Global Distribution of Small Reservoirs and Their Role in Surface Water Storage

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1. Introduction

- Global freshwater resources are increasingly stressed by population growth, agricultural expansion, and climate variability [1].
- Small agricultural reservoirs (< 0.1 km²) play a vital role in buffering irrigation and livestock supplies during dry seasons [2].
- However, comprehensive understanding of their global distribution and contribution to local water budgeting and management remains limited.

2. Objectives

- To globally identify small agricultural reservoirs (<0.1 km^2) by combining Sentinel-2 NDWI with Sentinel-1 backscatter in cloud-impacted seasons.
- To provide a comprehensive dataset of spatio-temporal distribution of agricultural reservoirs and their storage capacity.

3. Methods and data

- Global land-cover datasets were harmonized to build a gap-filled cropland mask that excludes lakes, rivers, urban areas, wetlands, and forests.
- Cloud free Sentinel-2 images were filtered, a median composite was generated, NDWI was calculated, and the result was masked to cropland.
- When Sentinel-2 coverage was not sufficient, Sentinel-1 was filtered, a mean VV backscatter image was computed, a region-specific threshold was applied to detect surface water, and the result was merged with the NDWI mask.
- Connected-component analysis and pixel-count were used to group water objects, compute their areas, and classify reservoirs into size bins (300 m²–100 000 m²).
- Total number of reservoirs, their cumulative area, and storage capacity were aggregated in 50×50 km² grid cells and their seasonal variations were exported

4. Preliminary results

- The extent of small agricultural reservoirs was showcased in selected regions
- Seasonal variations of the extent of reservoirs in 20 tiles (3°x3°) were extracted from March 2023 until February 2025.

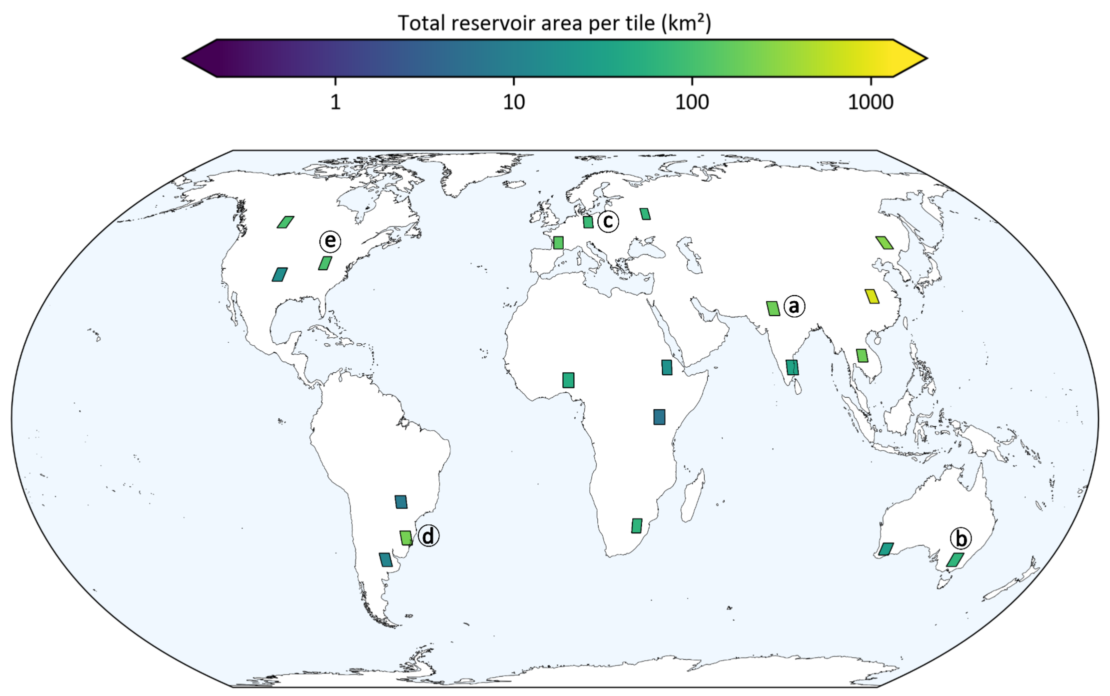
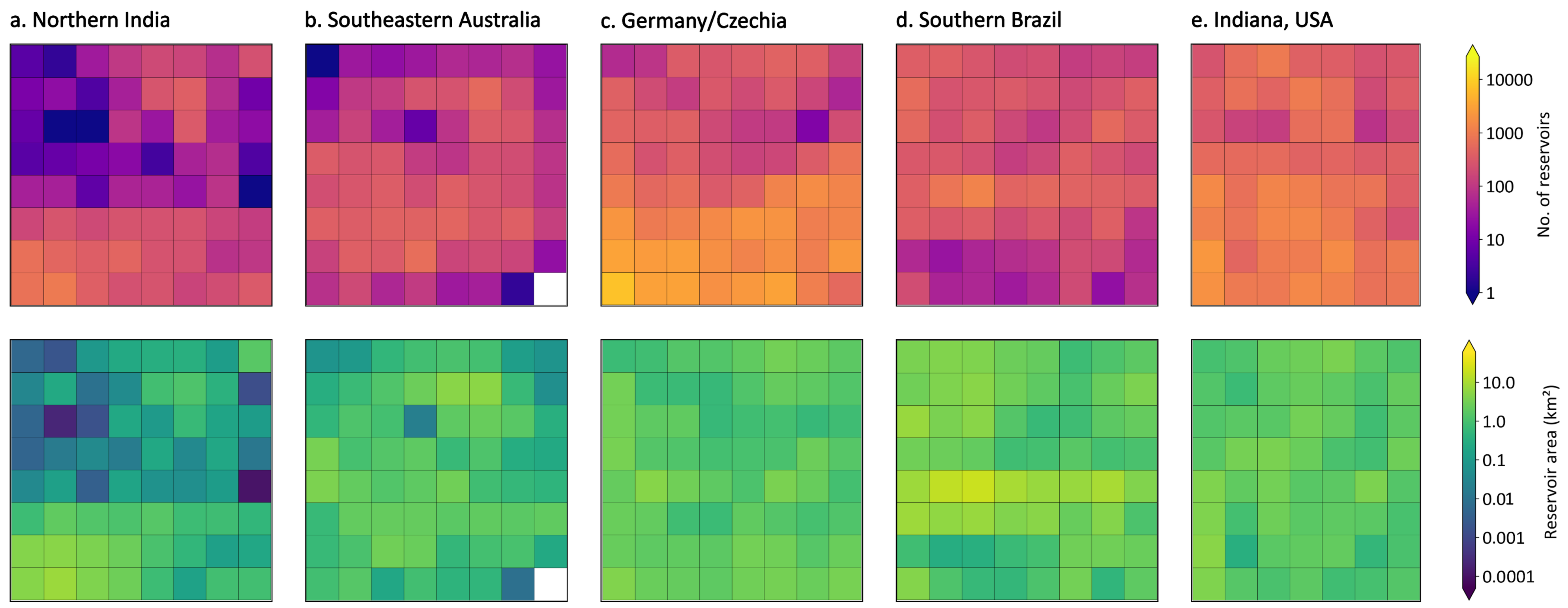


Figure 1: Global and regional views of mean reservoir extent (2023–2024):
a-e) Insets for five example tiles—North India, Southeast Australia, Germany/Czechia, South Brazil, and Indiana (USA), respectively—each showing 50×50 km² grids with (top) total reservoir count and (bottom) mean reservoir area (km²).
World map of 20 study tiles, coloured by mean reservoir area (km²)



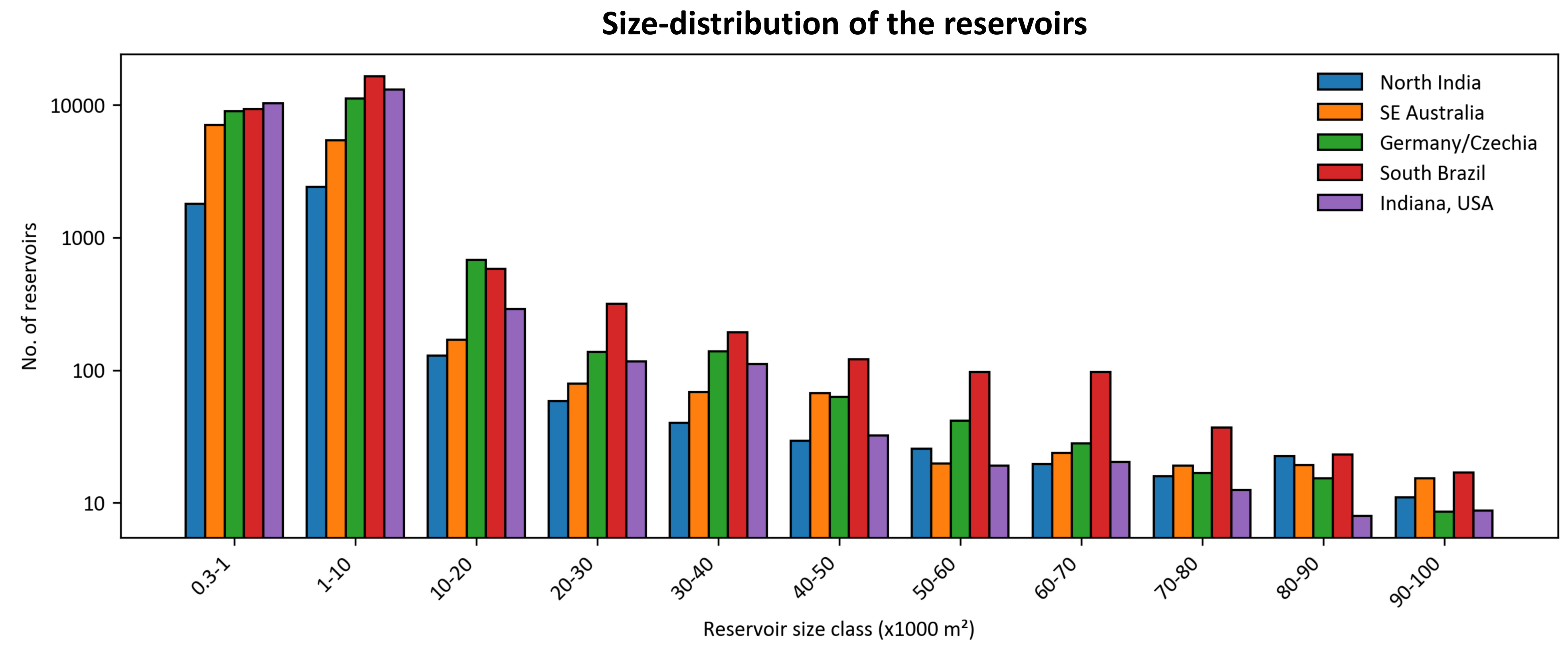


Figure 2: Reservoir size-class breakdown for key regions: *Comparative bar chart of reservoir counts by size class for the five tiles in Figure 1.*

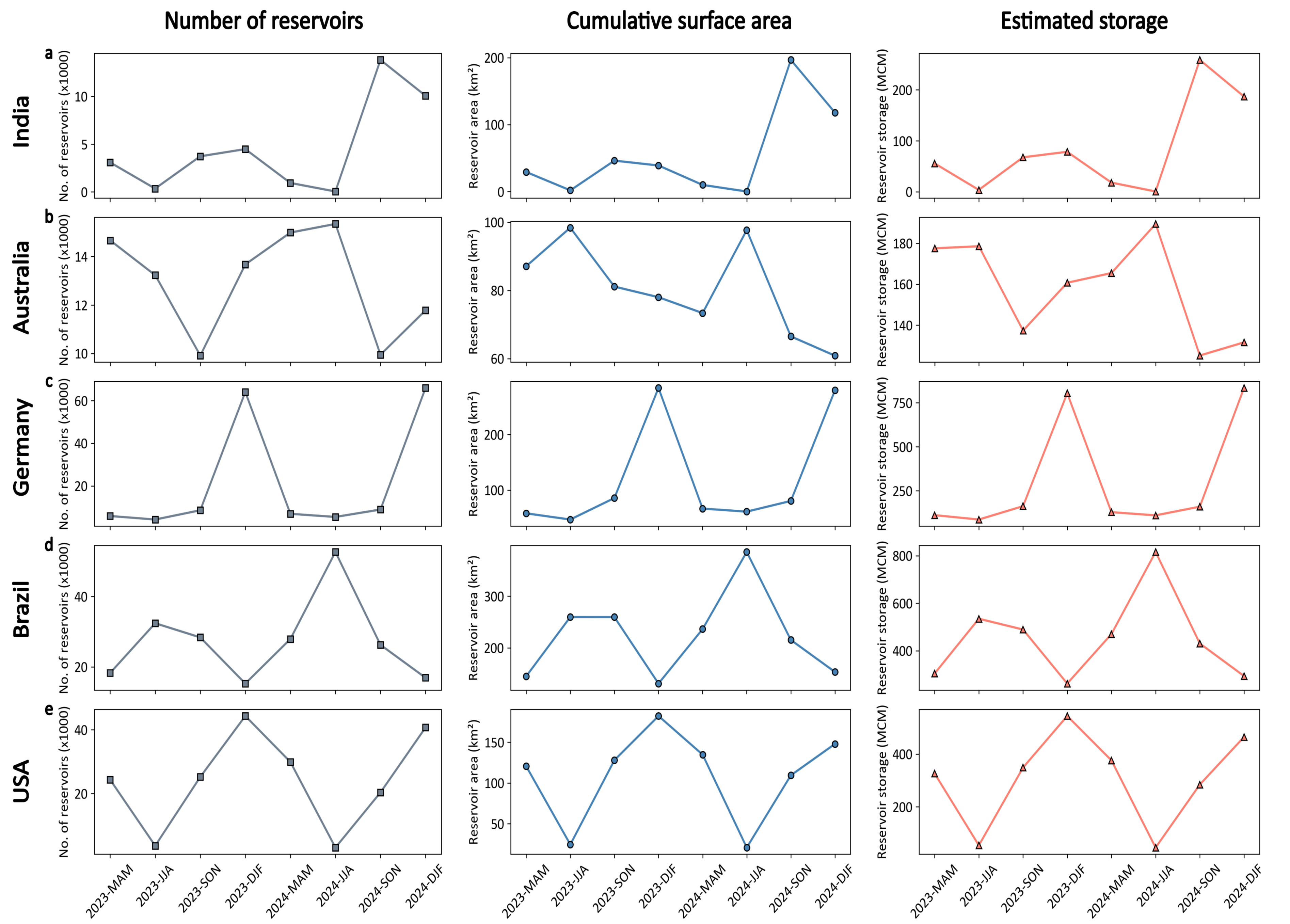


Figure 3: Seasonal dynamics for key regions:
a–e) Time series for tiles in Figure 1, depicting over eight seasons (2023 MAM to 2024 DJF): (left) total reservoir area (km²), (centre) reservoir density (# per grid cell), and (right) estimated storage (million m³) using power law ($V = 0.38 \times n \times A^{1.173}$) [3].

5. Next steps

- Machine-learning models will be developed to derive region-specific detection thresholds for both radar and optical data.
- The workflow will be scaled globally in Google Earth Engine to generate a comprehensive map of small reservoirs.
- An interactive dashboard will be built to allow dynamic exploration of seasonal trends, size-class breakdowns, and storage estimates.

6. References

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Abstract