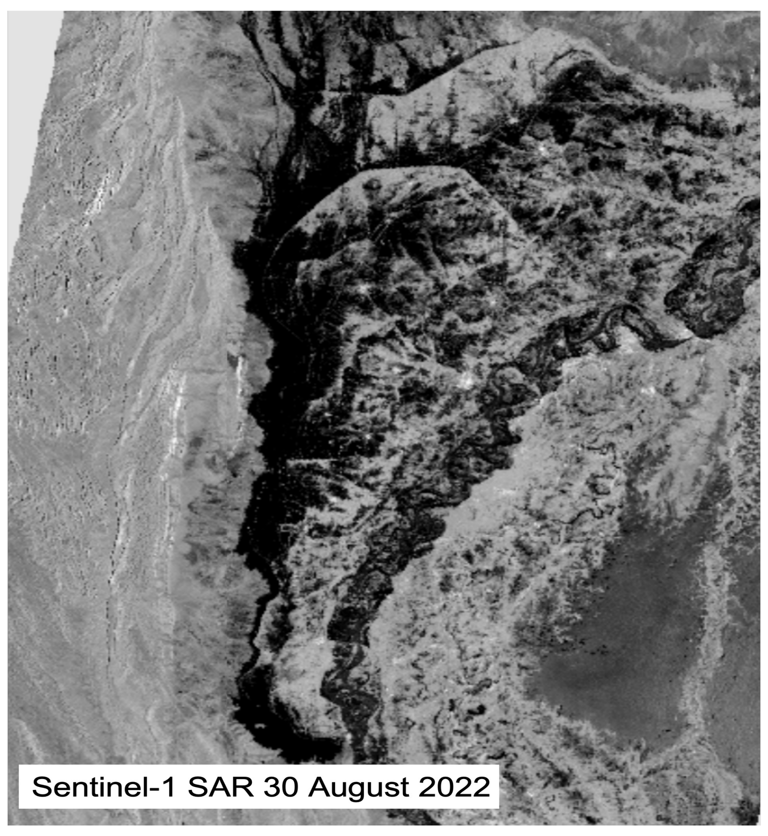
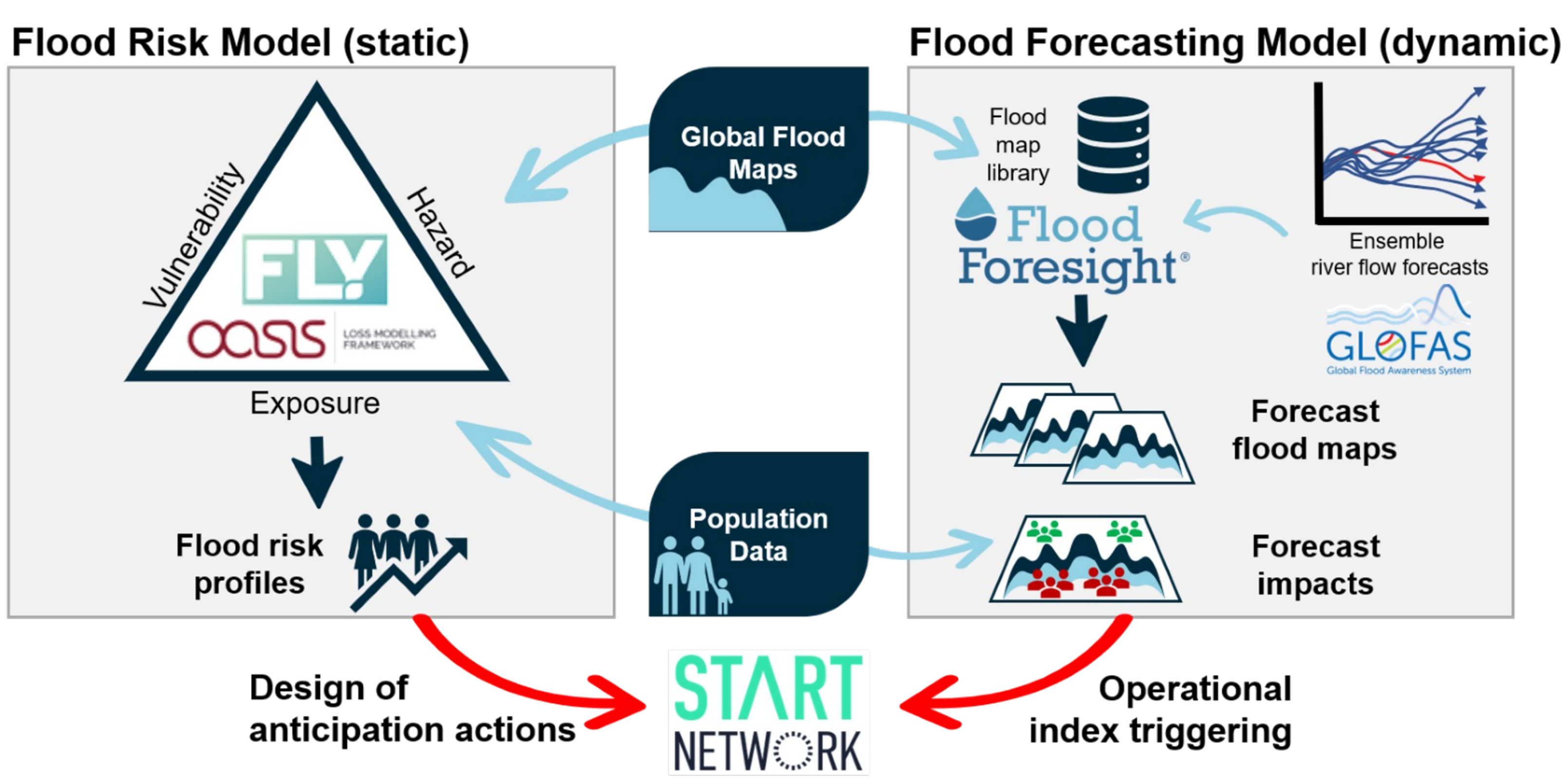

Sentinel-1 SAR 30 August 2022


Balochistan, Pakistan, 1 Sept 2022. The Conversation, Zahid Hussain

1. Introduction

- Forecast-based financing (FbF) schemes rely on accurate predictions of flood inundation. River discharge forecast below the return period (RP) threshold set can result in a *non-trigger* of flood map selection from a simulation library flood forecasting system.
- During a flood, earth observation data from synthetic aperture radar (SAR) sensors can be used to derive flood likelihood values.
- A data assimilation (DA) method is presented using SAR flood likelihood data to improve the flood map selection per sub-catchment or impact zone (IZ). The method is tested on selected IZ during catastrophic flooding in the Sindh province, Pakistan in August 2022.

2. Flood Foresight



3. DA framework

Observation likelihood term

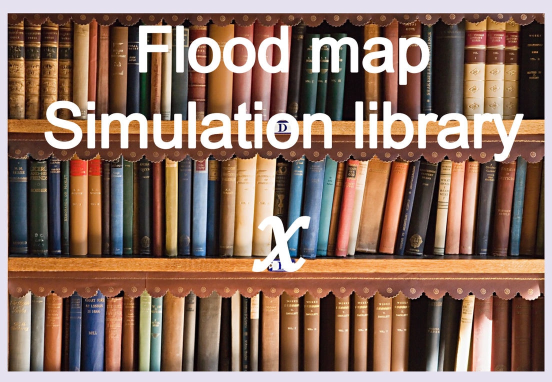
$$P(\mathbf{y}|\mathbf{x}) = \prod_{i=1}^{n} L_i^{H(x_i)}(1-L_i)^{1-H(x_i)}$$

Observation operator

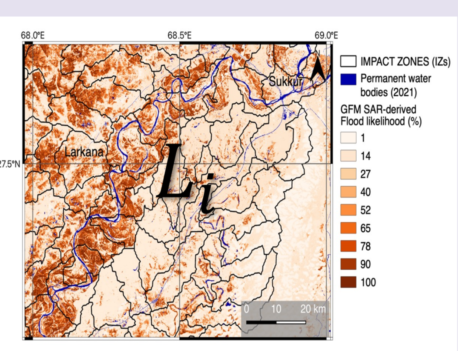
$$\mathbf{H}(\mathbf{x}) = \begin{cases} 1 & \text{flooded} \quad x_i > 0.2m \\ 0 & \text{unflooded} \quad \text{otherwise} \end{cases}$$

Cost function

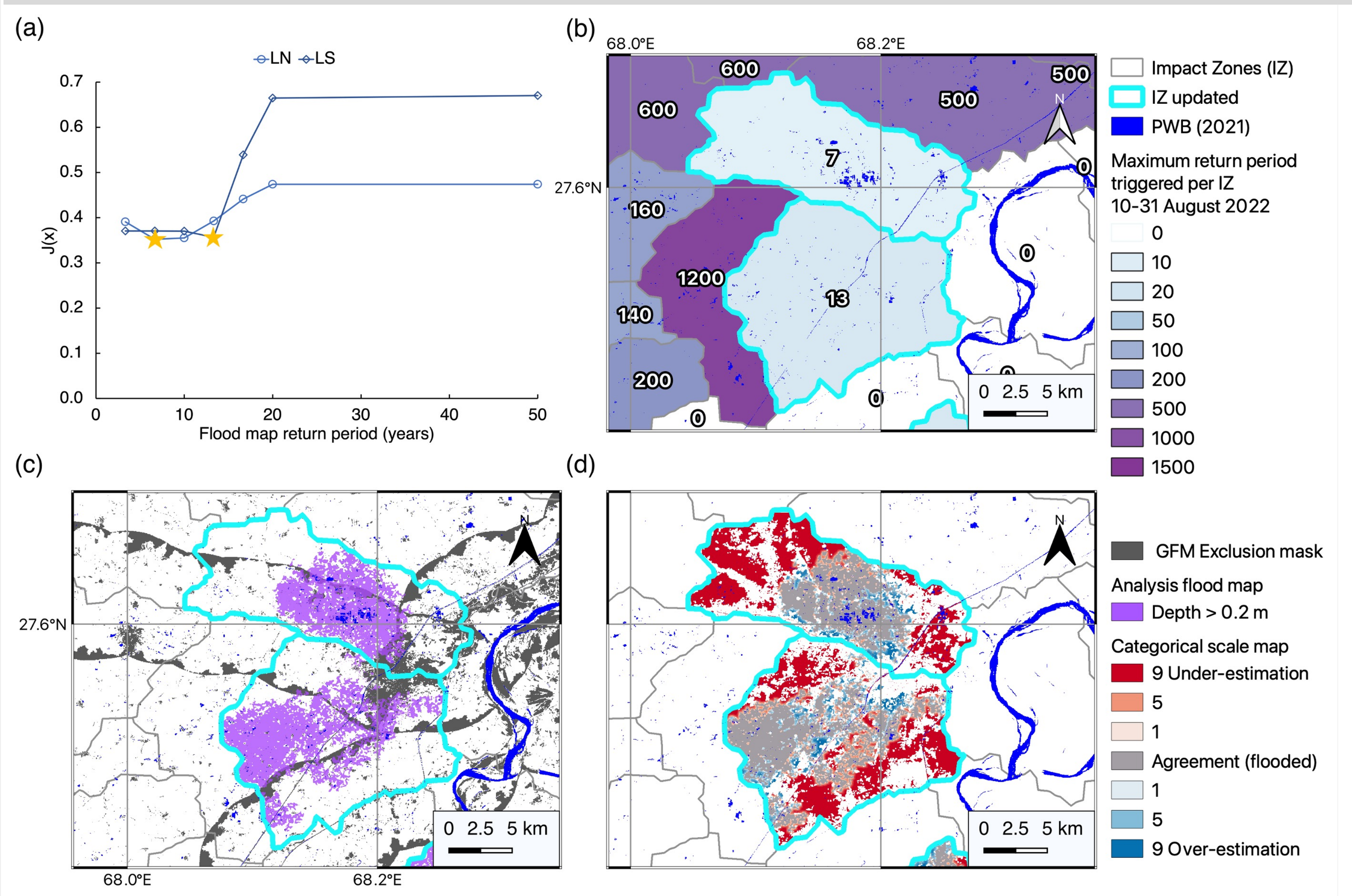
$$J(\mathbf{x}) = -\frac{1}{n}\sum_{i=1}^{n}\{\underbrace{H(x_i)\ln(L_i)}_{\text{FLOODED}} + \underbrace{(1-H(x_i)\ln(1-(L_i)}_{\text{UNFLOODED}}\}$$



Find the flood map per IZ that minimises the cost function

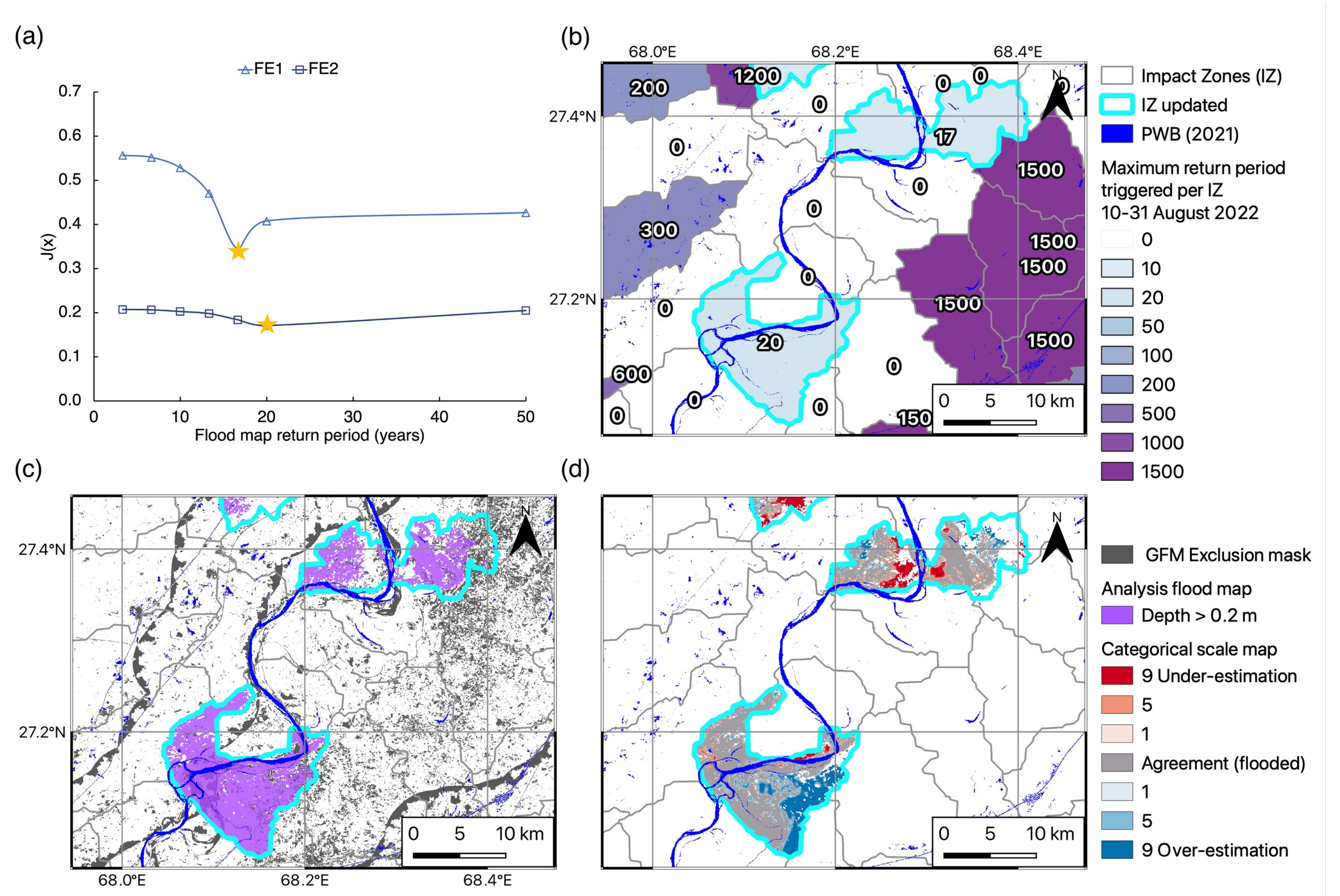


4. Results: Larkana, a mixed urban and rural area



- Flood maps triggered include flooding across masked (SAR) urban areas.
- Low RP triggered relative to neighbouring IZ.
- Analysis flood map is under-estimating flooding extent.

5. Results: Flood edge locations



- Smoother minimisation of J(x).
- Higher RP maps selected with good validation scores.
- Once the IZ is flood-filled the DA framework cannot distinguish between flood maps, additional depth observations are needed.

6. References

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- Hooker, H., Dance, S. L., Mason, D. C., Bevington, J., & Shelton, K. (2023). Assessing the spatial spread-skill of ensemble flood maps with remote-sensing observations. *Natural Hazards and Earth System Sciences*, *23*(8), 2769–2785. https://doi.org/10.5194/nhess-23-2769-2023

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