Sentinel 1 Time Series for Flood Mapping; Case Study: North of Iran

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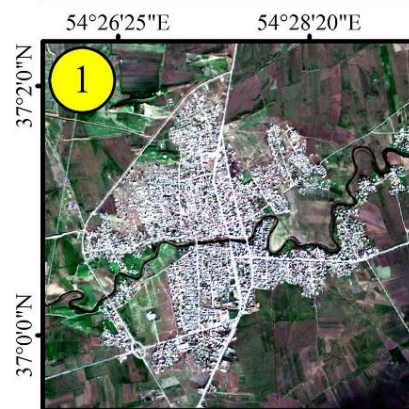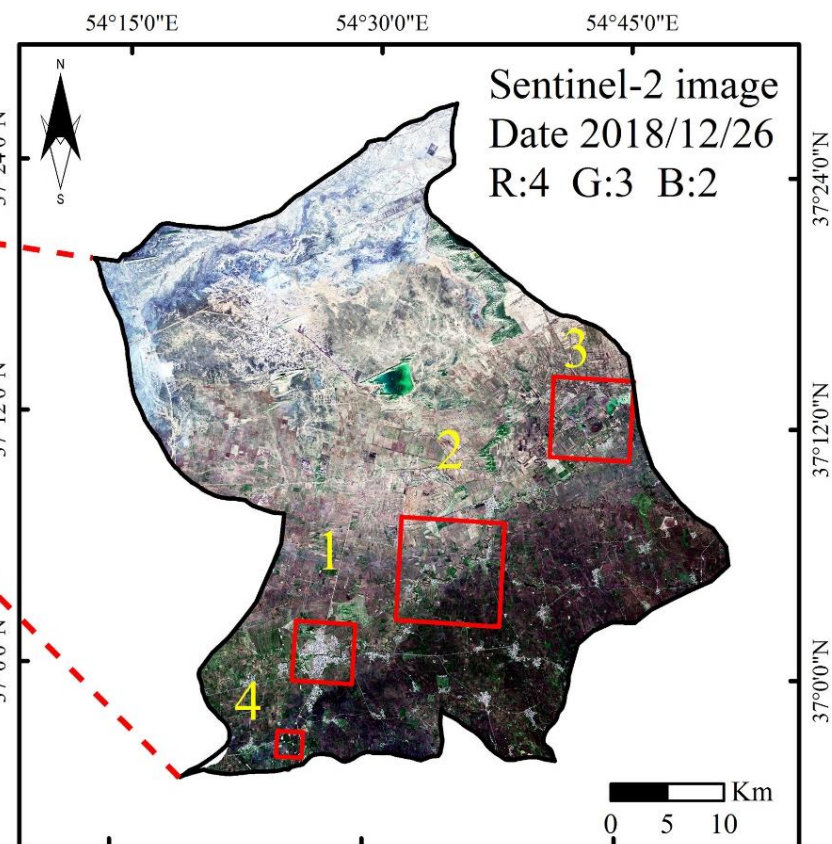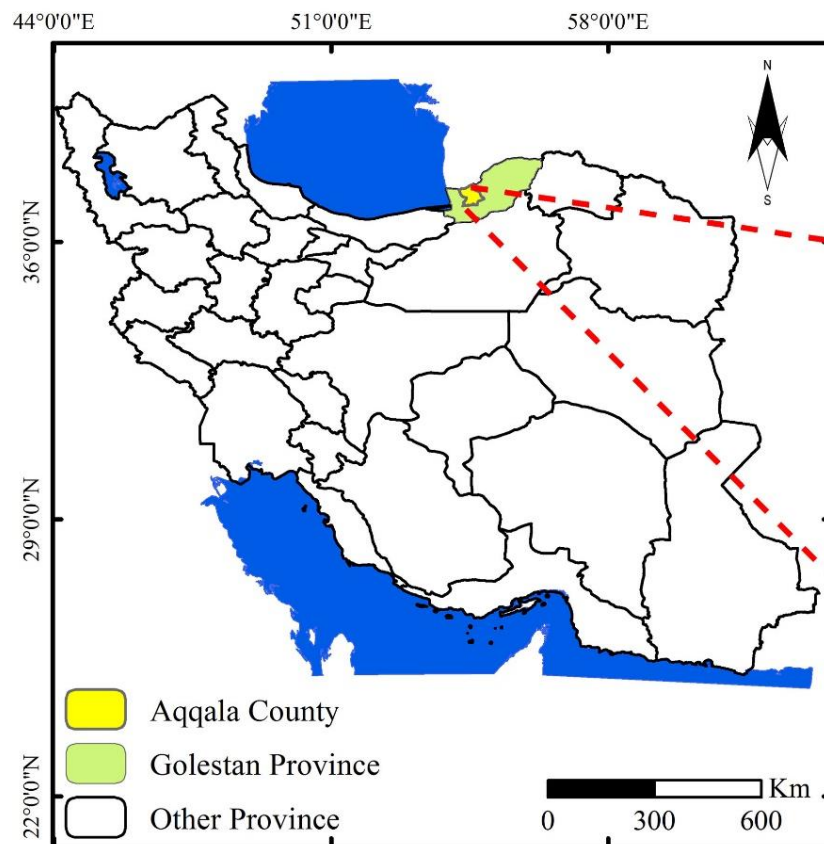
Introduction

Flood is considered to be one of the most destructive natural disasters.

It is important to detect the flood-affected area in a reasonable time.

In March 2019, a severe flood occurred in the north of Iran and lasted for two months.

54°15'0"E   54°30'0"E   54°45'0"E

Sentinel-2 image
Date 2018/12/26
R:4 G:3 B:2

37°24'0"N

37°12'0"N

37°0'0"N

Aqqala County
Golestan Province
Other Province

Km
0   300   600

Km
0   5   10

3

2

1

4

54°26'25"E   54°28'20"E

54°33'10"E   54°36'0"E

54°42'0"E   54°44'0"E

54°25'20"E   54°26'0"E

1

2

3

4

37°20'0"N

37°0'0"N

37°6'0"N

37°4'0"N

37°13'20"N

37°11'40"N

36°56'40"N

36°56'0"N

City
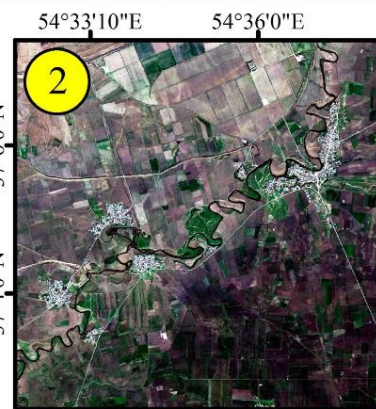
River

Lake

Farmland

Average monthly precipitation (2019)

Average annual precipitation (2010-2019)

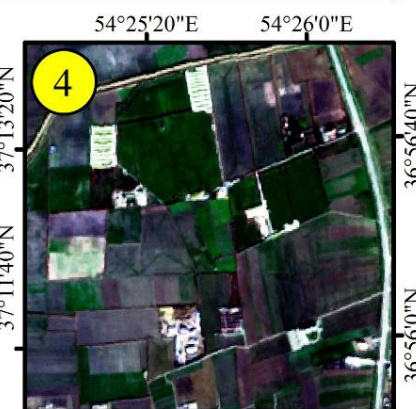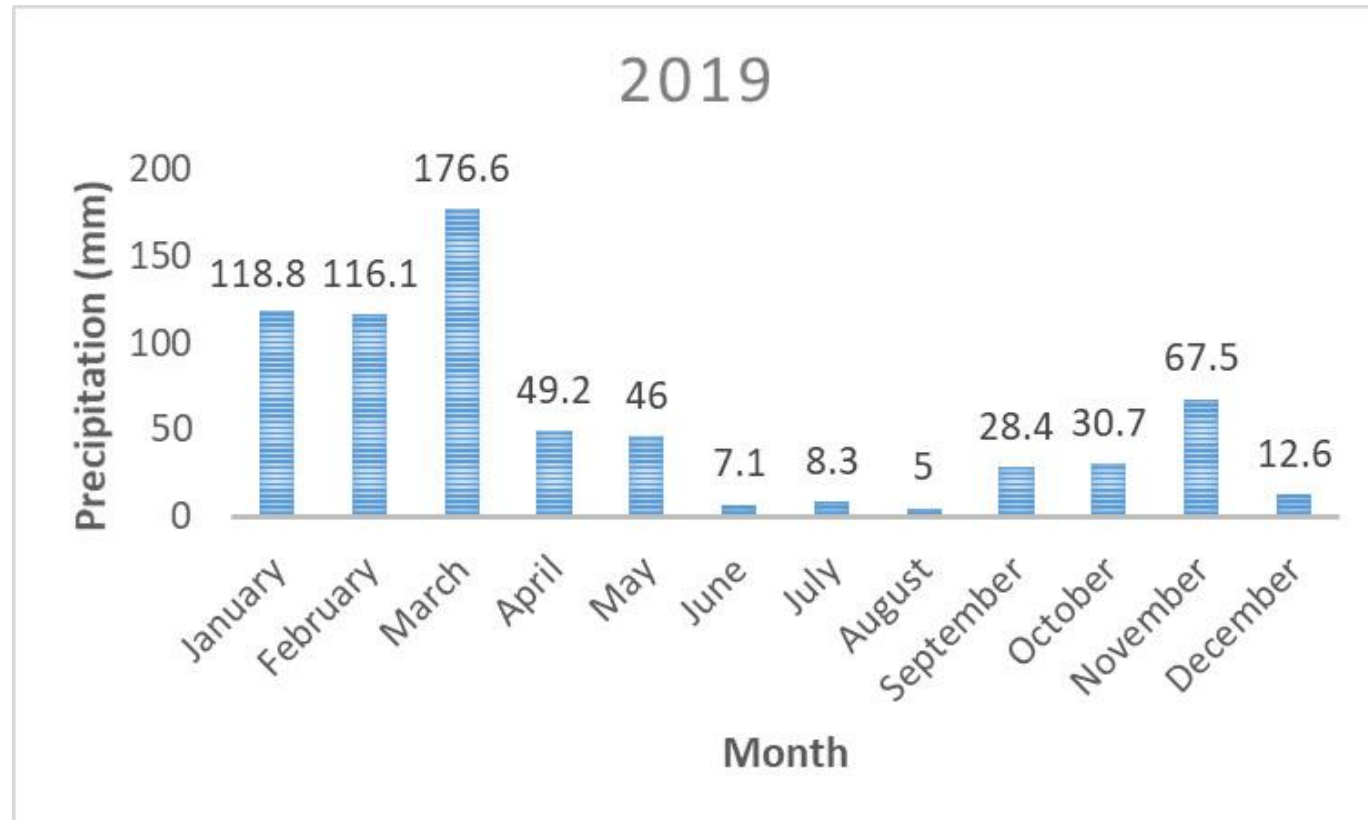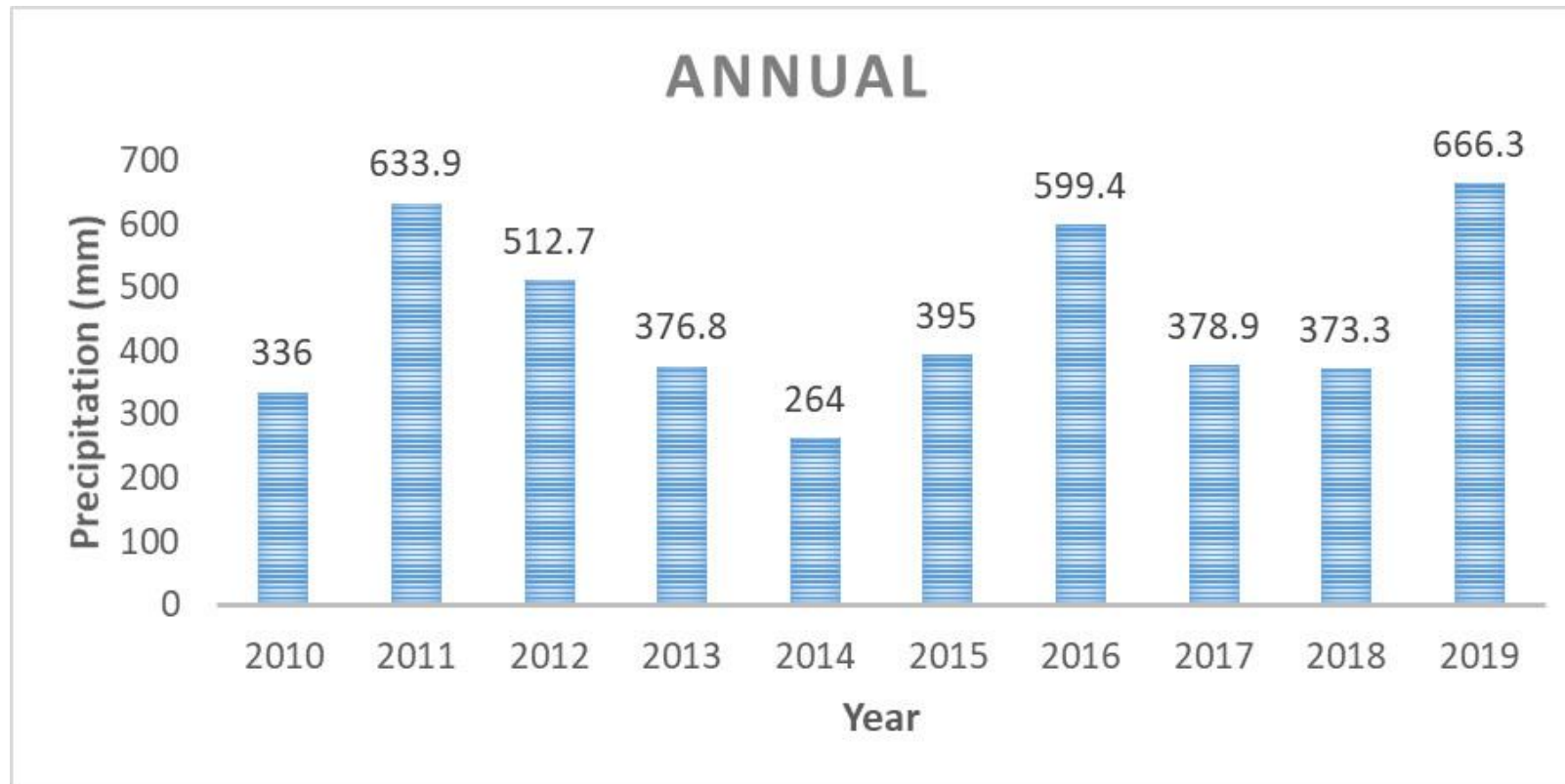From 2010 to 2019, the maximum annual precipitation occurred in 2019 (i.e., 666.3 mm), 236.3 mm and 256.3 mm higher than the 10-year and 20-year average annual precipitation in Aqqala county (Iran Meteorological Organization).

Elevation map
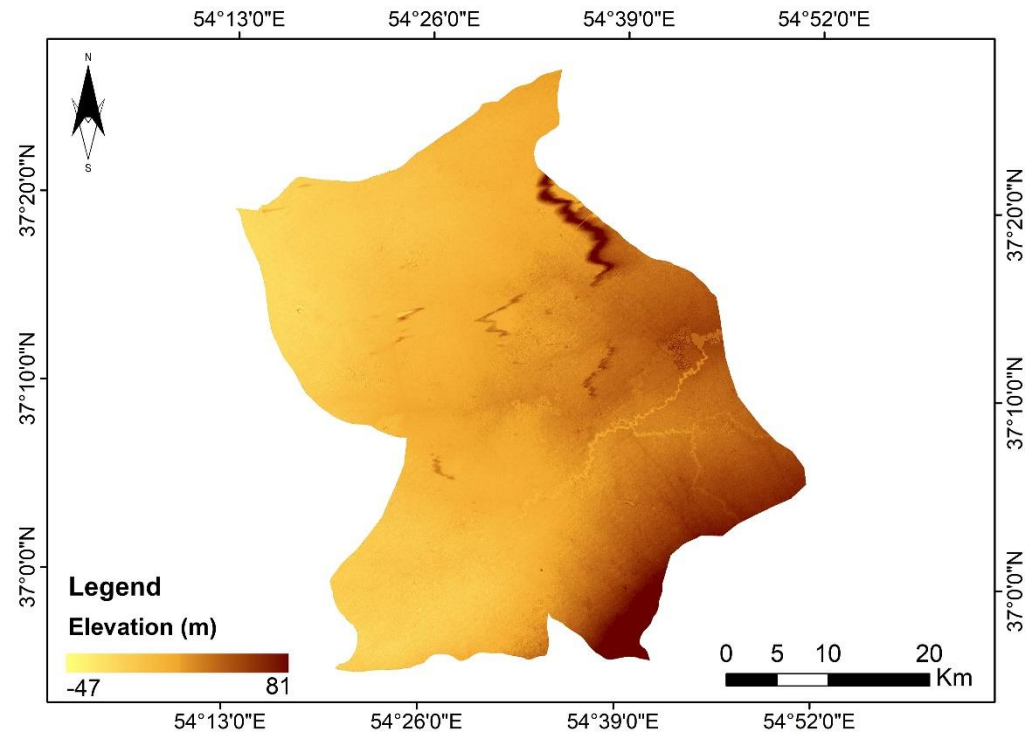
Slope map
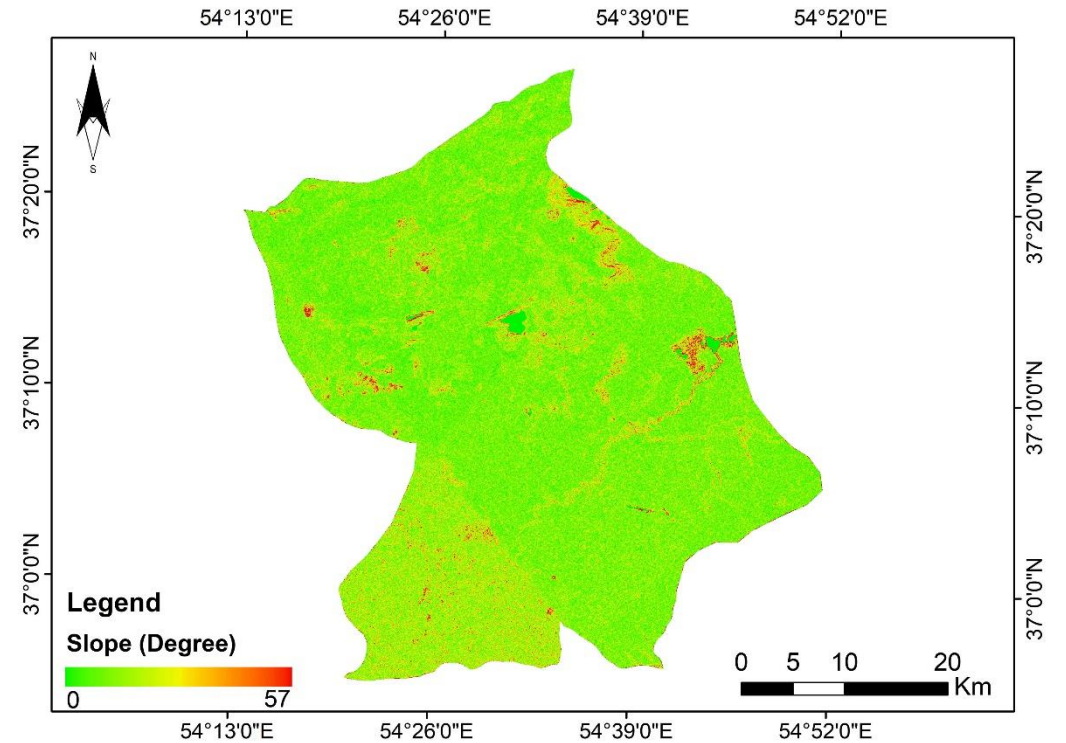
- Although optical images served as an efficient tool to monitor processes on the Earth, they have limitations for monitoring floods caused by long rainfall.

- Optical wavelengths cannot penetrate the clouds. However, clouds seem transparent in long-wavelength in the microwave part of the spectrum. SAR images contain unique information in cloud-prone areas.

Sentinel 1

Sentinel-1 began its mission on April 3, 2014. Sentinel-1 is an imaging radar located in the polar orbit. It provides dual-polarized (VH and VV) images with 10 m spatial resolution and its incidence angle ranges between 20 and 46. Sentinel-1 operates at C band with the wavelength of circa 5 cm. Its polar orbit and dual-polarization capability make it possible to rapidly transmit the data into the ground stations (ESA, 2014).

Satellite/ Sensor	Image captured	Mode	Processing level	Acquisition date
Sentinel-1A	Pre- flood	IW	Level-1 GRD	2019.03.11
Sentinel-1A	During the flood	IW	Level-1 GRD	2019.03.23
Sentinel-1A	During the flood	IW	Level-1 GRD	2019.04.04
Sentinel-1A	During the flood	IW	Level-1 GRD	2019.04.16
Sentinel-1A	During the flood	IW	Level-1 GRD	2019.04.28
Sentinel-1A	During the flood	IW	Level-1 GRD	2019.05.10
Sentinel-1A	During the flood	IW	Level-1 GRD	2019.05.22
Sentinel-1A	Post -flood	IW	Level-1 GRD	2019.06.03

Multi-temporal Sentinel-1 images
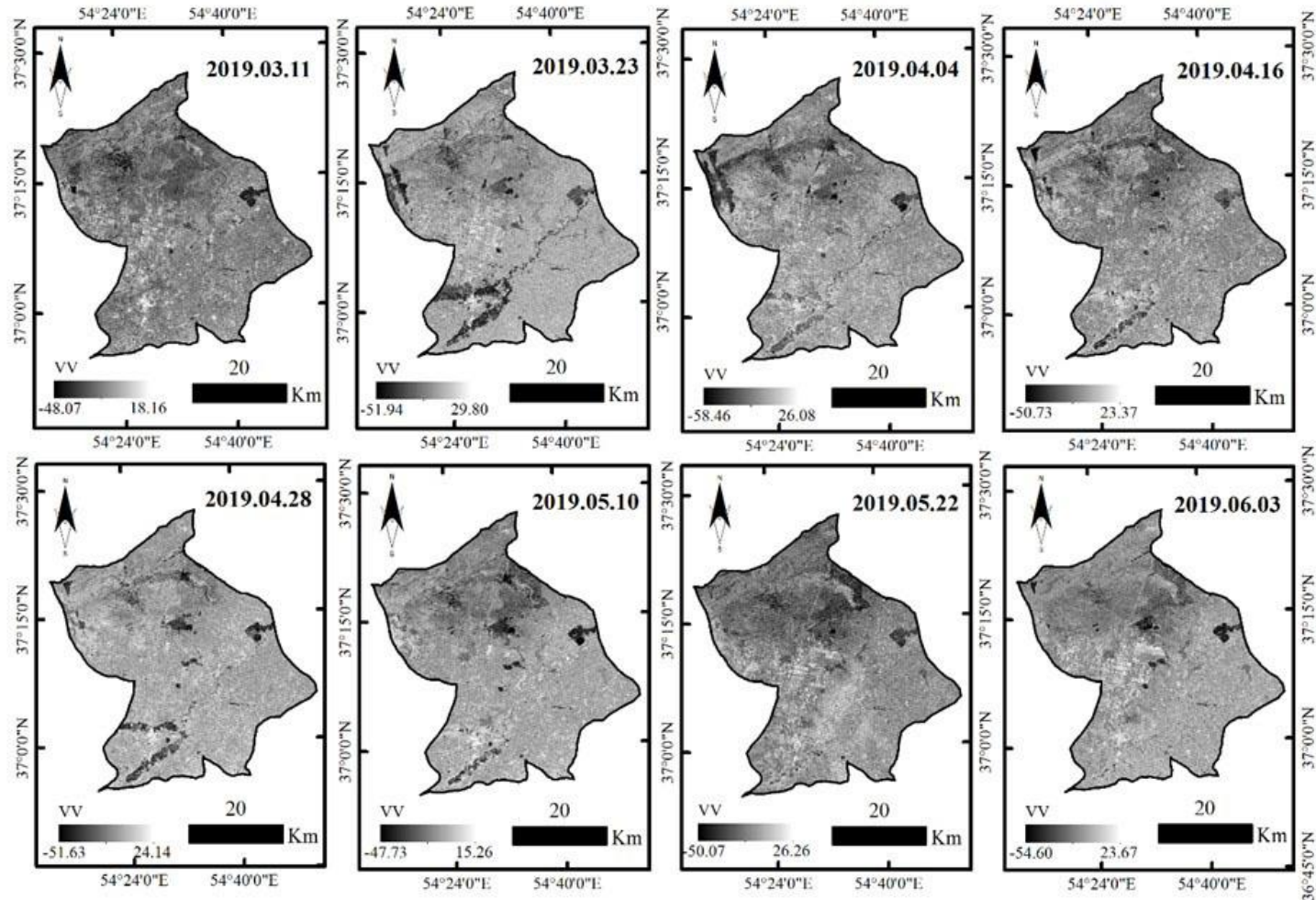
- Sentinel-1 images have been pre-processed in Google Earth Engine (Cloud Platform) based on the Sentinel-1 toolbox.

- Google Earth Engine offers an exciting tool for flood mapping because it saves time and accelerates image processing.

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│  Sentinel-1 time series images           │
│      🗺️  🗺️  🗺️  ...                       │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│                          ┌ Apply orbit file        │
│                          │ Thermal noise removal    │
│ Sentinel-1 images        │ Radiometric calibration  │
│ Pre-processing        ───┤ Speckle filtering        │
│                          │ Terrain correction       │
│                          └ Conversion to dB         │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│  Otsu automatic thresholding method      │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│  Map of flooded areas                    │
│      🗺️  🗺️  🗺️  ...                       │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│  Accuracy assessment                     │
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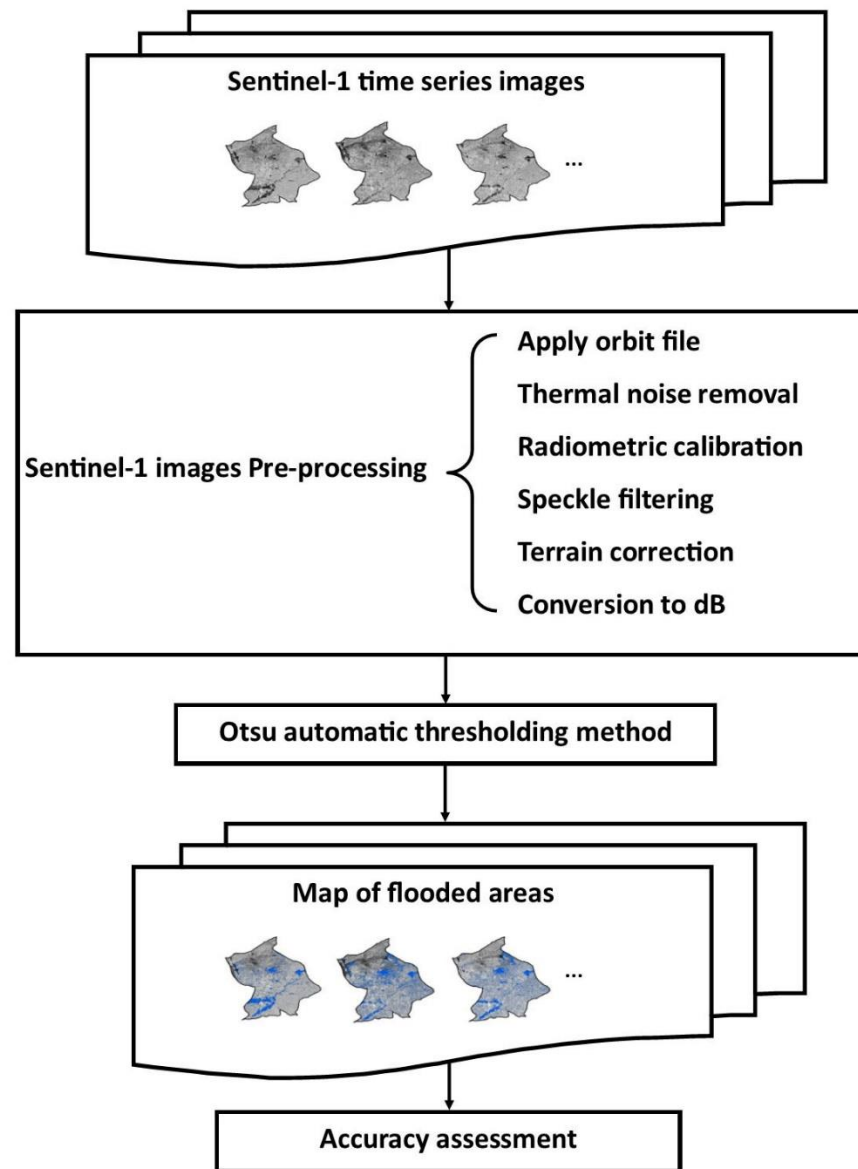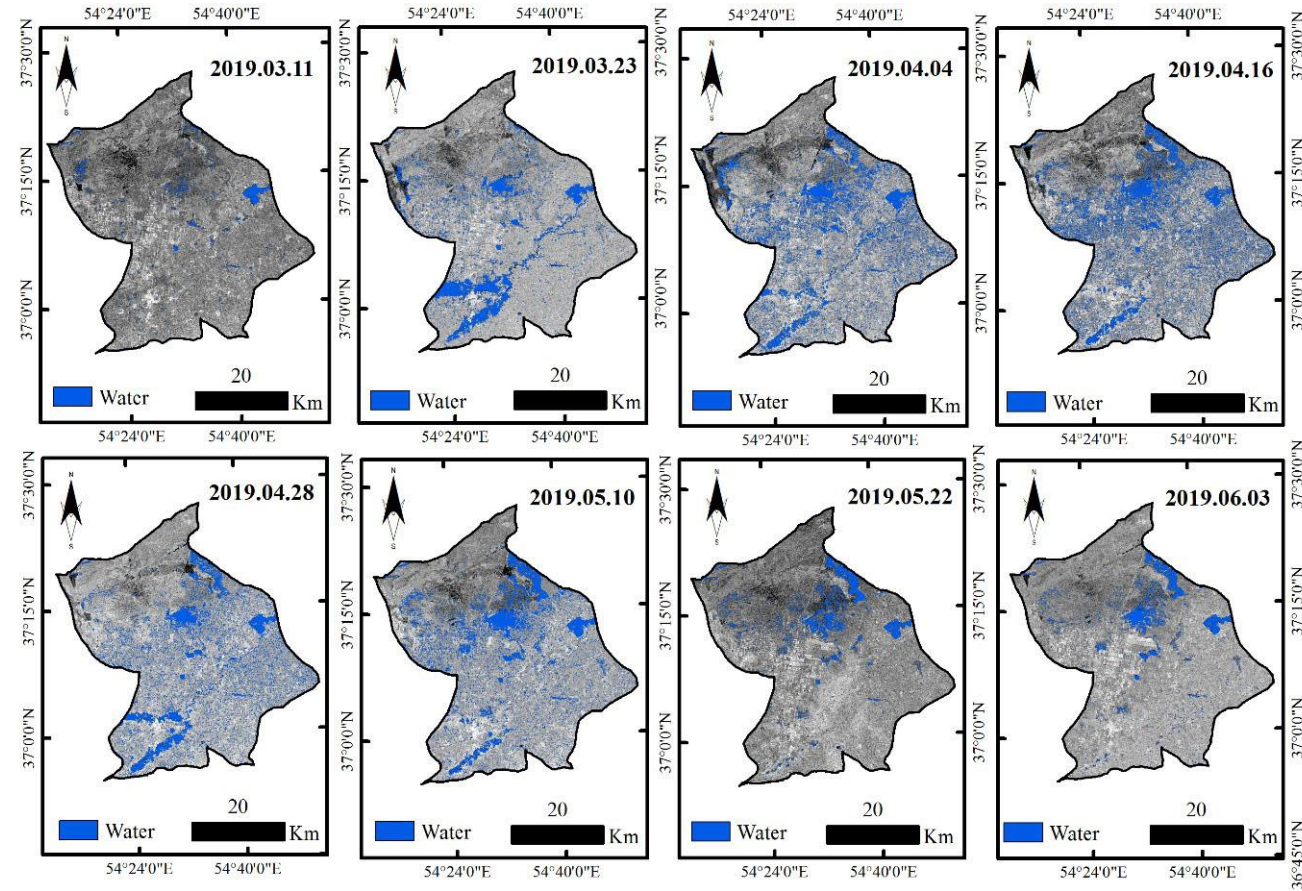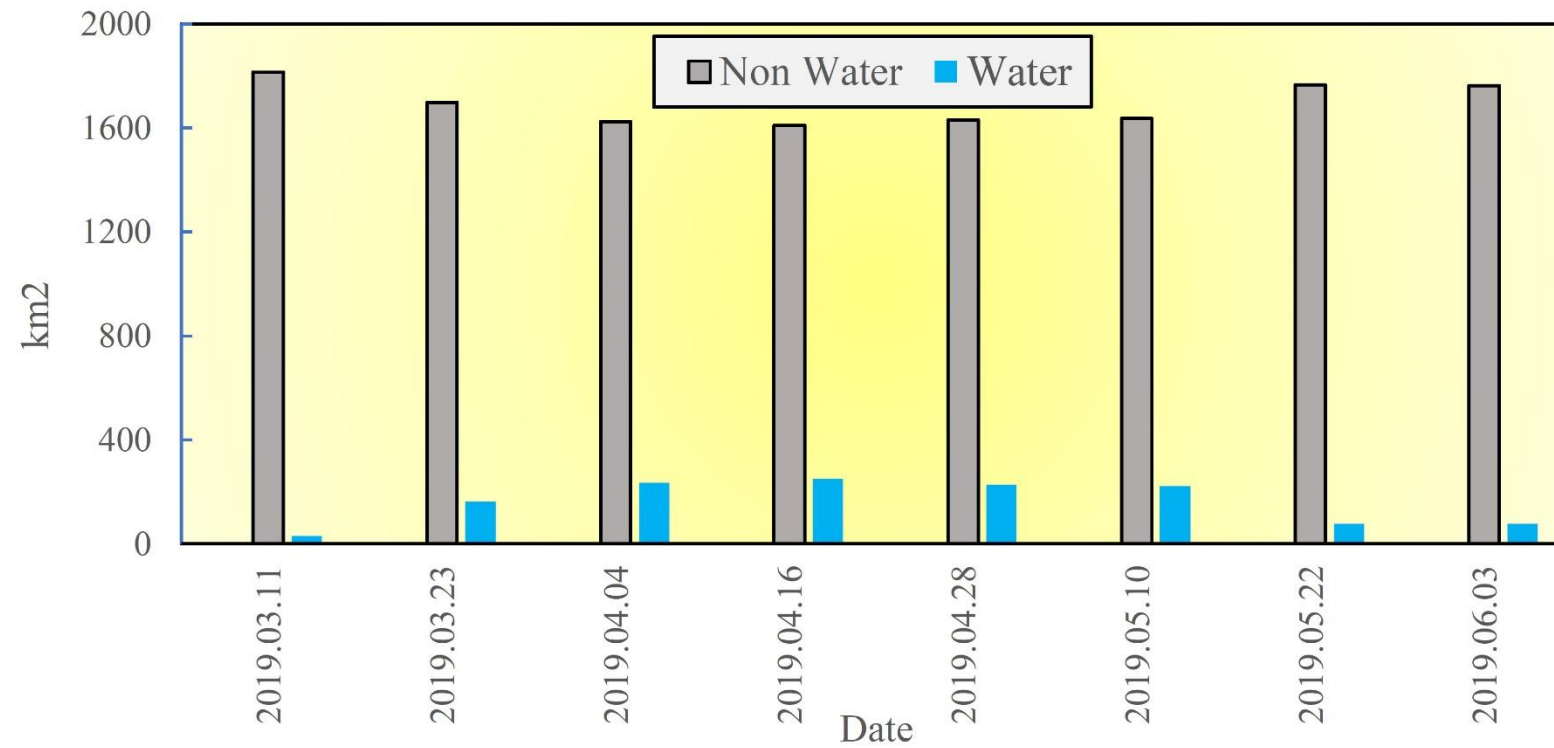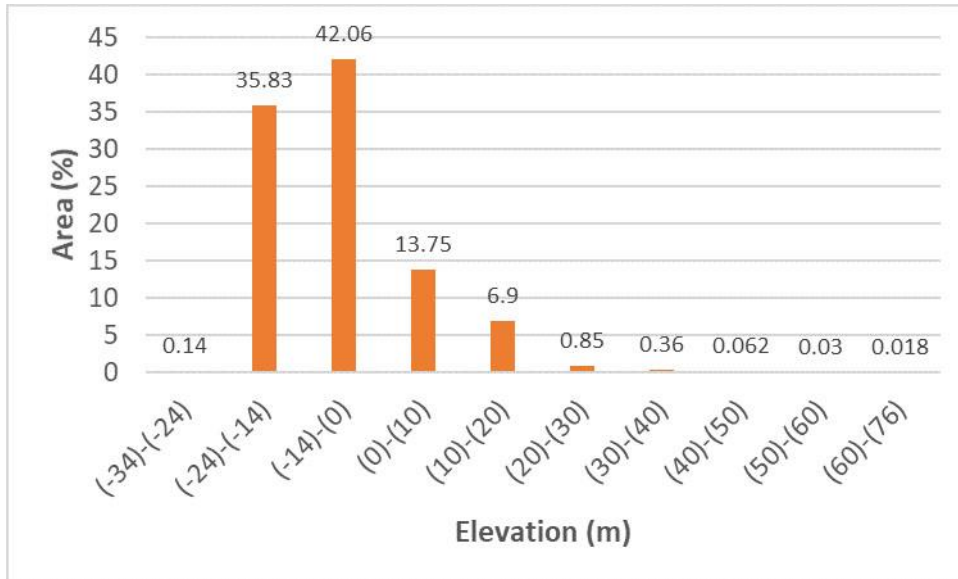
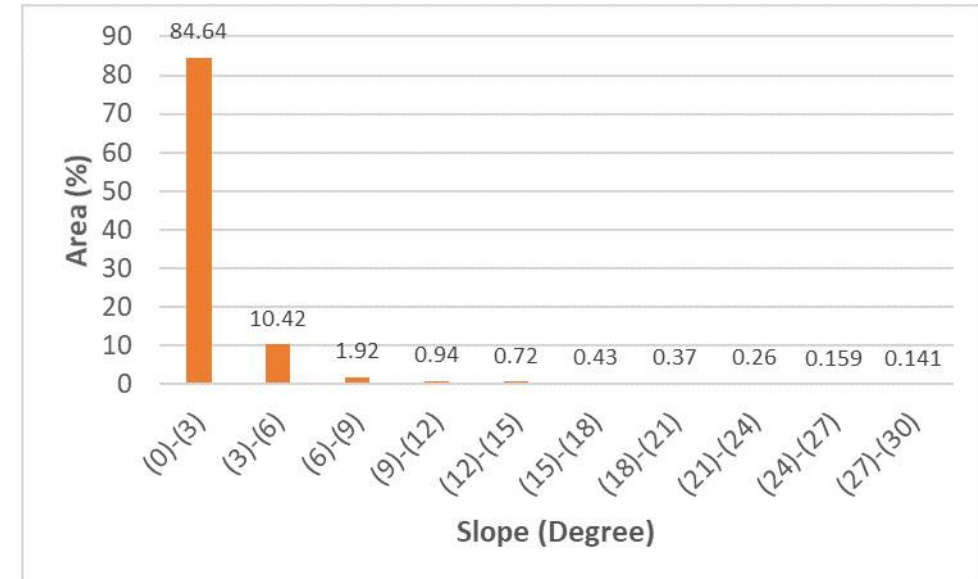# Detected flooded area overlaid on Sentinel-1 images
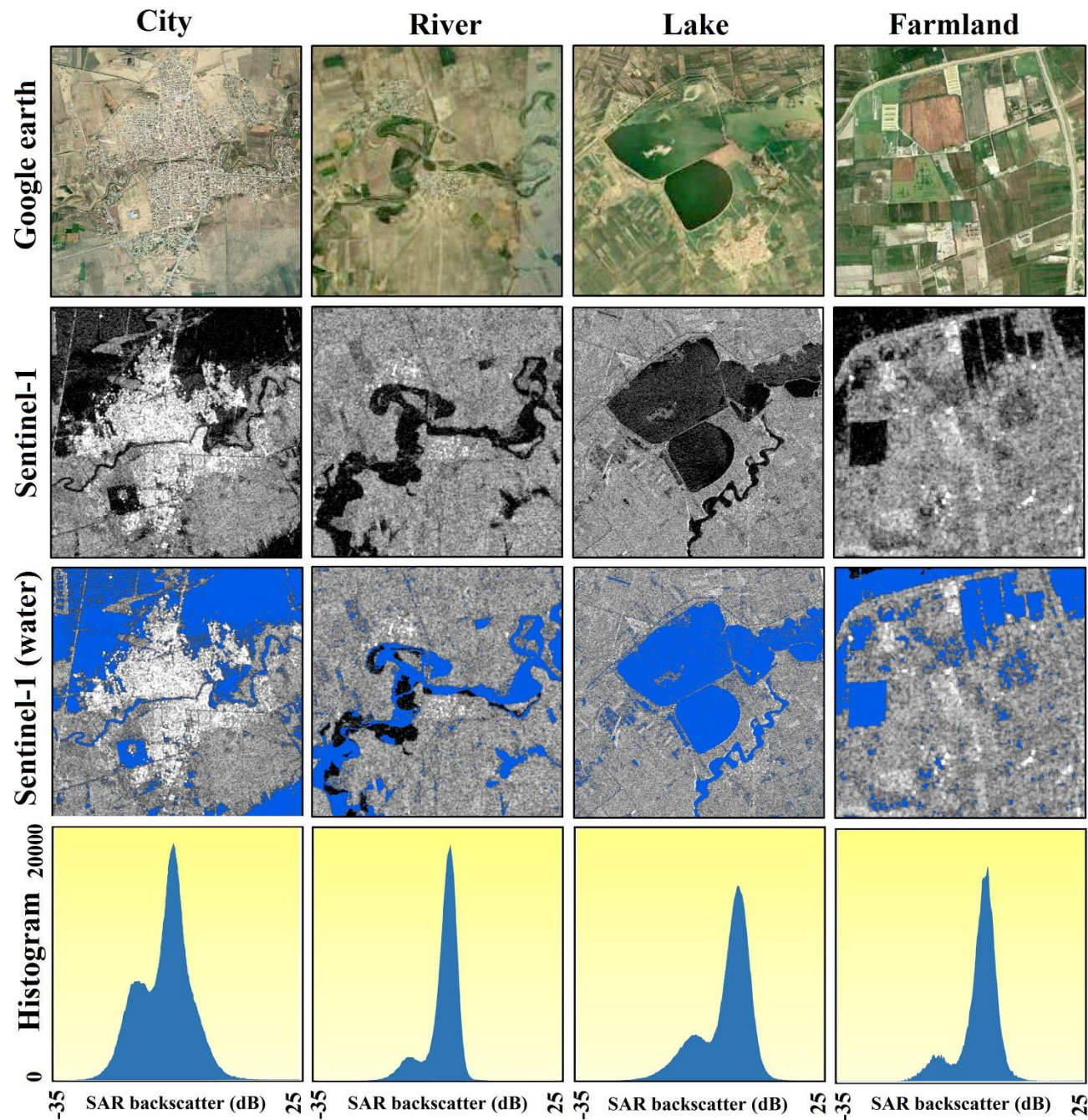
Changes of the flood extent

Percentage of flooded areas at different elevations

Percentage of flooded areas at different slopes

Water surfaces detected by the Otsu algorithm in four subsets of Sentinel-1 images

Conclusion

- The exploitation of Sentinel-1 images highlights the application of the presented research. Sentinel-1 full archive is freely available from its mission start, and its spatial and temporal resolution makes it suitable for timely flood mapping.

- The research's findings demonstrate that SAR images can effectively be used in flood inundation mapping. This is of critical importance in the calibration and validation of flood inundation models. This will help the authorities to make proper decisions in disaster time.

Moharrami, Meysam, Mohammad Javanbakht, and Sara Attarchi. "Automatic flood detection using sentinel-1 images on the google earth engine." *Environmental monitoring and assessment* 193.5 (2021): 1-17.

Thank you for your attention!