RAPID GENERATION OF FLOOD MAPS USING DUAL-POLARIMETRIC SYNTHETIC APERTURE RADAR IMAGERY

MinJeong Jo[1] , Batuhan Osmanoglu[2] , Seung-Kuk Lee

[1]USRA, NASA-GSFC, Greenbelt, MD, 20771 USA – minjeong.jo@nasa.gov
[2]NASA-GSFC, Greenbelt, MD, 20771 USA – batuhan.osmanoglu@nasa.gov
[3]UMD, NASA-GSFC, Greenbelt, MD, 20771 USA – seungkuk.lee@nasa.gov

ABSTRACT: Rapid generation of synthetic aperture radar (SAR) based flood extent and flood depth maps provide valuable data in disaster response efforts. We present a simple but powerful method using dual-polarimetric SAR imagery. A RGB false-color map is generated using pre- and post-flooding imagery, allowing operators to distinguish between existing standing water in pre-flooding data and recently flooded areas. This method works very well in areas of standing water, while large omission errors can be seen in urban areas due to the double-bounce effect. A flood depth map is also estimated by using an external DEM. Compared with FEMA flood product, flood water depth from the proposed method showed low bias with small dispersion. This automatic flood mapping system will contribute to the rapid assessment for disaster relief efforts.
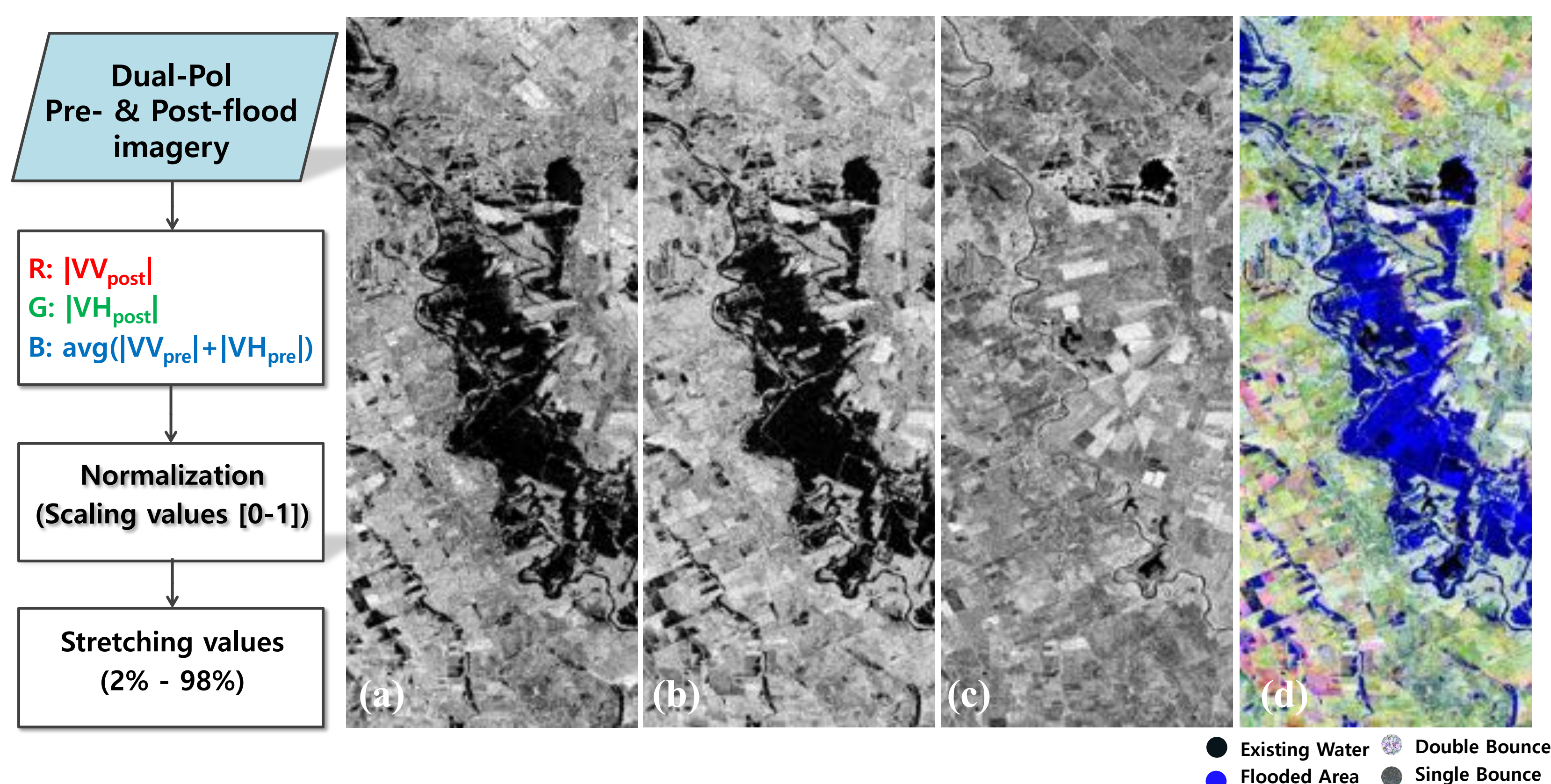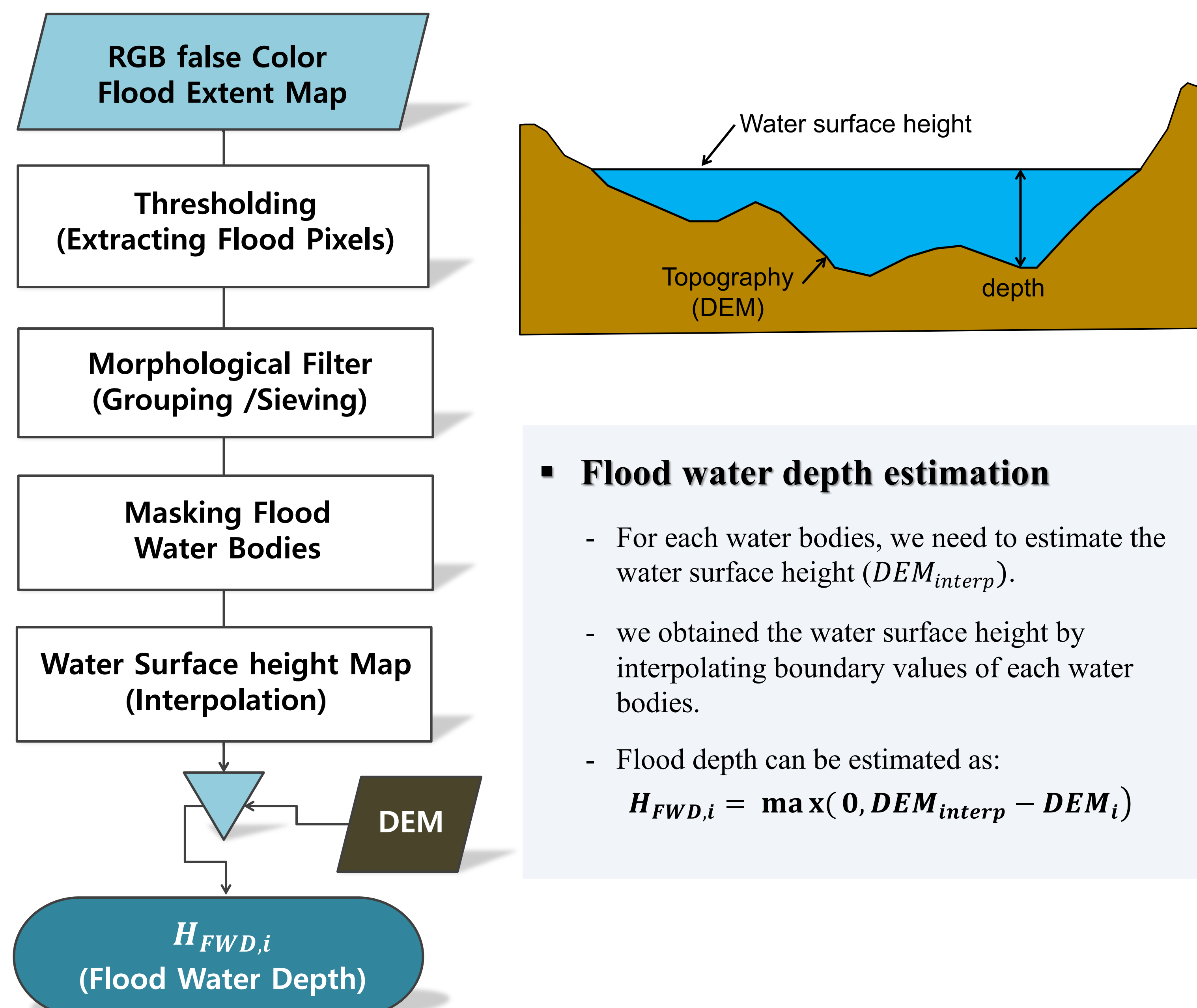
RGB Color Composition Map

Dual-Pol Pre- & Post-flood imagery

R: $|VV_{post}|$
G: $|VH_{post}|$
B: $avg(|VV_{pre}|+|VH_{pre}|)$

Normalization (Scaling values [0-1])

Stretching values (2% - 98%)

Existing Water   Double Bounce
Flooded Area   Single Bounce

Figure 1. False color map generation for flood monitoring using dual-polarimetric SAR imagery.
(a) |VV-post|, (b) |VH-post|, (c) avg(| VV-pre| + |VH-pre|), (d) RGB color composition map.

Flood Depth Mapping Method

RGB false Color Flood Extent Map

Thresholding (Extracting Flood Pixels)

Morphological Filter (Grouping /Sieving)

Masking Flood Water Bodies

Water Surface height Map (Interpolation)

DEM

$H_{FWD,i}$ (Flood Water Depth)

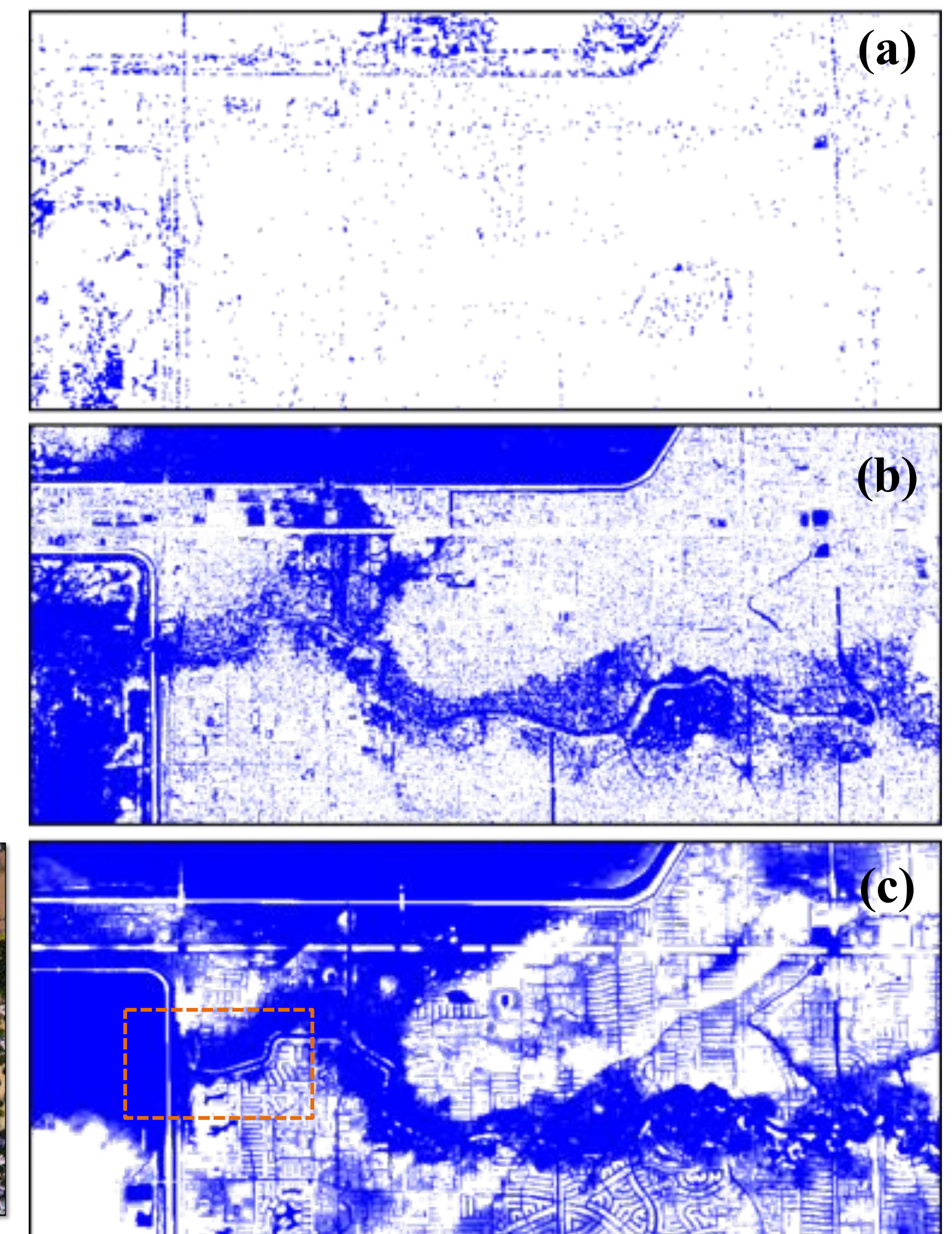Water surface height

Topography (DEM)   depth

- **Flood water depth estimation**
  - For each water bodies, we need to estimate the water surface height (DEM_{interp}).
  - we obtained the water surface height by interpolating boundary values of each water bodies.
  - Flood depth can be estimated as:
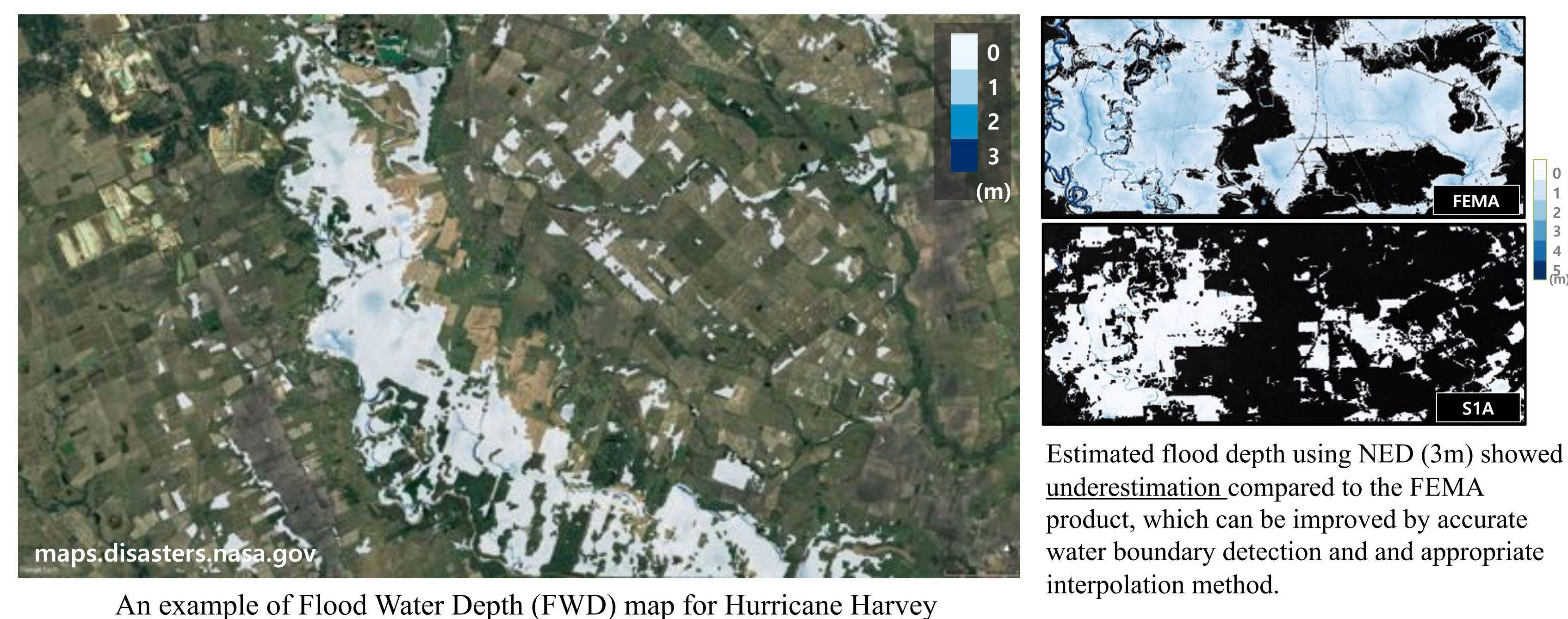 $$H_{FWD,i} = \max(0, DEM_{interp} - DEM_i)$$

Urban Flood Map

- Large omission errors in urban areas by Sentinel-1 SAR amplitude based approach.

- Complementary method using high resolution optical imagery for urban flood detection.

(a) Sentinel-1 dual-polarimetric SAR data - amplitude difference between pre- and post-imagery

(b) Multi-spectral optical data (Planet) - Normalized Difference Water Index

(c) FEMA maximum flood extent map

Sep. 1, 2017. *washingtonpost.com*

Flood Depth Map

maps.disasters.nasa.gov

An example of Flood Water Depth (FWD) map for Hurricane Harvey

0 1 2 3 (m)

FEMA

S1A

0 1 2 3 4 (m)

Estimated flood depth using NED (3m) showed underestimation compared to the FEMA product, which can be improved by accurate water boundary detection and and appropriate interpolation method.

Issues & Opportunities

- SAR-based flood map method works well in rural areas, while it shows large omission errors in urban areas.
- Complementary use of high-resolution optical imagery can be an opportunity to map urban flooded areas.

ACKNOWLEDGMENT

IGARSS 2019, July 28-August 2, 2019

Goddard SPACE FLIGHT CENTER