Damage Proxy Maps and Flood Proxy Maps: Theory, thresholding, strengths and limitations

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Devastation from the 2018 Palu earthquake. Image from the Jakarta Post.

Overview of training

1. Theory of Damage Proxy Maps
2. Theory of Flood Proxy Maps
3. Thresholding exercise for Flood Proxy Maps
4. Demonstration of flood app

Introduction to the theory of creating damage maps

- Damage maps are usually created using estimates of coherence:

$$\gamma = \frac{\left|\langle c_1 c_2^* \rangle\right|}{\sqrt{\langle c_1 c_1^* \rangle}\sqrt{\langle c_2 c_2^* \rangle}}$$

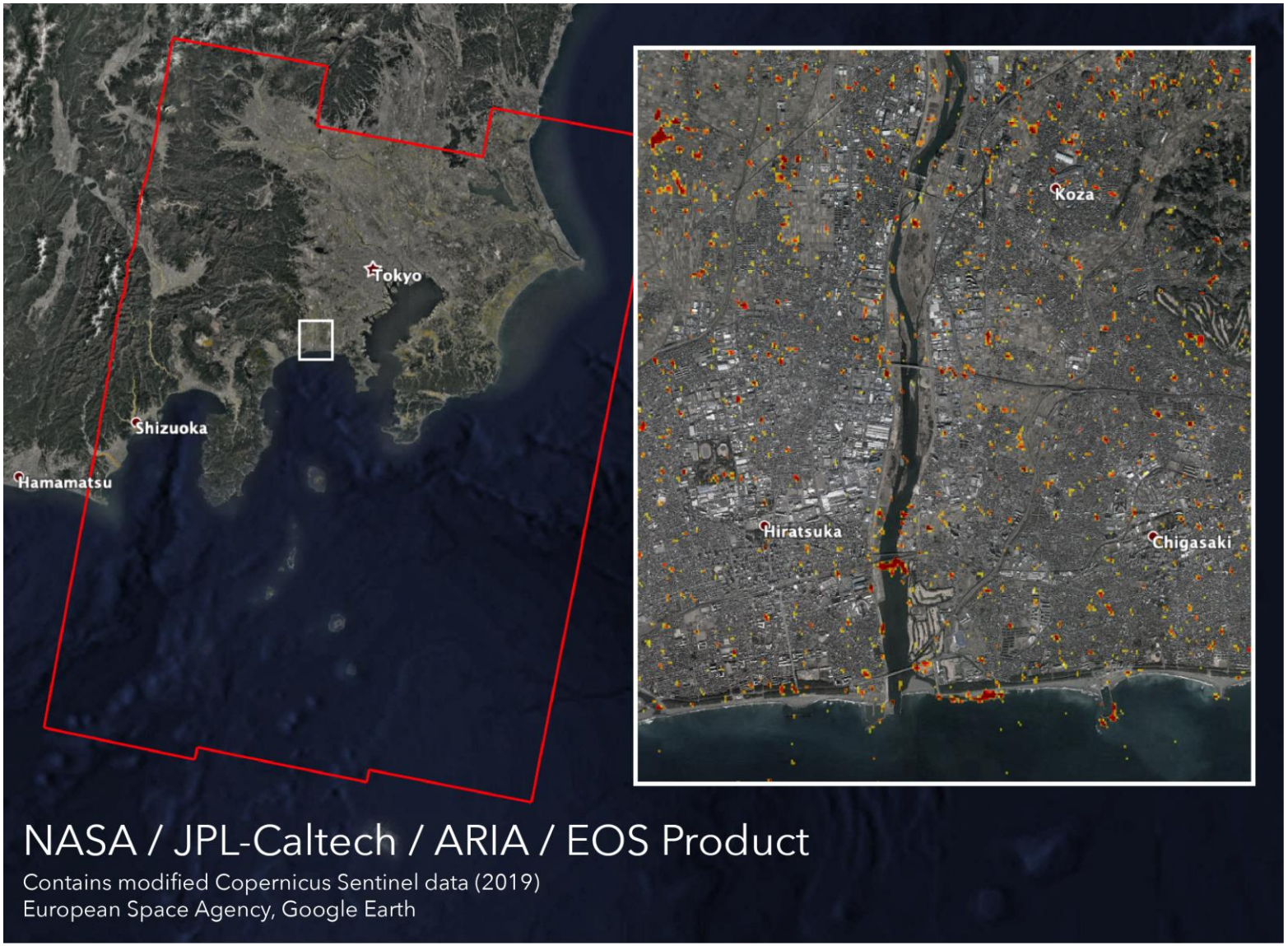
- To suppress background noise caused by natural changes (temporal decorrelation) we take the difference of two coherence images prior to the event and spanning the event.

- Coherence estimates are highly sensitive to how you process the raw SAR data.

- After calculating the coherence, we estimate thresholds to determine what level of decorrelation represents damage. This is done using external validation data.

(Yun et al., 2015)

Example DPM: Typhoon Hagibis, October 2019



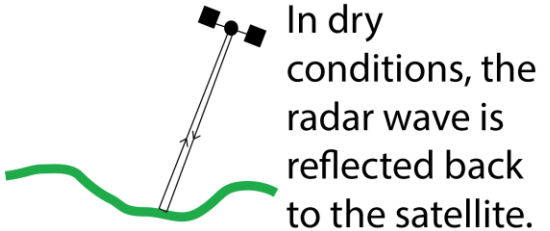
Red and yellow pixels show damaged buildings, imaged by Sentinel-1

Introduction to the theory of creating flood maps

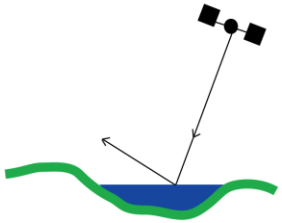
- How the amplitude changes during a flood event is very much dependent on land cover.

- We manually decide on thresholds (the minimum change estimated to reflect a flooded pixel).

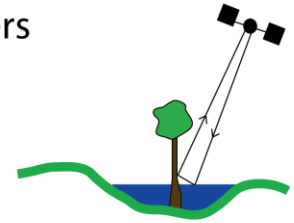
- Some thresholds are for negative (open water) amplitude changes. Some are for positive (e.g., flooded vegetation)



In dry conditions, the radar wave is reflected back to the satellite.



Open flood waters reflect the signal away from the satellite.



How the signal amplitude changes depends on surface features.

Introduction to the theory of creating flood maps

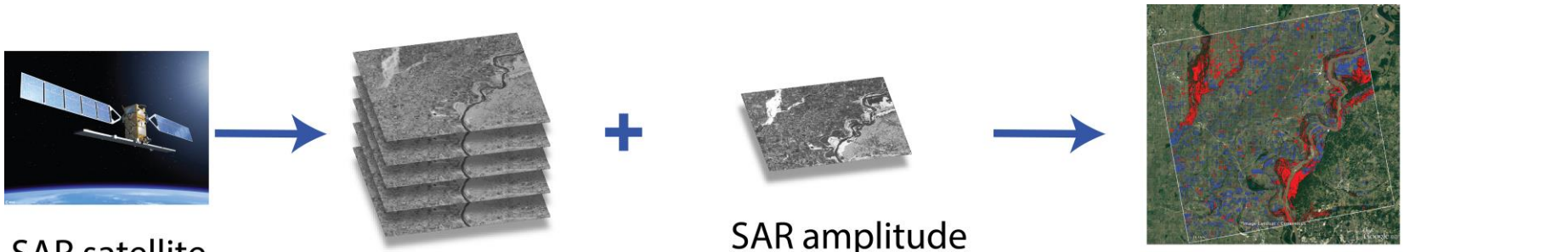
- To create FPMs we first calculate SAR amplitudes for scenes before and during the event.

- We then calculate the log amplitude ratio (LAR) for before the event (A_{pre}) and the co-event scene (A_{co}):

$$LAR = \log_{10}(A_{co} / A_{pre})$$

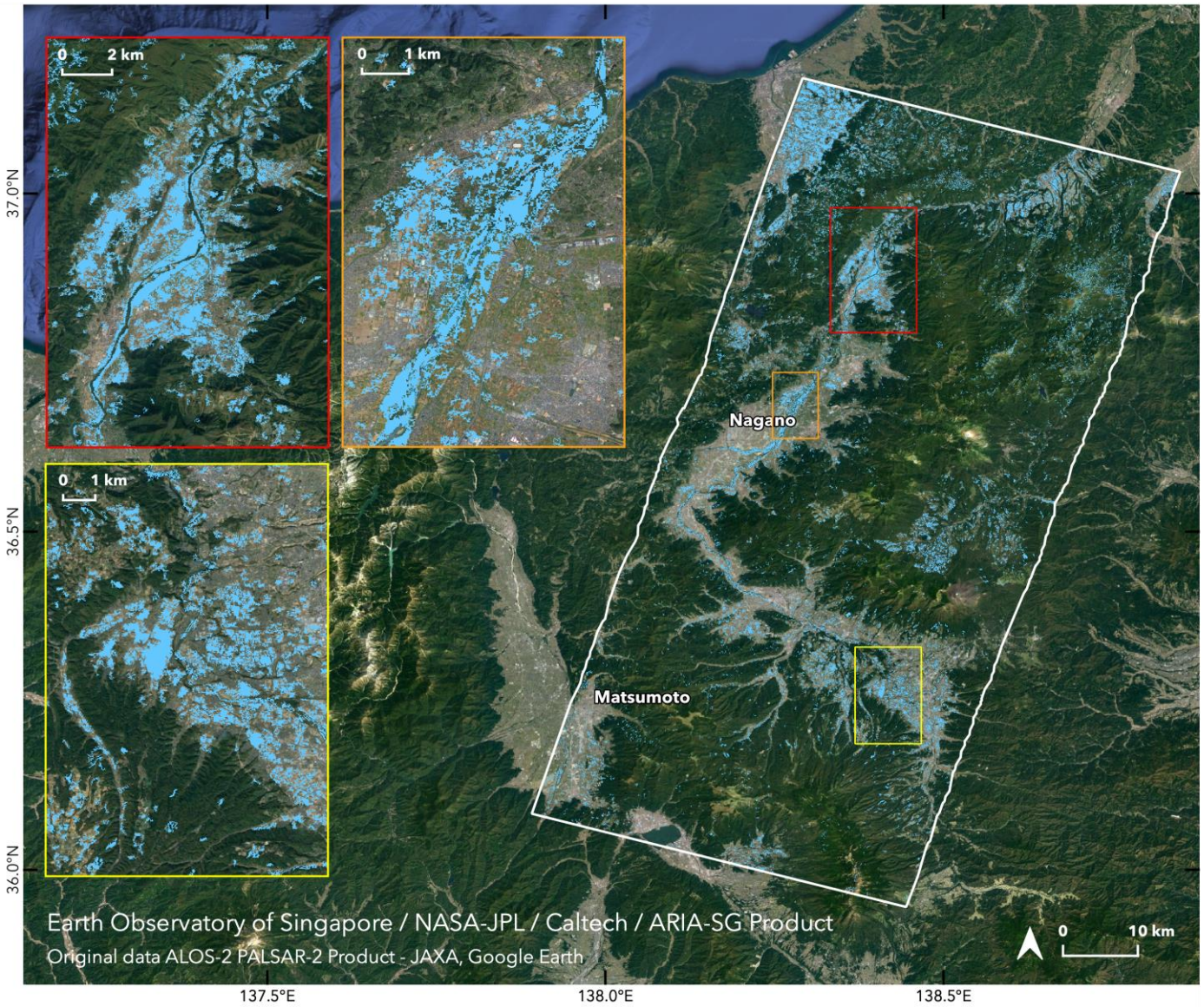
- The log ratios are then used to map flood extent.

- More advanced analysis involves a stack of pre-event scenes rather than single pre-event SAR scene.



(Lin et al., 2019)

Example FPM: Typhoon Hagibis, October 2019



Light blue pixels show flooded areas, imaged by ALOS-2.

- Thresholding exercise for Flood Proxy Maps
- Demonstration of flood app

Thank you!

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