Can We Reconstruct Cloud-Covered Flooding Areas in Harmonized Landsat and Sentinel-2 Image Time Series?

Zhiwei Li[1,2], Shaofen Xu[1], Qihao Weng[1,2,*]

[1] Department of Land Surveying and Geo-Informatics & [2] Research Centre for Artificial Intelligence in Geomatics
The Hong Kong Polytechnic University

THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學

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Project Webpage

INTRODUCTION: Earth observation satellites provide data for continuous and extensive flood monitoring, yet limitations exist when using optical images due to cloud cover [1]. Recent studies have developed gap-filling methods for reconstructing cloud-covered areas in water maps [2-3]. However, these methods are not tailored for and validated in cloudy and rainy flooding scenarios with rapid water extent changes and limited clear-sky observations. To overcome these limitations, this study developed a novel method for seamless time series flood mapping under varying cloud cover conditions.

METHODOLOGY

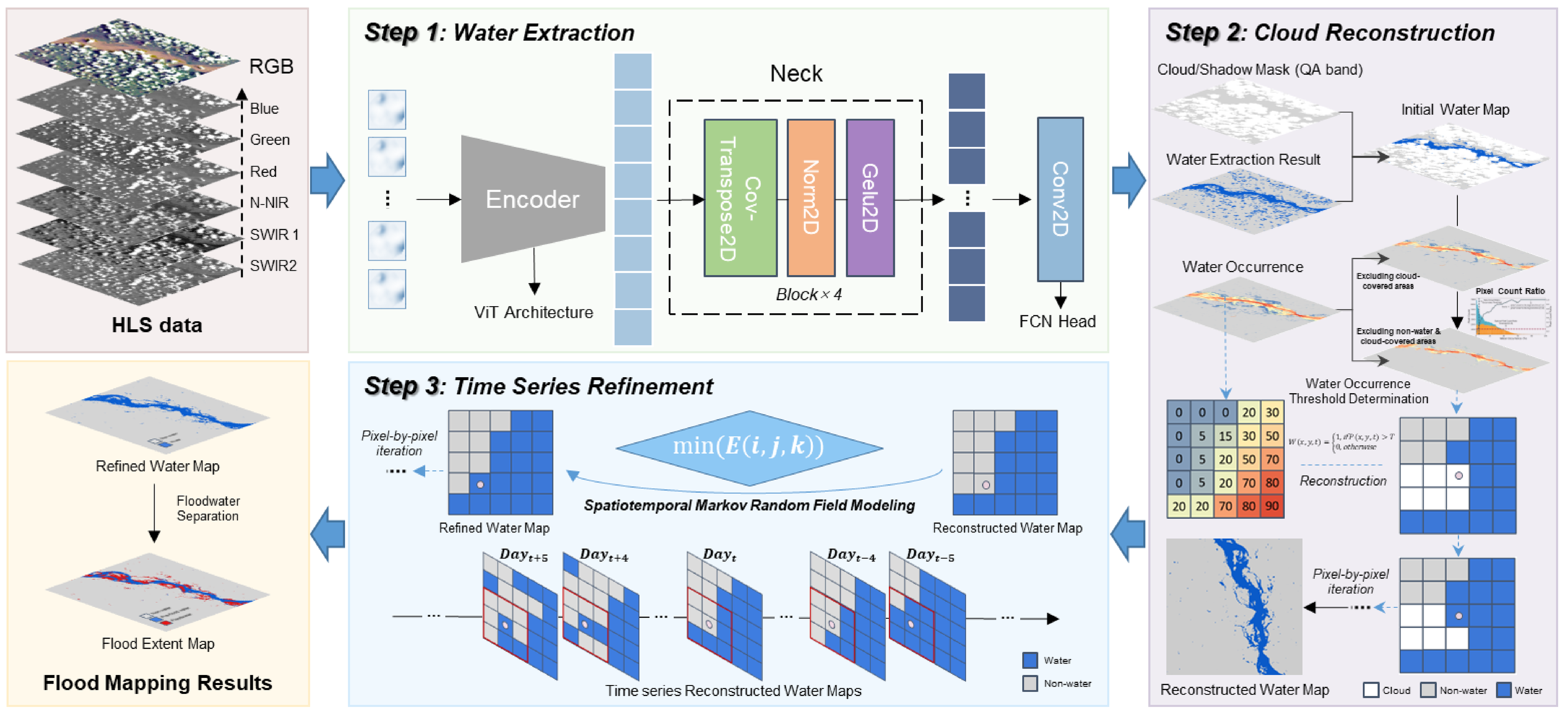

Fig. 1. Flowchart of the proposed seamless time series flood mapping method. ***Step 1***: Water extraction for each HLS image via a large foundation model [4]; ***Step 2***: Reconstruction of cloud-covered areas in each water map adhering to the submaximal stability assumption; ***Step 3***: Refining time series water maps via the spatiotemporal Markov random field modeling.

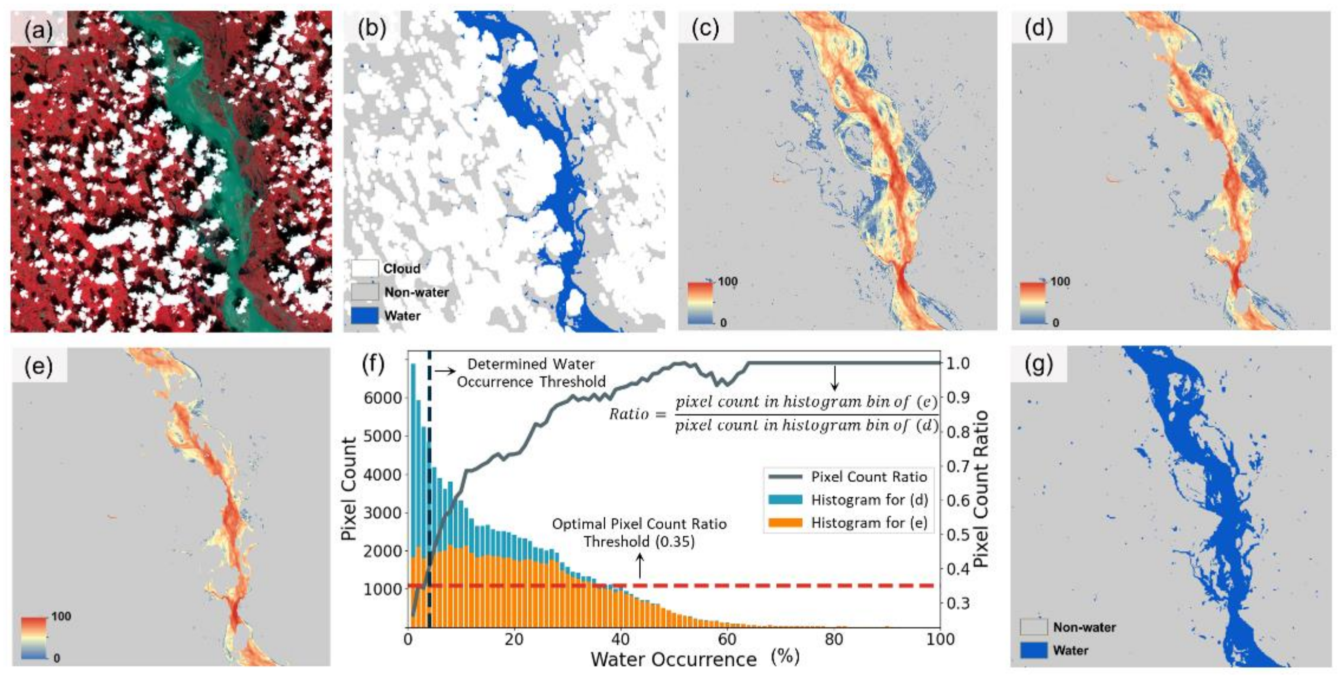

Fig. 2. Illustration of reconstructing cloud-covered areas in the water map. **(a)** Cloudy HLS image; **(b)** Initial cloud-covered water map; **(c)** Water occurrence excluding cloud-covered areas in the GSW dataset; **(d)** Water occurrence excluding cloud-covered areas; **(e)** Water occurrence excluding non-water and cloud-covered areas; **(f)** Water occurrence histograms for (d) and (e) and determination of the water occurrence threshold. **(g)** Reconstructed binary water map.

RESULTS

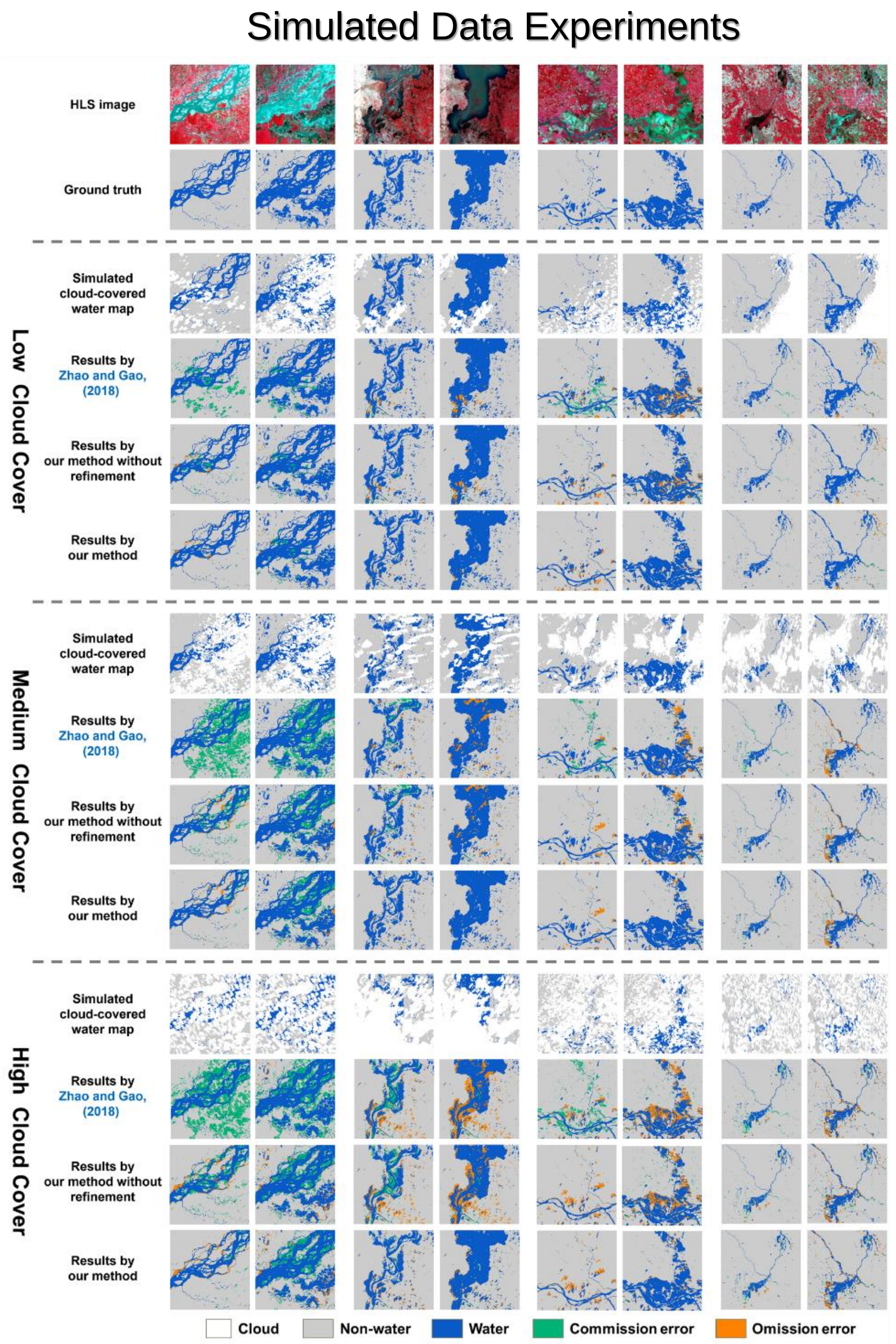

Fig. 3. Comparison of water extent maps reconstructed by the compared gap-filling method [2] and the proposed method with and without spatiotemporal modeling-based refinement through simulated data experiments.

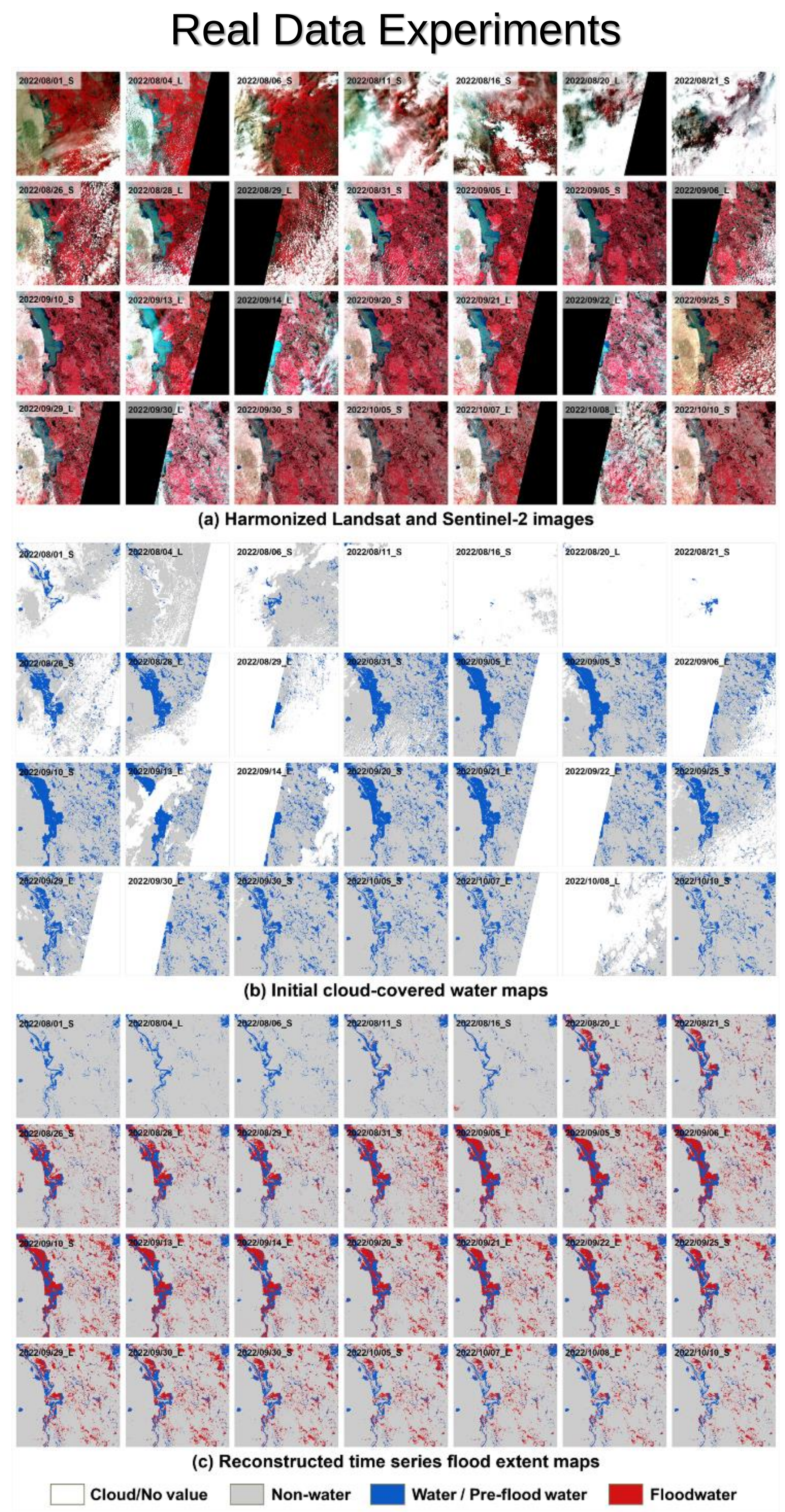

Fig. 4. Example reconstruction results of the proposed method for seamless time series flood extent mapping over Sindh, Pakistan during the 2022 flood event.

VALIDATION

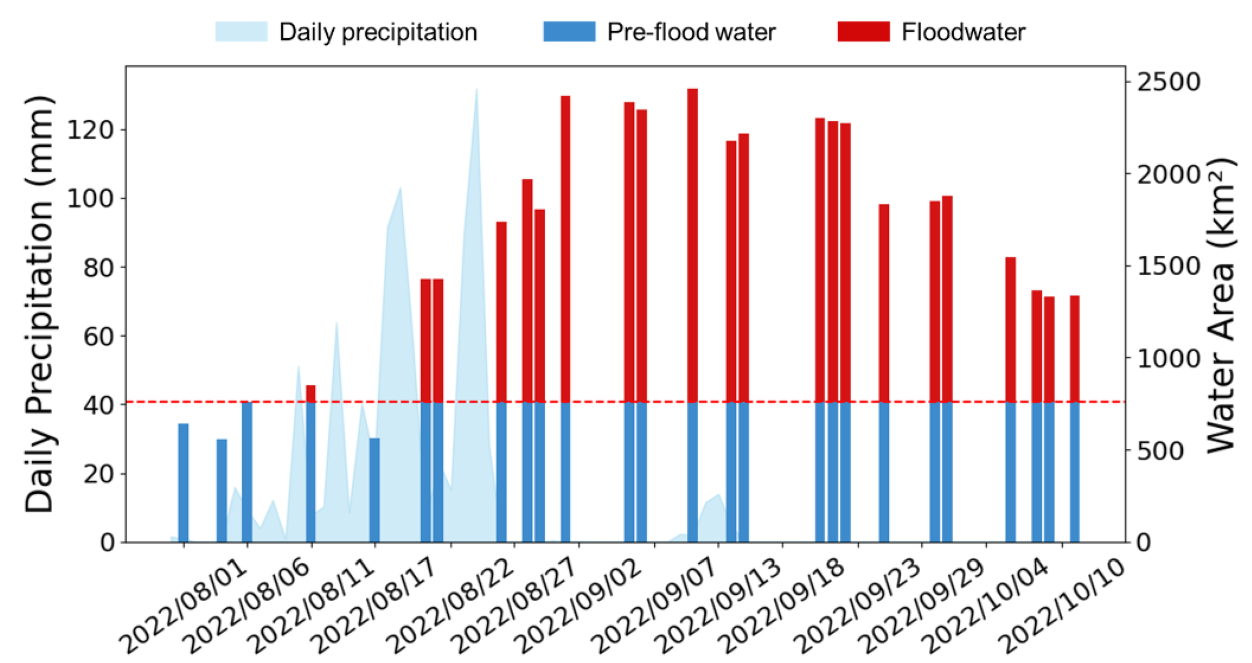

Fig. 5. Comparison of areas of identified floodwater (red bar) with daily precipitation (light blue background) over Sindh, Pakistan during the 2022 flood event.

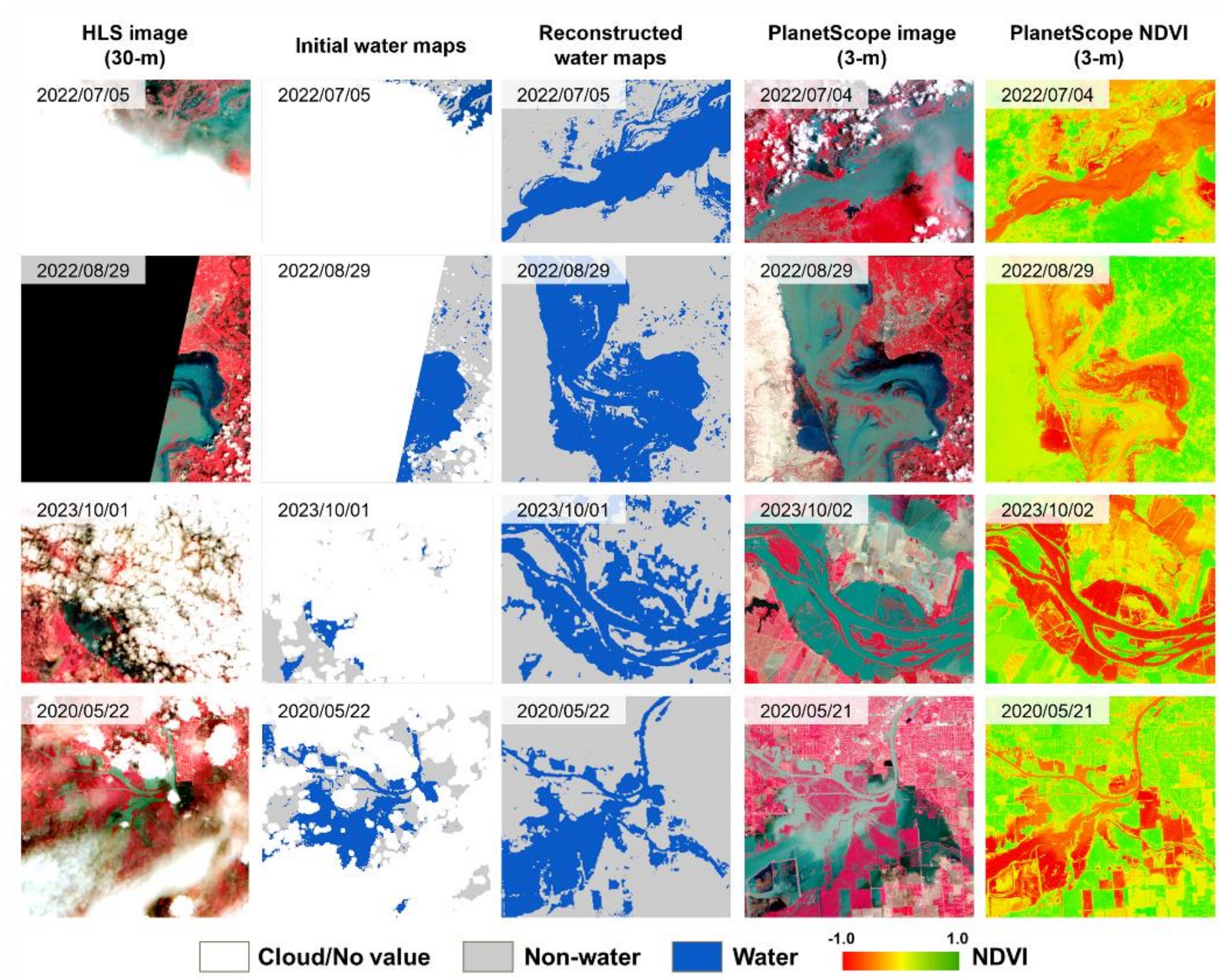

Fig. 6. Comparison of reconstructed flood extent maps with high-resolution PlanetScope images.

CONCLUSIONS

- We developed a robust method to reconstruct cloud-covered areas in time series water maps and evaluated its effectiveness for seamless flood mapping under flooding scenarios with varying cloud cover.
- The proposed method was proven effective in enhancing time series flood monitoring and outperformed the compared gap-filling method in reconstructing cloud-covered flooding areas.
- Future studies could explore the harmonization of water maps derived from multi-modal and multi-sensor data, as well as the transferability of the proposed method in mapping extreme flooding events.

KEY REFERENCES

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