



# Towards time-continuous long-term monitoring of global lakes and reservoirs: a novel algorithm for improving temporal frequency of lake area time series

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F. Yao, J. Wang, C. Wang, and J.-F. Crétau. Constructing long-term high-frequency time series of global lake and reservoir areas using Landsat imagery. *Remote Sensing of Environment*, 232 (2019): 111210, doi:10.1016/j.rse.2019.111210.

## Objectives

Improved monitoring of inundation extent variations in lakes and reservoirs is crucial for assessing surface water resources in a growing population and a changing climate. Although long-record optical satellites, such as Landsat missions, provide sub-monthly observations at fairly fine spatial resolution, cloud contamination often poses a major challenge for producing temporally continuous time series.

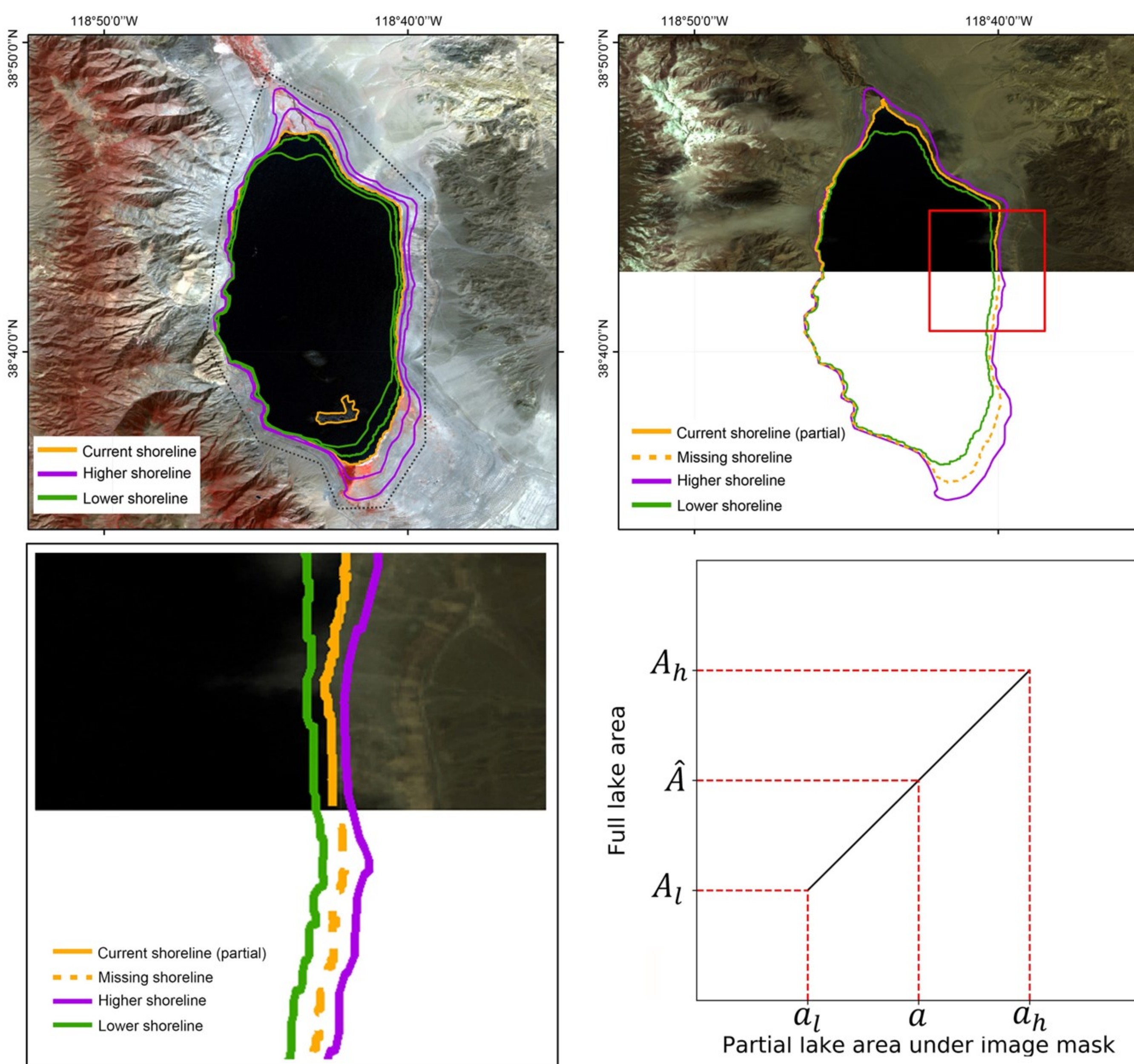
### Our objectives

- To improve the temporal frequency and accuracy of long-term water mapping using Landsat imagery
- To produce an up-to-date high-resolution record of global lake/reservoir area time series (**GLATS**; <https://lakewatch.users.earthengine.app/view/glats>)

## Methods

This method automates three steps to recover water areas from contaminated images on a cloud-based platform Google Earth Engine

- Step 1: Leveraging multiple indices to optimize water mapping
- Step 2: Correcting errors from minor contaminations by isobaths extracted from cloud-free images
- Step 3: Recovering water areas under major contaminations through a vector-based interpolation

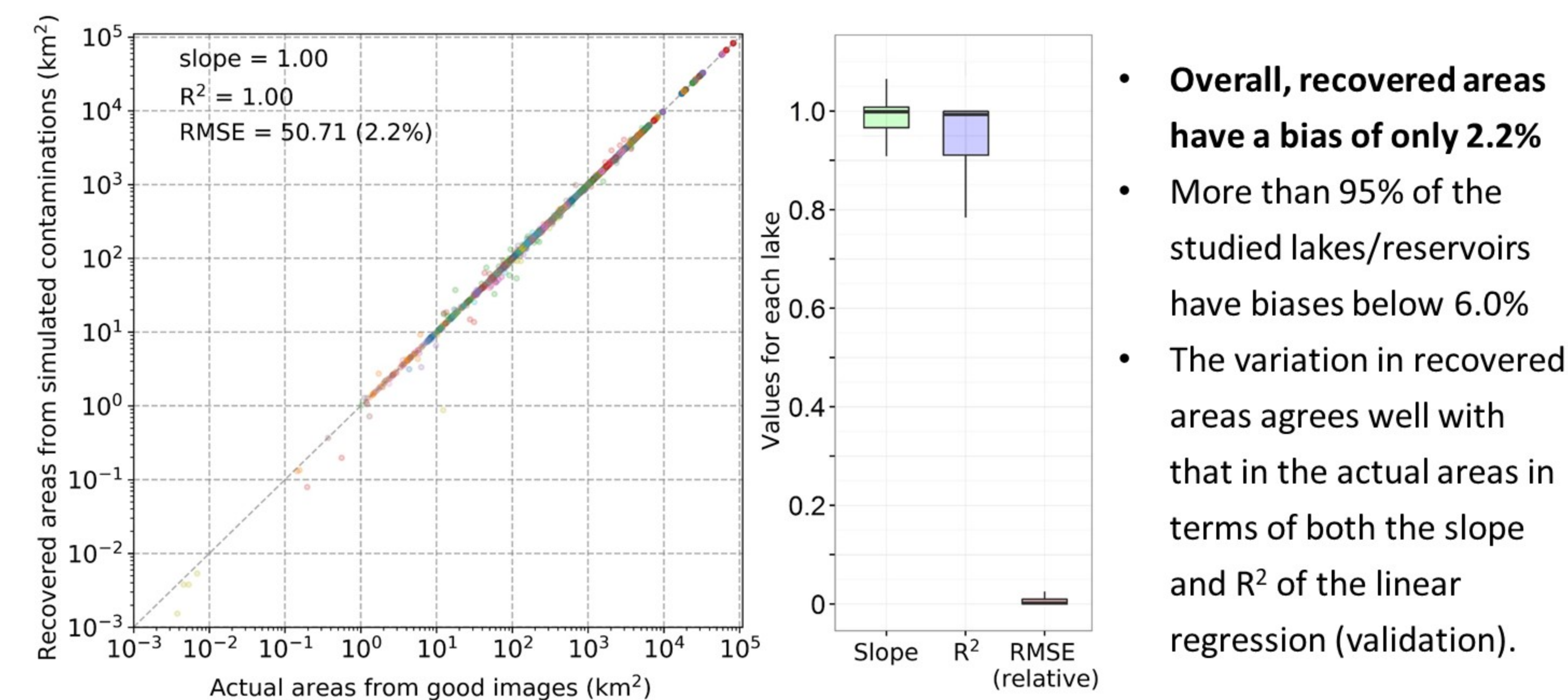


### Validations

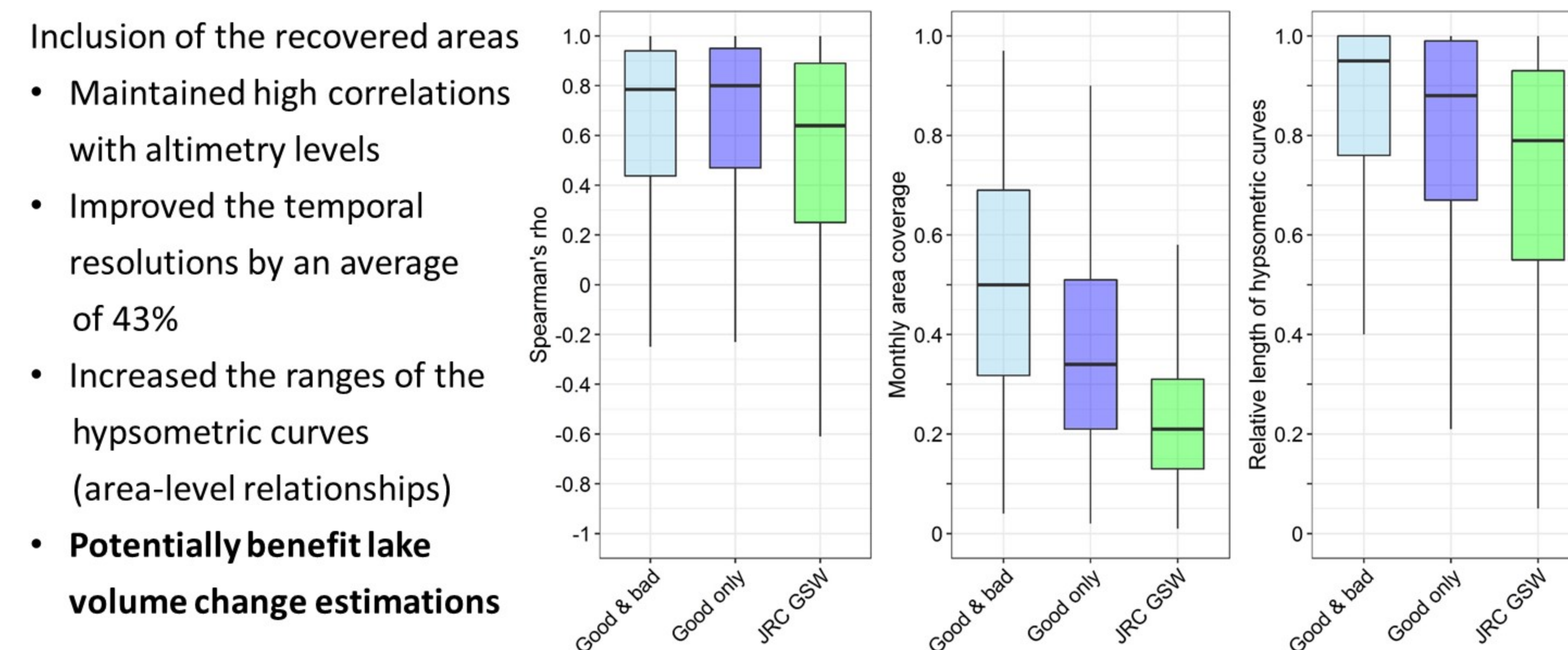
- Complete areas mapped from good images were used to assess the recovered areas from simulated partial observations in the same images.
- Comparison with altimetry water levels in terms of area-level (A-L) correlations. Altimetry levels were acquired from Hydroweb, DAHITI, and USDA G-REALM.

## Results: Validations on 400+ lakes/reservoirs

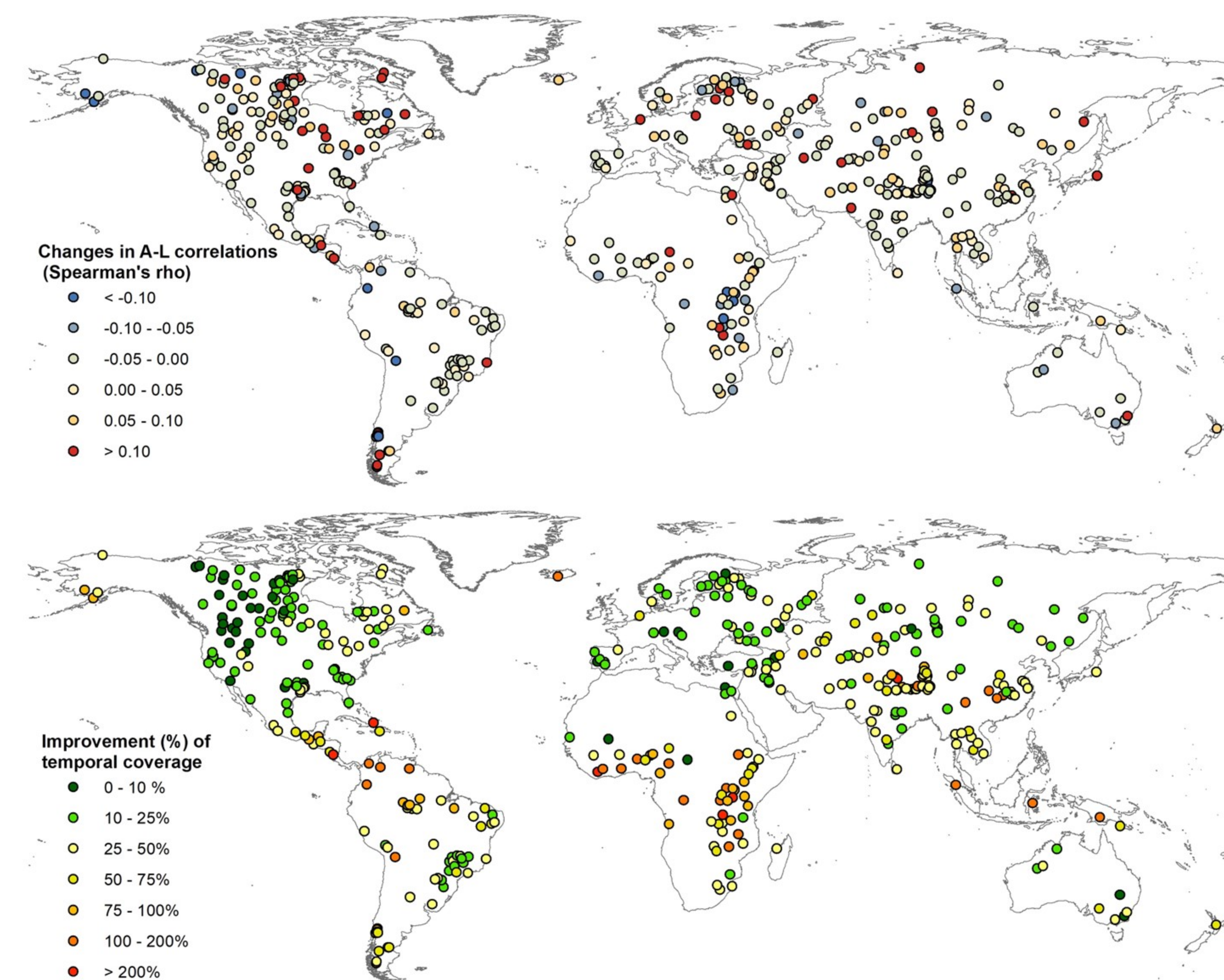
Validation of recovered areas from simulated contaminations on good images



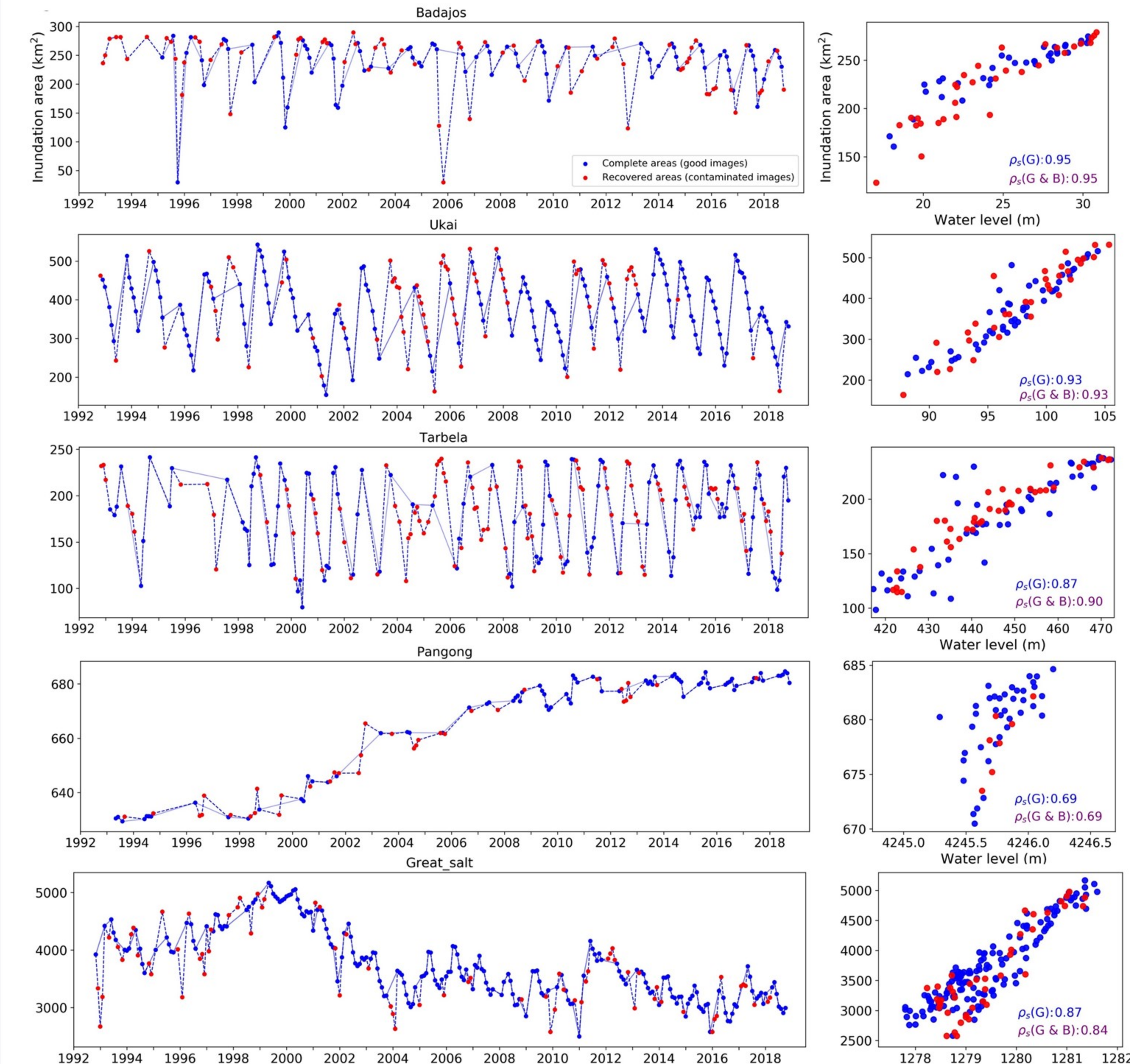
Validation of recovered areas by altimetry water levels



Impacts of recovered areas from contaminated images on A-L correlations and temporal coverage



## Results: Applications on challenging scenarios



This method was tested to be robust under various challenging scenarios, including fluvial lakes in humid basins with frequent cloud contaminations, reservoirs with complex shape geometries, water bodies in deep valleys with terrain shadows, high-altitude lakes with snow/ice covers, and saline lakes with high mineral concentrations.

## Conclusions

- This method could accurately estimate lakes and reservoir water areas from contaminated Landsat imagery with a mean relative error of 2.2%.
- The combined water area time series from both good and contaminated images show strong correlations with altimetry water levels, with Spearman's rho greater than 0.8 for most lakes/reservoirs.
- The combined area time series increased the monthly coverage using good images alone by an average of 43%, achieving a bi-monthly frequency for open surface water mapping.
- This method has a potential to i) assisting water area recovery for other optical and SAR sensors (e.g., Sentinel-2 and SWOT), and ii) estimating lake/reservoir storage variations in conjunction with altimetry sensors.

## Data Availability

Our produced global lake/reservoir area time series (**GLATS**) will be available on the website <https://lakewatch.users.earthengine.app/view/glats> or upon reasonable request.