Water Use With Cloud Computing: Prospective for Food and Water Security in Smallholder Irrigation Schemes

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Introduction

Agriculture is experiencing a global water shortage.

Food security can be improved by understanding how irrigated lands use water.

Thriving **evapotranspiration models incorporating remote sensing data** ➔ new unprecedented spatial and temporal resolutions.

Objective and Study Area

- **To investigate long-term irrigated crop water consumption** in two smallholder irrigation schemes in a west African semi-arid area (Burkina Faso)
- Accomplished by concentrating on the dry season (October to May) from 2000 to 2020, i.e., croplands are irrigated areas.
- Surroundings areas with significant land cover changes in the last 20 years (Figure 1)

Irrigation system: Lake Bam ➔ unmanaged; Bagré reservoir ➔ managed

Methods

- Entire study done in the cloud-computing environment Google Earth Engine (Gorelick *et al.*, 2017).

(1) Image classification
croplands are distinguished from other land uses categories using random forest image classification.

(2) Evapotranspiration mapping
The indicator "**water use**" ➔ estimated amount of water consumed per irrigated hectare (m^3ha^{-1}).

- derived from an automated tool implemented in the Google Earth Engine platform named geeSEBAL (Laipelt *et al.*, 2021).
- based on the Surface Energy Balance Algorithm for Land (SEBAL) and uses actual evapotranspiration from a surface energy balance model (Bastiaanssen *et al.*, 1998).

Actual evapotranspiration (mm) x Irrigated surface (ha) = Water use (m^3ha^{-1})

Daily information from 233 Landsat images (Landsat 5, 7 and 8- Bagré: 115 and Bam: 118) was used to convert monthly to seasonal actual evapotranspiration using ERA5 Land as meteorological inputs.

Results

Image Classification

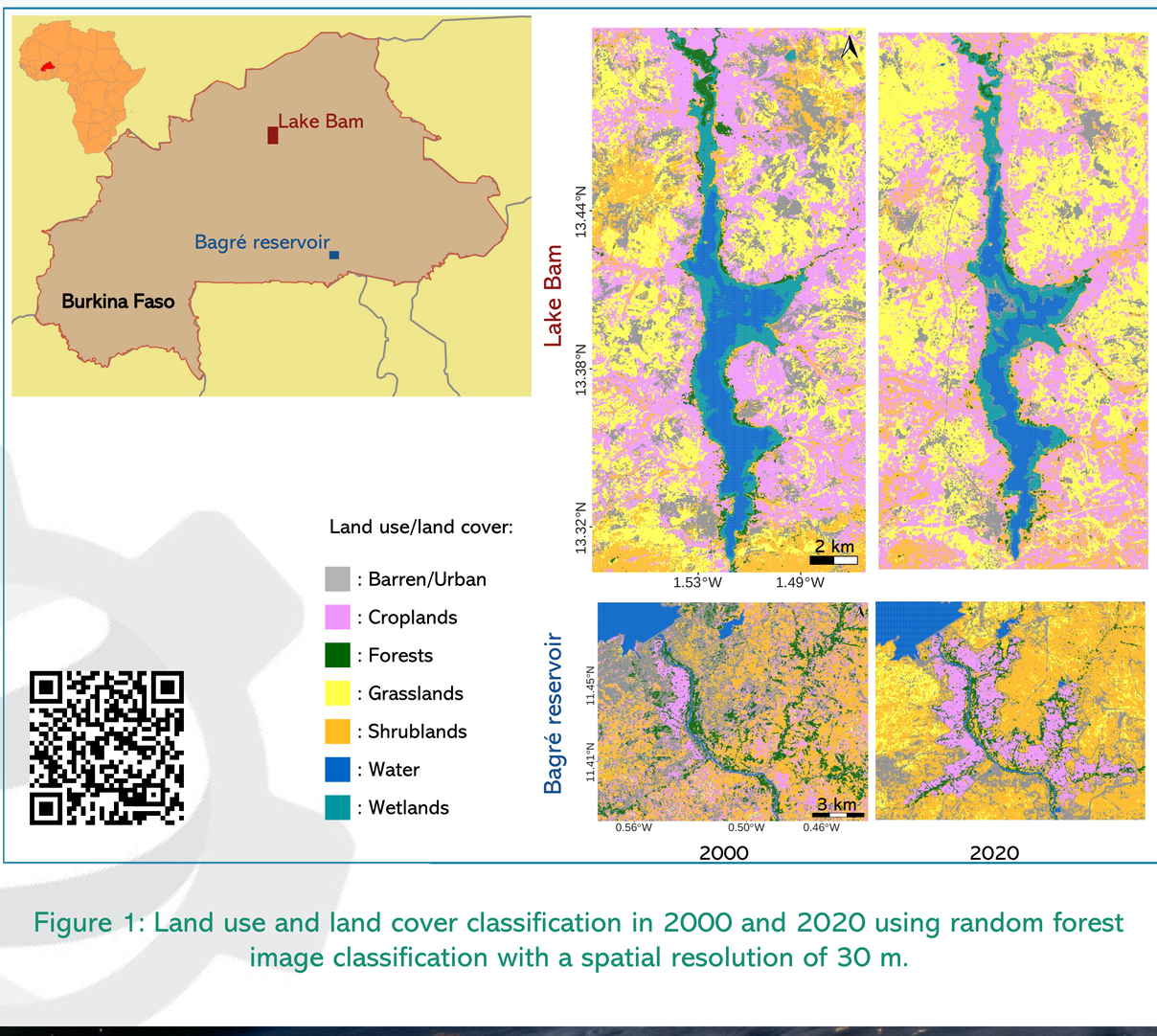

Figure 1: Land use and land cover classification in 2000 and 2020 using random forest image classification with a spatial resolution of 30 m.

Spatiotemporal Trends in Crop Water Use

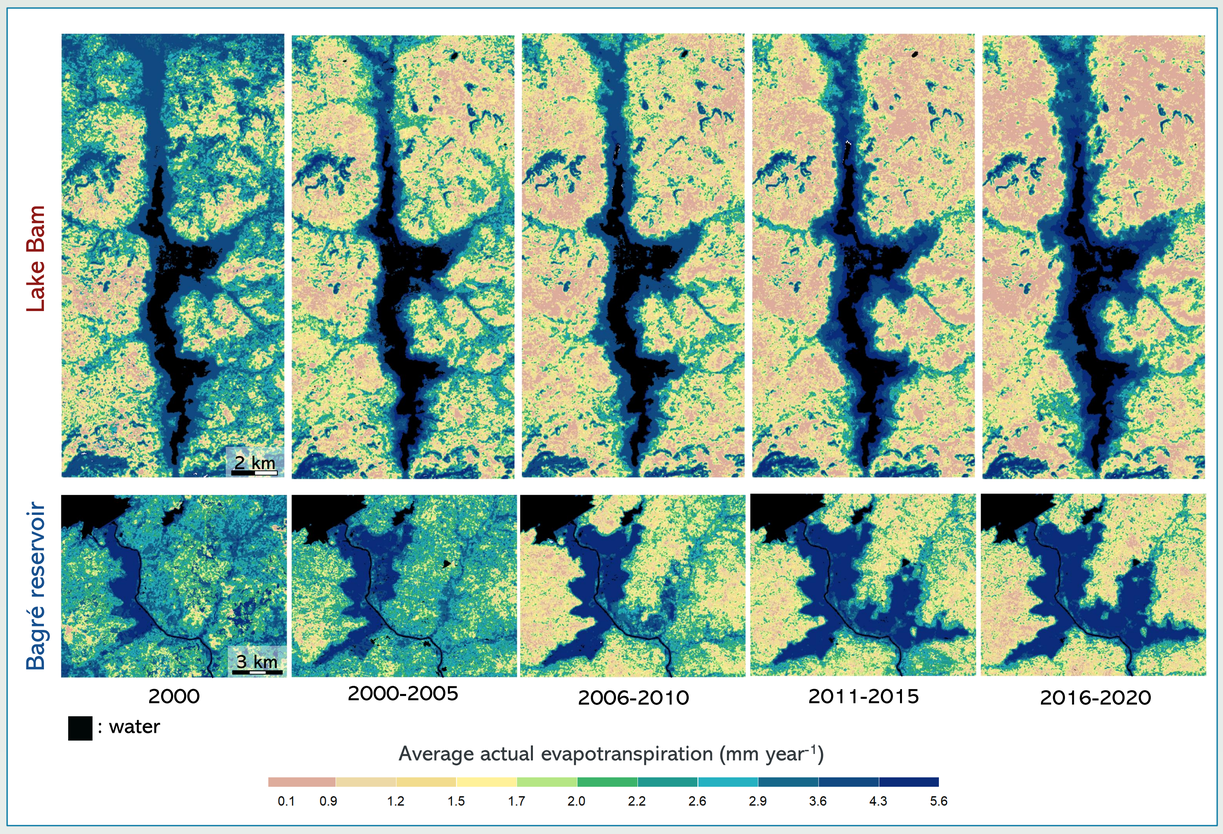

Figure 2: Actual evapotranspiration per year (mm $year^{-1}$) during the dry season (October to May), averaged over 5-year intervals from 2000 to 2020. 30 m is the resolution.

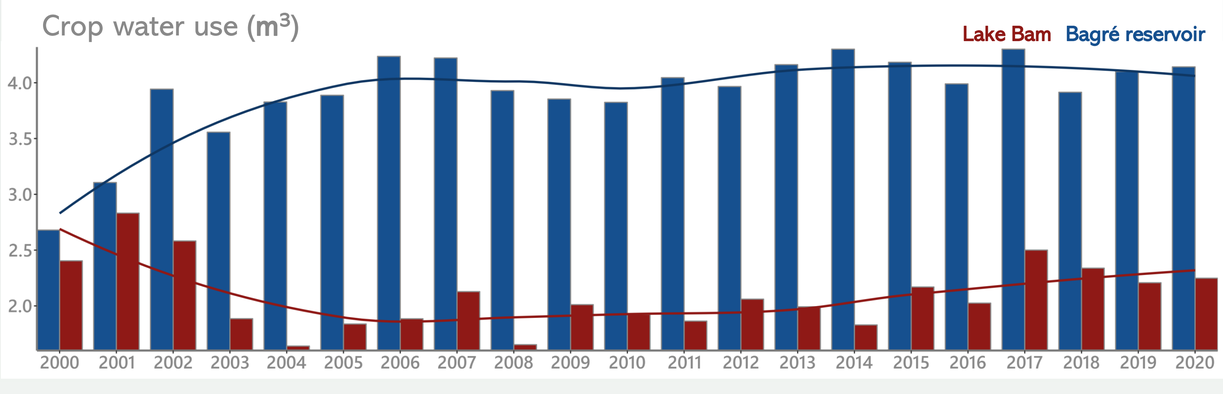

Table 1: Summary statistics in crop water use

Area	Rate of change (m^3 $year^{-1}$)	Relative change (%)	Irrigated lands expansion	
			2000 (km^2)	2020 (%)
Bam	0.14*	-6	9.8	+1.4
Bagré	0.45	+55	4.3	-24

*not statistically significant

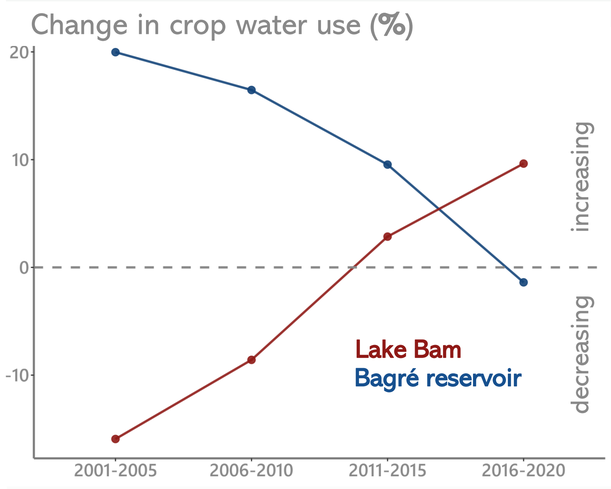

Figure 4: Change in crop water use (%) relative to the previous period over a 5-year interval from 2000 to 2020. 30 m is the resolution.

References

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Conclusion

Google Earth Engine
- Significant **potential for long-term assessment of crop water use**
- More timely and cost-effective information updates for water management in **areas where data is scarce and informal.**

- Managed Bagré reservoir: increasing crop water use and shrinking water demand.
- Unmanaged Lake Bam: decreasing crop water use and growing water demand.

Future with the increasingly limited water resources: investigate crop water productivity
- improve food security and
- better water management strategies