Sentinel-1 multitemporal InSAR coherence to map floodwater in urban areas

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GFP- 4 November 2020

SAR SCATTERING MECHANISMS
FLOOD VS NO FLOOD

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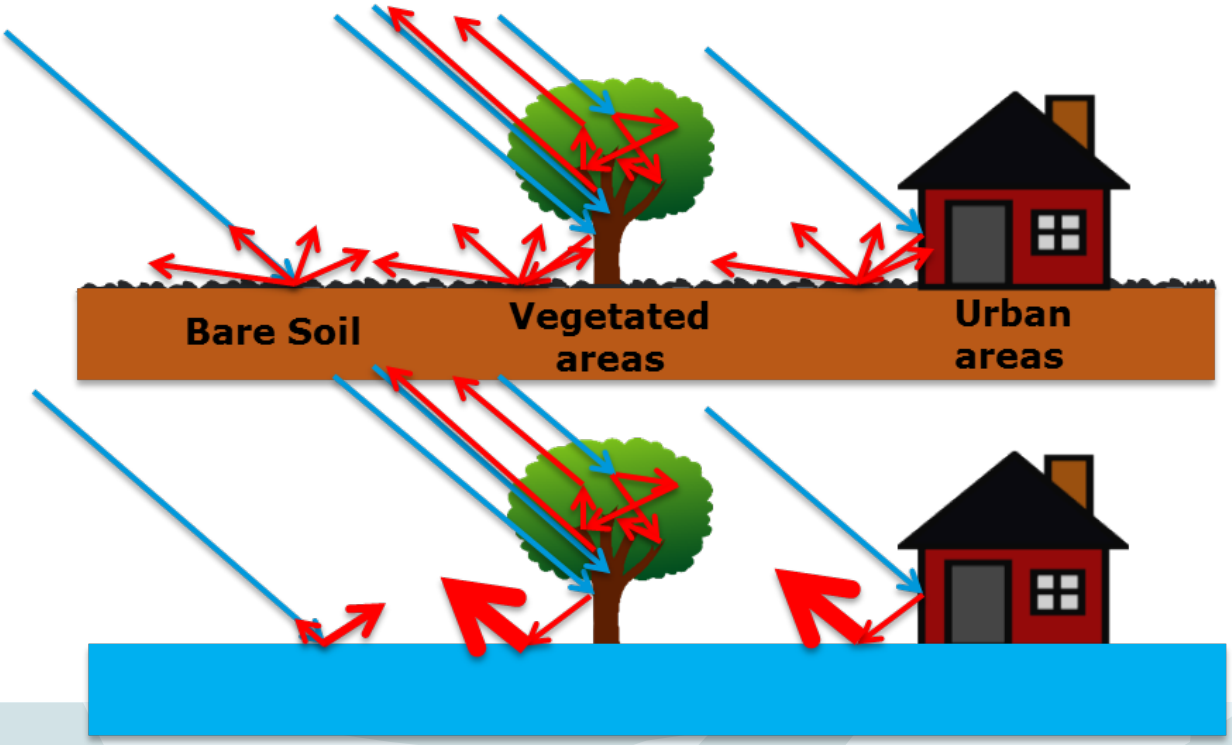

SAR INTENSITY LIMITATIONS

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- If we consider the angle between the flight direction and the street alignment, the increase is high for small angles, while it is reduced for higher angles.

- As a consequence, the increase of the Double-Bounce due to the presence of floodwater may not be sufficiently high if buildings are not parallel to the SAR flight direction. This type of increase is hardly detectable using only the backscatter intensity in a complex urban environment.

THE ROLE OF VV AND VH POLARIZATIONS

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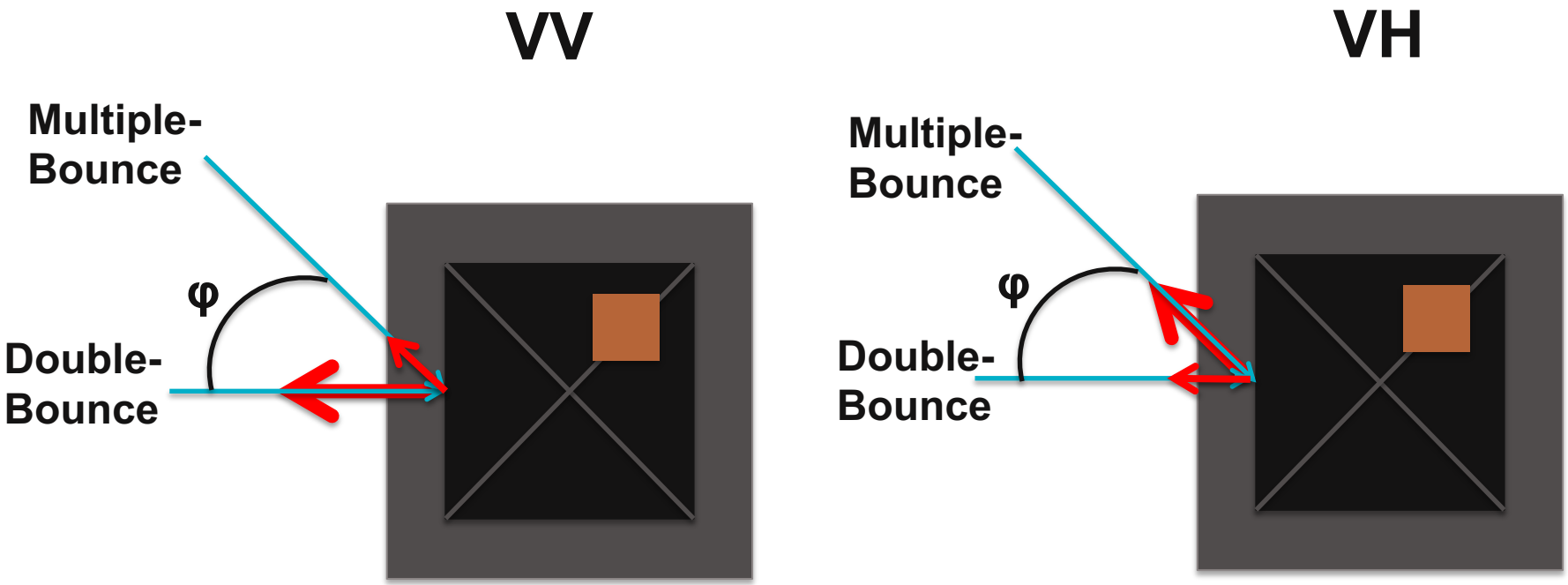

CONTEXT

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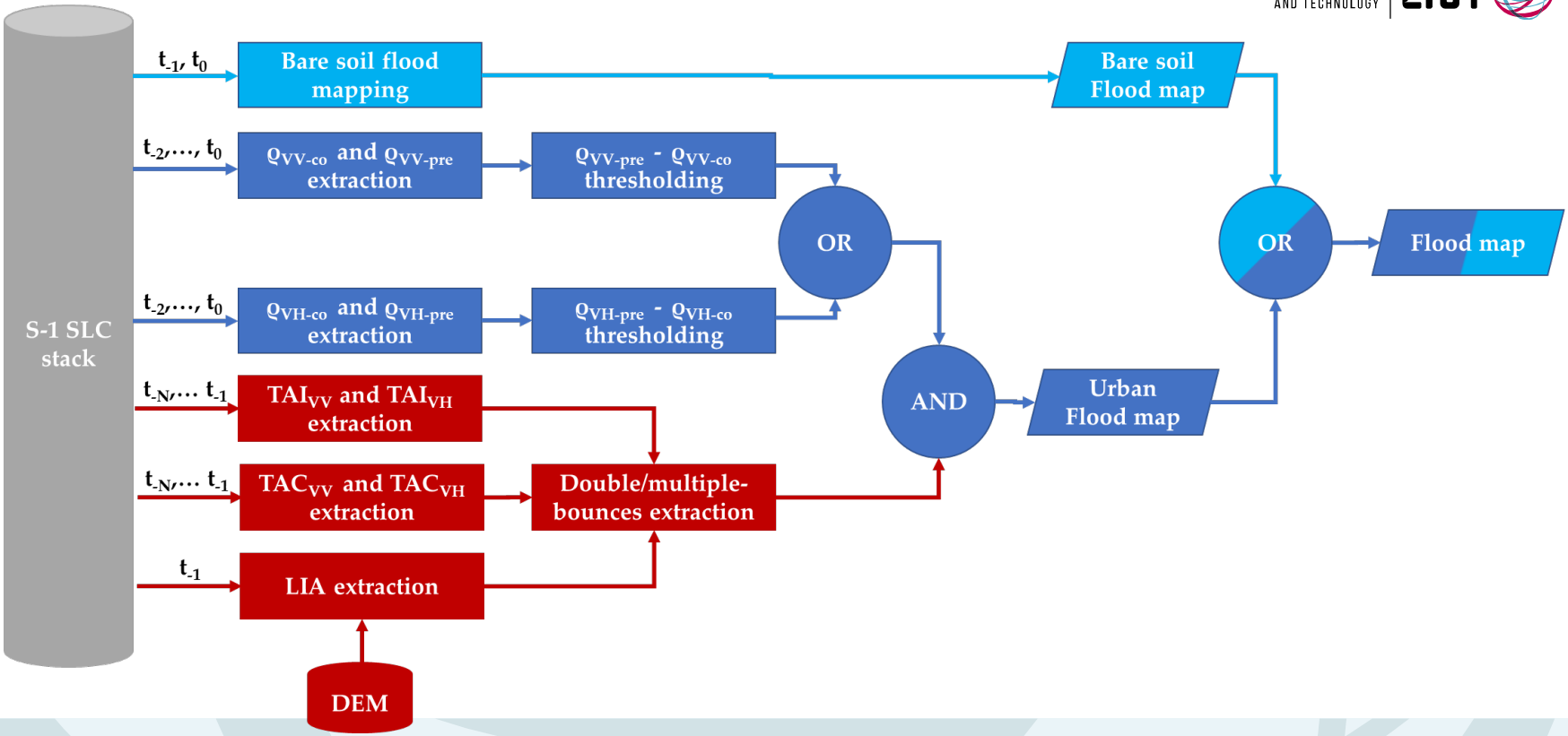
- Two peculiar scattering mechanisms are present in urban areas:
  - **Double-bounce** occurring for orthogonal illumination of building facades
    - **High co**-polarization backscattering
  - **Multiple-bounces** occurring for oblique illumination of buildings facades
    - **High cross**-polarization backscattering

- Backscattering increase in both polarizations may not be sufficiently high to highlight the presence of water.

- The multi-temporal **InSAR coherence** from co- and cross- polarizations can be profitably used to detect the presence of **floodwater in urban area**.

METHODOLOGY



- *M. Chini et al., "A Hierarchical Split-Based Approach for parametric thresholding of SAR images: flood inundation as a test case", IEEE Transactions on Geoscience and Remote Sensing, 55 (12), 6975-6988, 2017.*
- *M. Chini et al., Towards a 20 m Global Building Map from Sentinel-1 SAR Data , Remote Sensing, 10 (11), 1833, 2018.*
- *M. Chini et al., "Sentinel-1 InSAR Coherence to Detect Floodwater in Urban Areas: Houston and Hurricane Harvey as A Test Case , Remote Sensing, 11 , 107, 2019.*
- *R. Pelich et al., "Mapping floods in urban areas from dual-polarization InSAR coherence data", IEEE Geoscience And Remote Sensing Letters, Submitted.*

URBAN MAPPING

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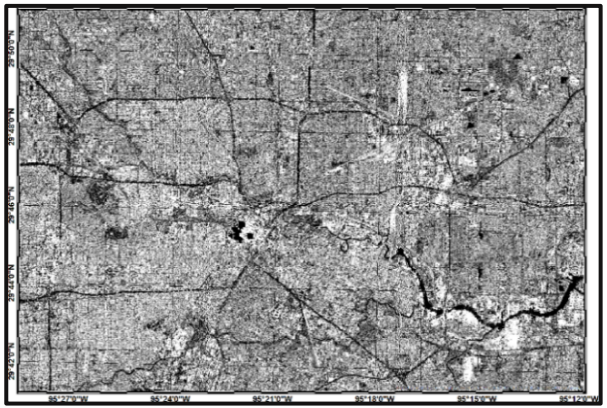
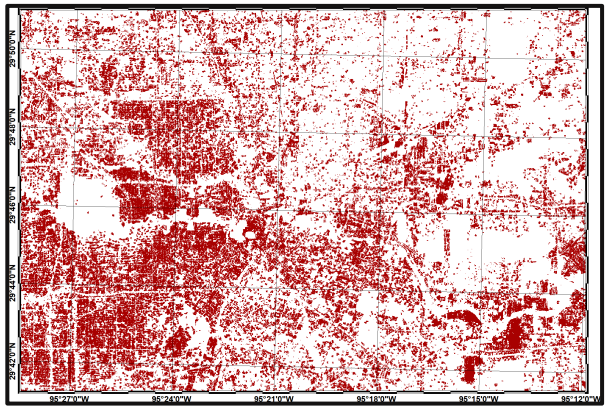
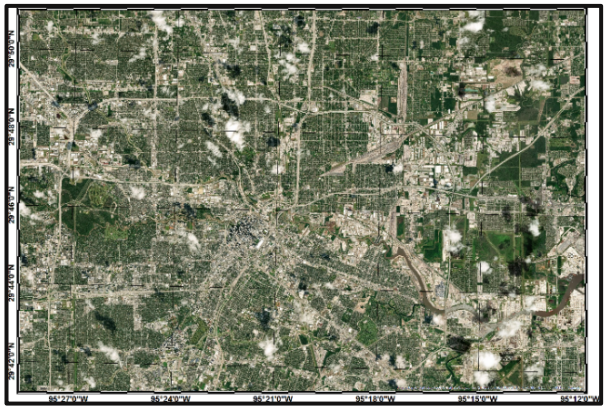
Sentinel-1



Building map



Optical image



TEST CASE 1: HOUSTON 2017

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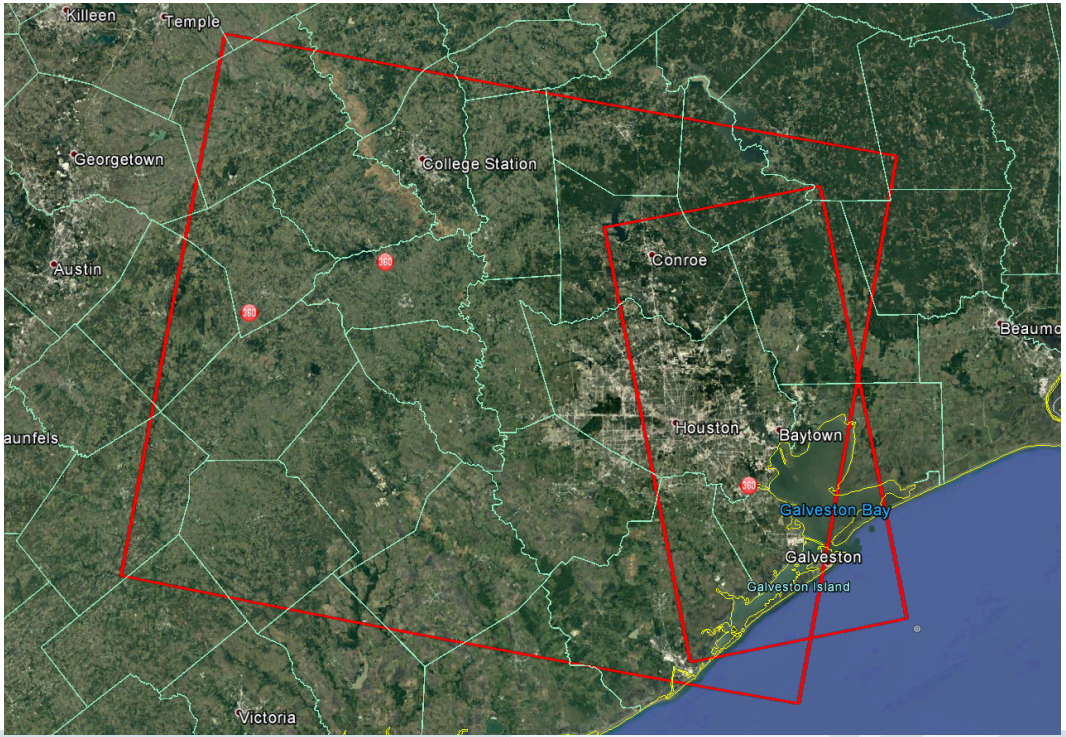
Satellite	Date
S1-A IW	18/08/2017 12:22
S1-B IW	24/08/2017 12:22
S1-A IW	30/08/2017 12:22



TEST CASE 1: HOUSTON 2017

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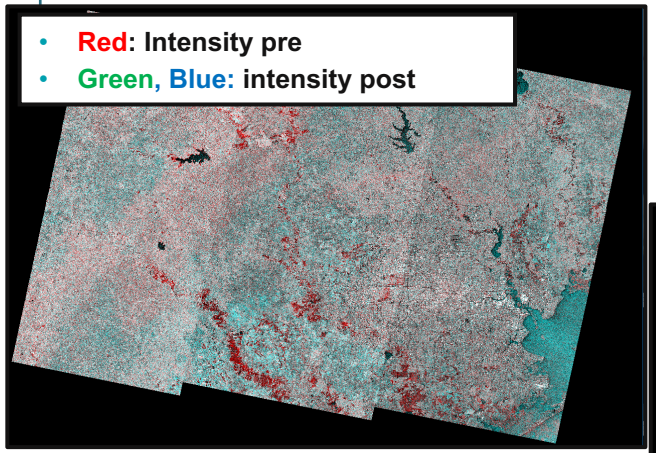

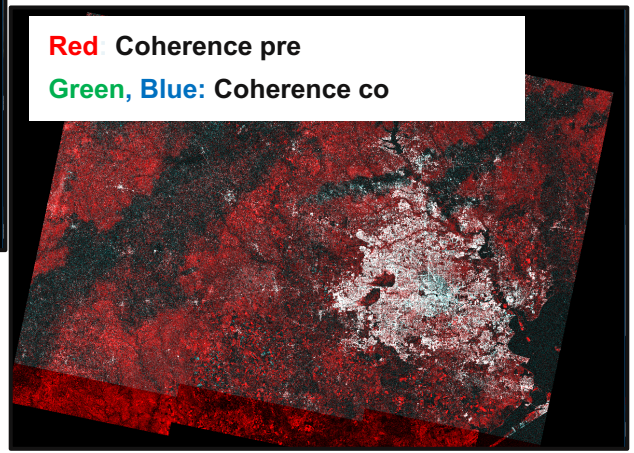

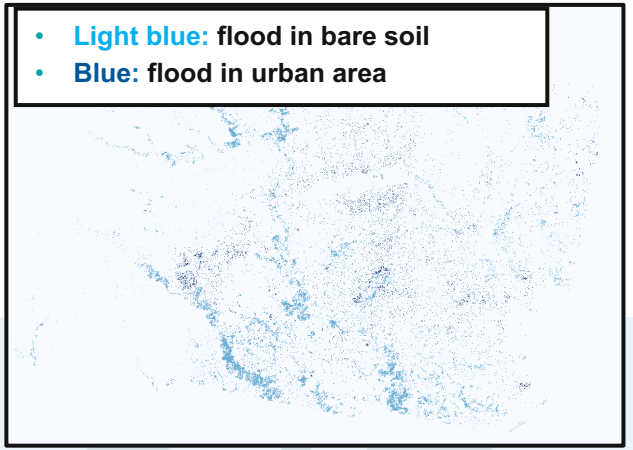

TEST CASE 1: HOUSTON 2017

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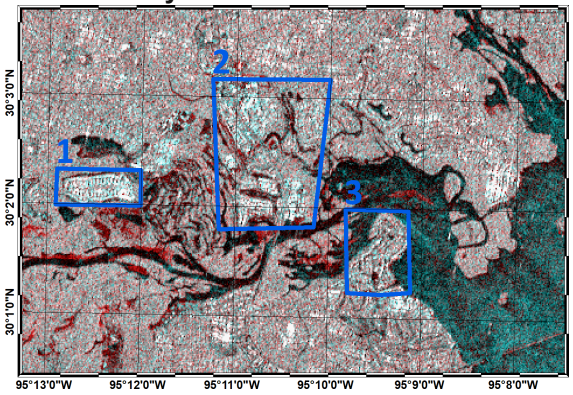
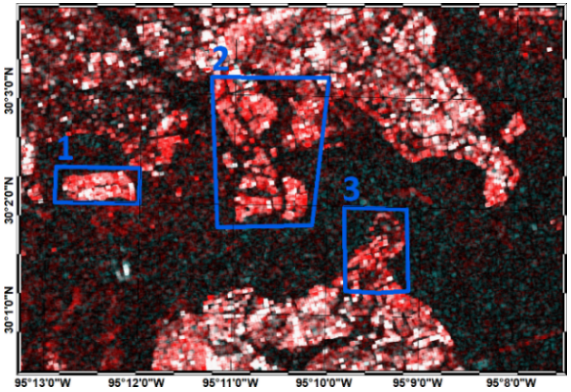
- **Light blue:** flood in bare soil
- **Blue:** flood in urban area

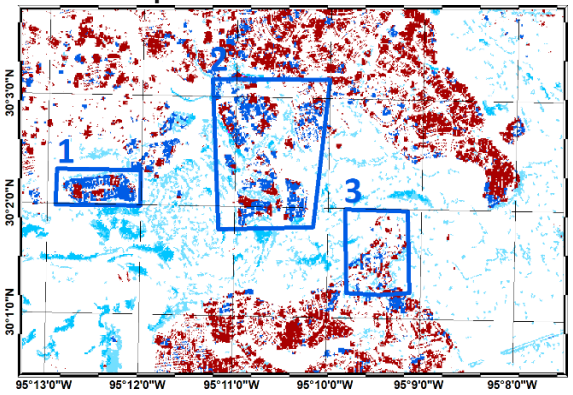
RGB Intensity

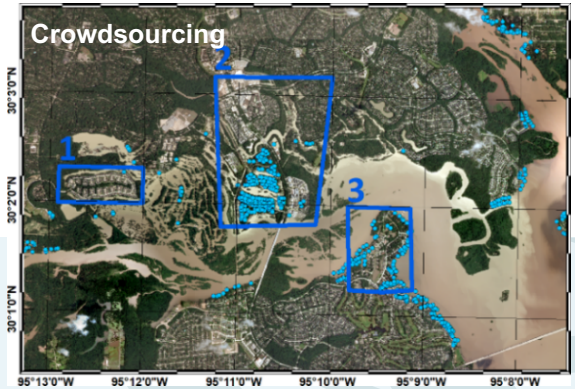


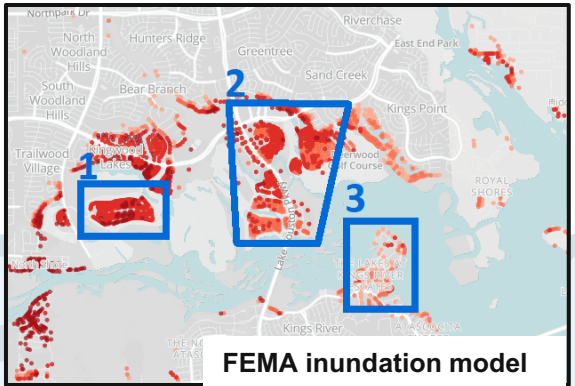
RGB coherence



Flood map







FEMA inundation model

Aerial photo of AOI 1

TEST CASE 1: HOUSTON 2017

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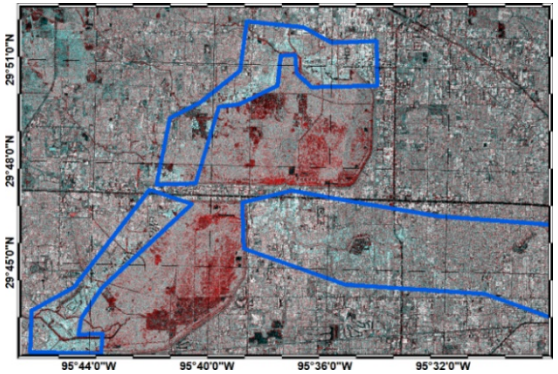
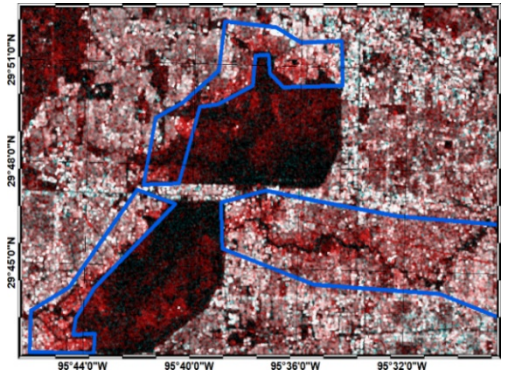
- **Light blue:** flood in bare soil
- **Blue:** flood in urban area

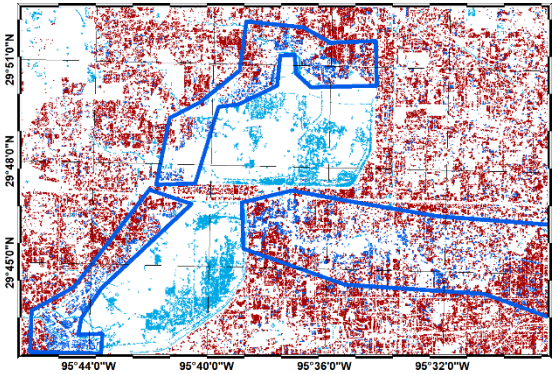
RGB Intensity

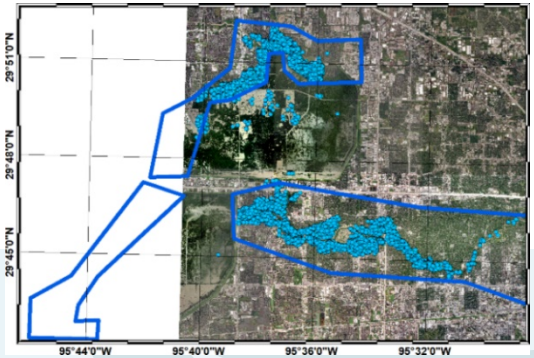


RGB coherence

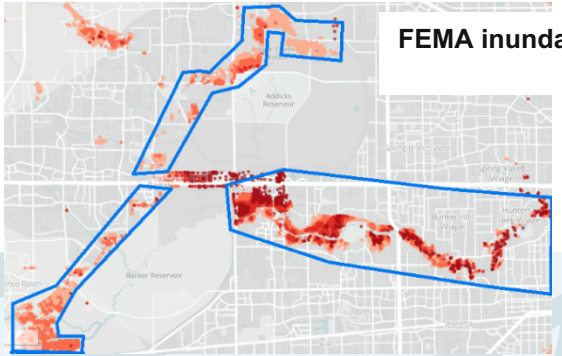


Flood map





Digital Globe VHR imagery and crowdsourcing



FEMA inundation model

TEST CASE 2: JAKARTA 2020

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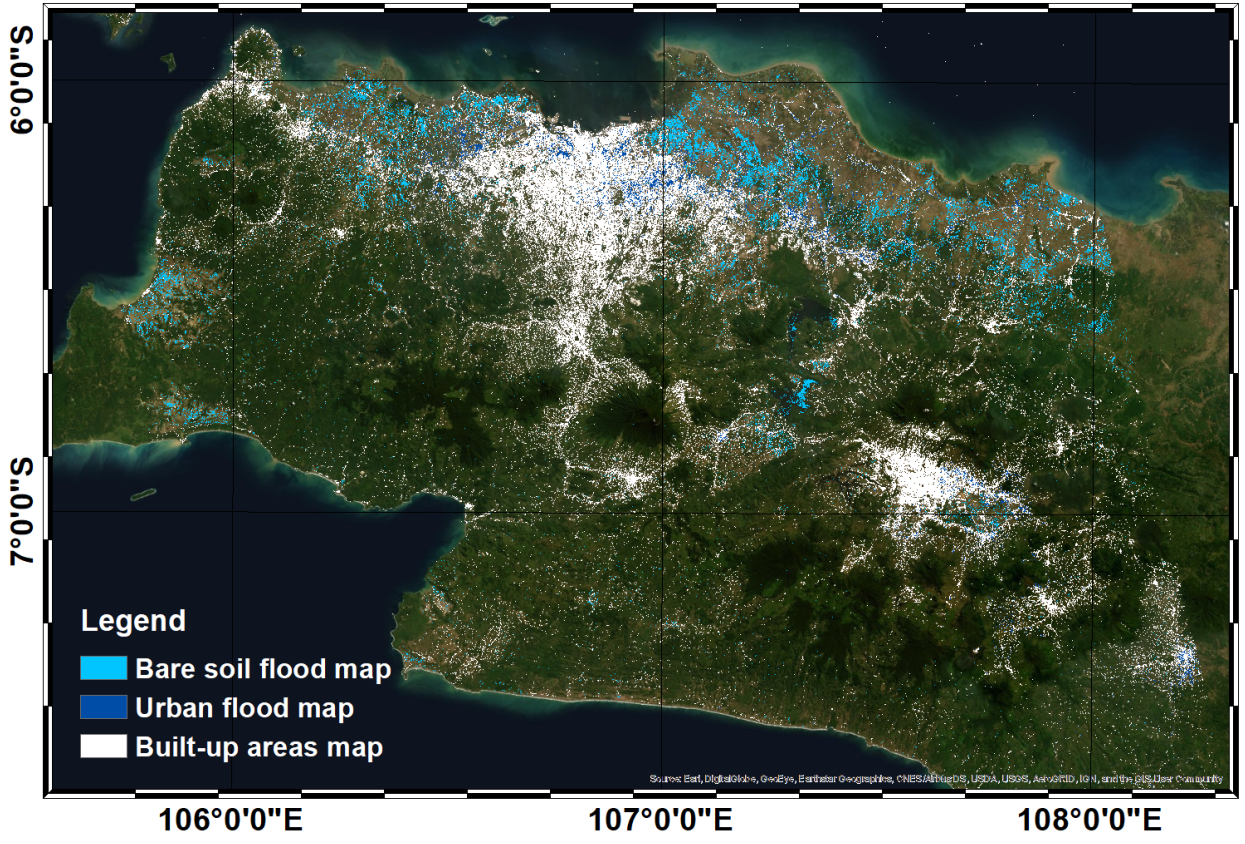

TEST CASE 2: JAKARTA 2020

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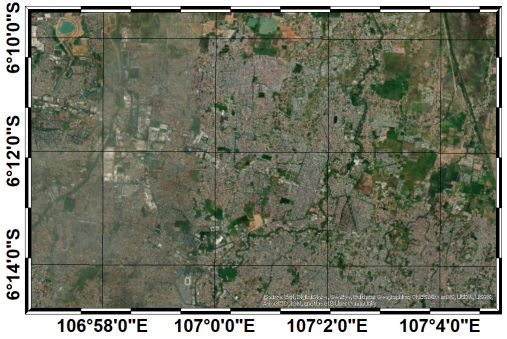
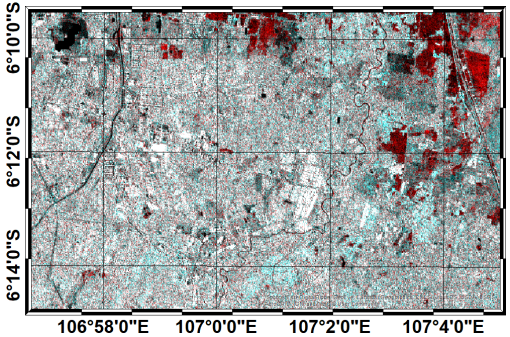
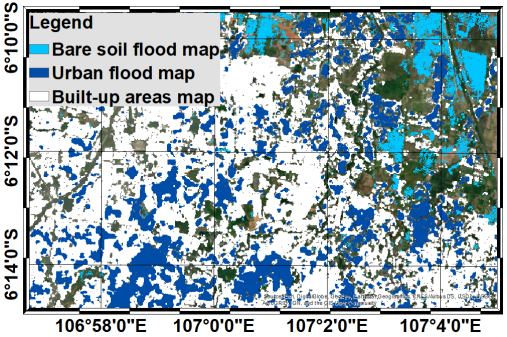
Optical image

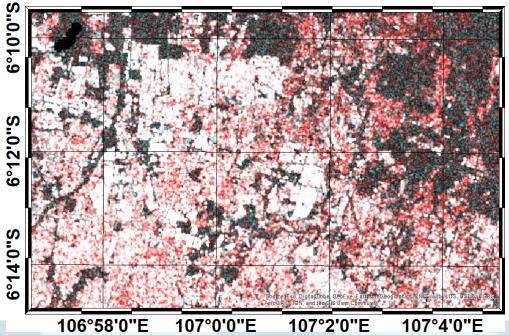


Intensity Pre-Post RGB

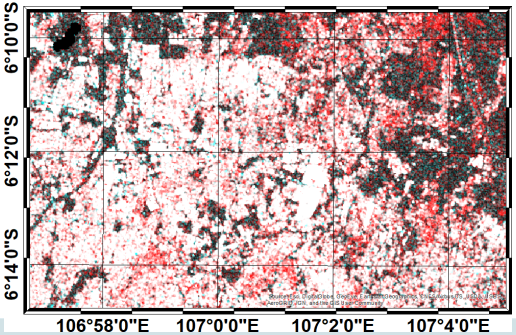


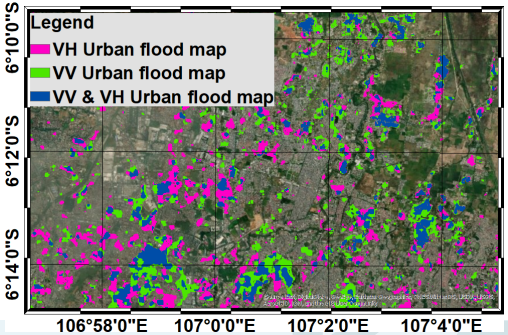


Coherence Pre-Co VH RGB



Coherence Pre-Co VV RGB





CONCLUSIONS

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- An automatic algorithm capable of mapping floodwater in urban areas using 20m Sentinel-1 InSAR coherence has been presented.

- It exploits:
  - the short temporal and small spatial baselines of Sentinel-1 image pairs;
  - the intensity and the InSAR coherence from both VV and VH polarizations.

- The algorithm was tested using Sentinel-1 images acquired during different flood events from recent years.

- Results show the necessity of using both co- and cross-polarizations multitemporal InSAR coherence to detect floodwater in urbanized areas.

R. Pelich et al., “Mapping floods in urban areas from dual-polarization InSAR coherence data”, *IEEE Geoscience And Remote Sensing Letters, Submitted.*

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PILOT 2: SATELLITE EO-DERIVED WATER BODIES AND FLOODWATER RECORD OVER EUROPE

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SAR-BASED FLOOD MAPPING PRODUCTS

- Demonstration data set : Monsoon-related flooding in Myanmar (2017 – 2018)

Google Earth Engine APP:

https://yuli.users.earthengine.app/view/myanmarflood

e-shape

EuroGEO GEO GROUP ON EARTH OBSERVATIONS Copernicus

The e-shape project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 820852