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Identification of Flood Extents using Synthetic Aperture Radar images

Abdul Rehman, Department of Computer Science Engineering, Sant Longowal Institute of Engineering and Technology, Punjab, India

Under the supervision of Prof. Alok Bhardwaj, Mehta Family School of Data Science and Artificial Intelligence, Indian Institute of Technology Roorkee

Introduction and Motivation

- Synthetic Aperture Radar (SAR) is an all-weather, day-and-night satellite observation technique to observe the earth's surface processes as shown in Figure 1.
- Flood is considered to be one of the major disasters causing huge losses to life and property across the globe. In particular, floods occur in different parts of India every year during the monsoon season.
- Our motivation in this work is to use SAR to identify flood extents and to assist in emergency response operations. SAR is a useful tool for flood detection as it is operational during cloud cover and rainfall to give information on flood extents.

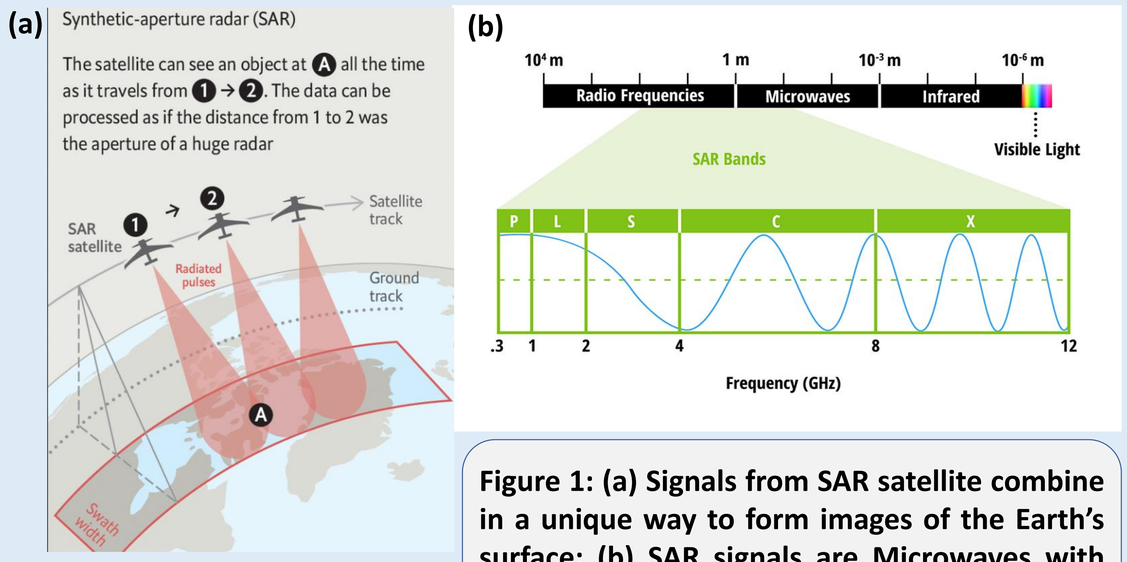


Figure 1: (a) Signals from SAR satellite combine in a unique way to form images of the Earth's surface; (b) SAR signals are Microwaves with wavelength between 1cm and 1 m.

Study Area and Data

- We have selected two flood extents representative of the flooding situation in urban and semi-urban areas. A major reason to select the two events is that SAR images were acquired within a few hours of the flood events.
- The first flood event occurred due to Hurricane Matthew on 8 October 2016 Hurricane Matthew in the Lumberton, North Carolina region of USA as shown in Figure 2 (Lin et al. 2019) (Figure 2 and Figure 3(a)).
- The second flood event occurred in Phitsanulok, which is a semi-urban area in Thailand on 13 October 2017. Phitsanulok is exposed to floods each year. The SAR image of the flood event is shown in Figure 3(b).
- For both study areas, we have selected SAR images from the SENTINEL-1 satellite operated by European Space Agency Satellite.

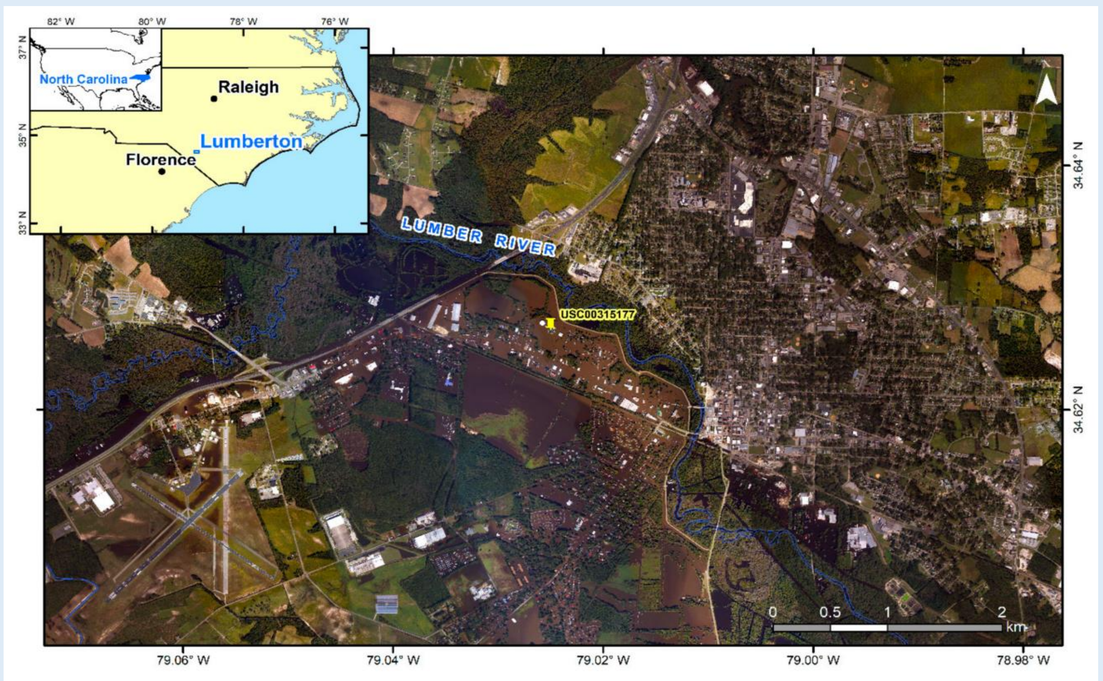
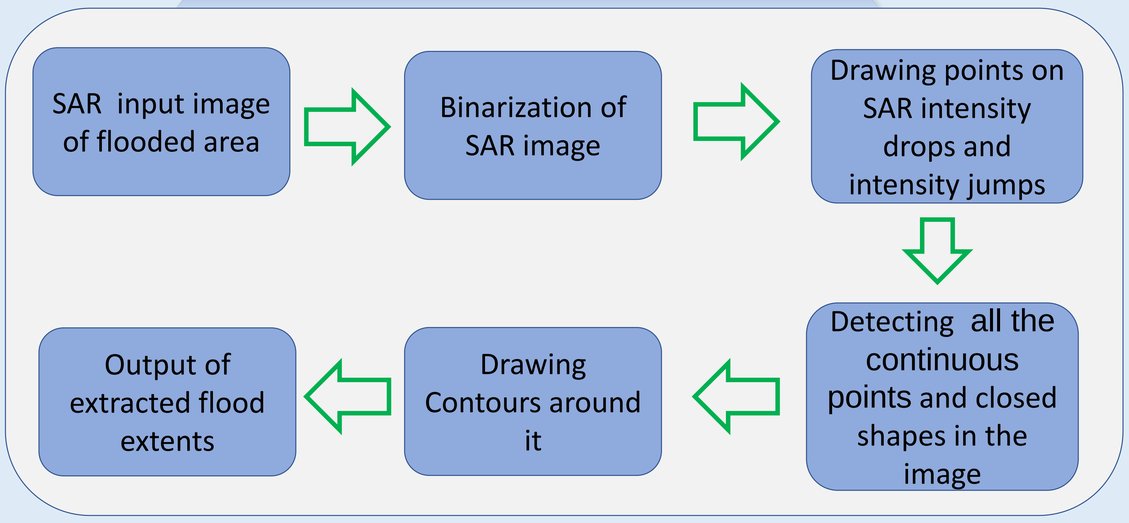


Figure 2: Aerial imagery of Lumberton, North Carolina showing flood extents in the center of the image. Our aim is to extract the flood extent from SAR image of the same event shown in Figure 3(a).

Methodology



Result

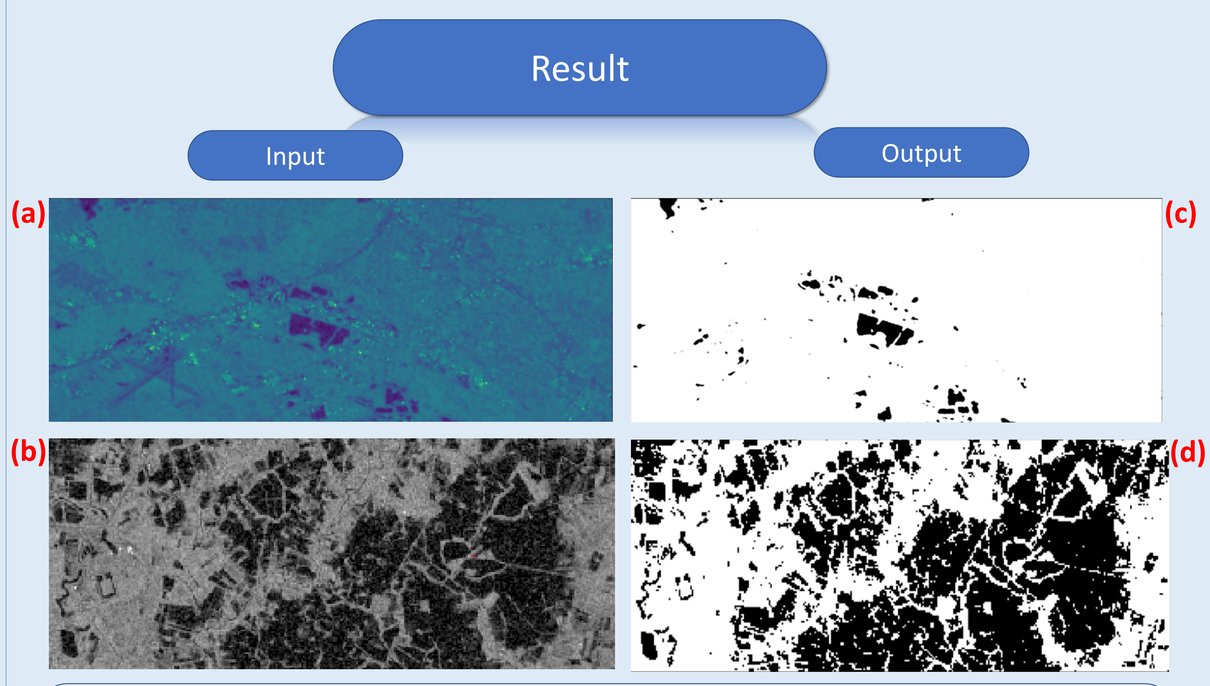


Figure 3: (a) SAR image of Lumberton flood obtained from Sentinel-1 satellite; **(b)** SAR image of Phitsanulok obtained from Sentinel-1 satellite. In both (a) and (b) the flood extents are represented by darker regions in the images. **(c)** Extracted flood extents for Lumberton flood; **(d)** Extracted flood extents for Phitsanulok flood

Conclusions and Future Work

- Flood extents are detected successfully in single SAR images. Our approach can be used in real-time to detect flood extents. This information is critical for first responders to plan aid kits, tents, etc.

Future Work:

- We have not performed an accuracy assessment on the extracted flood extents in terms of generation confusion matrix and accuracy assessment metrics. This will be completed in near future.

References

1. Figure 1: https://www.earthdata.nasa.gov/learn/backgrounders/what-is-sar (accessed on July 5, 2022) and https://www.economist.com/technology-quarterly/2022/01/27/synthetic-aperture-radar-is-making-the-earths-surface-watchable-24/7 (accessed on July 5, 2022).
2. Figure 2: Yunung Nina Lin, Sang-Ho Yun, Alok Bhardwaj, Emma M. Hill. (2019). Urban Flood Detection with Sentinel-1 Multi-Temporal Synthetic Aperture Radar (SAR) Observations in a Bayesian Framework: A Case Study for Hurricane Matthew, *Remote Sensing*, 11, 1778
3. Figure 3(a) from Lin et al. 2019
4. Figure 3(b) from M.Tech. Thesis of Sarwesh Samdarshi, ' Flood detection using synthetic aperture radar data and artificial intelligence, 2022, IIT Roorkee

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