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Outstanding Student & PhD candidate Presentation contest

Increasing cropping options in seasonal floodplain wetlands of sub-Saharan Africa: A remote-sensing approach for assessing available green water for cultivation

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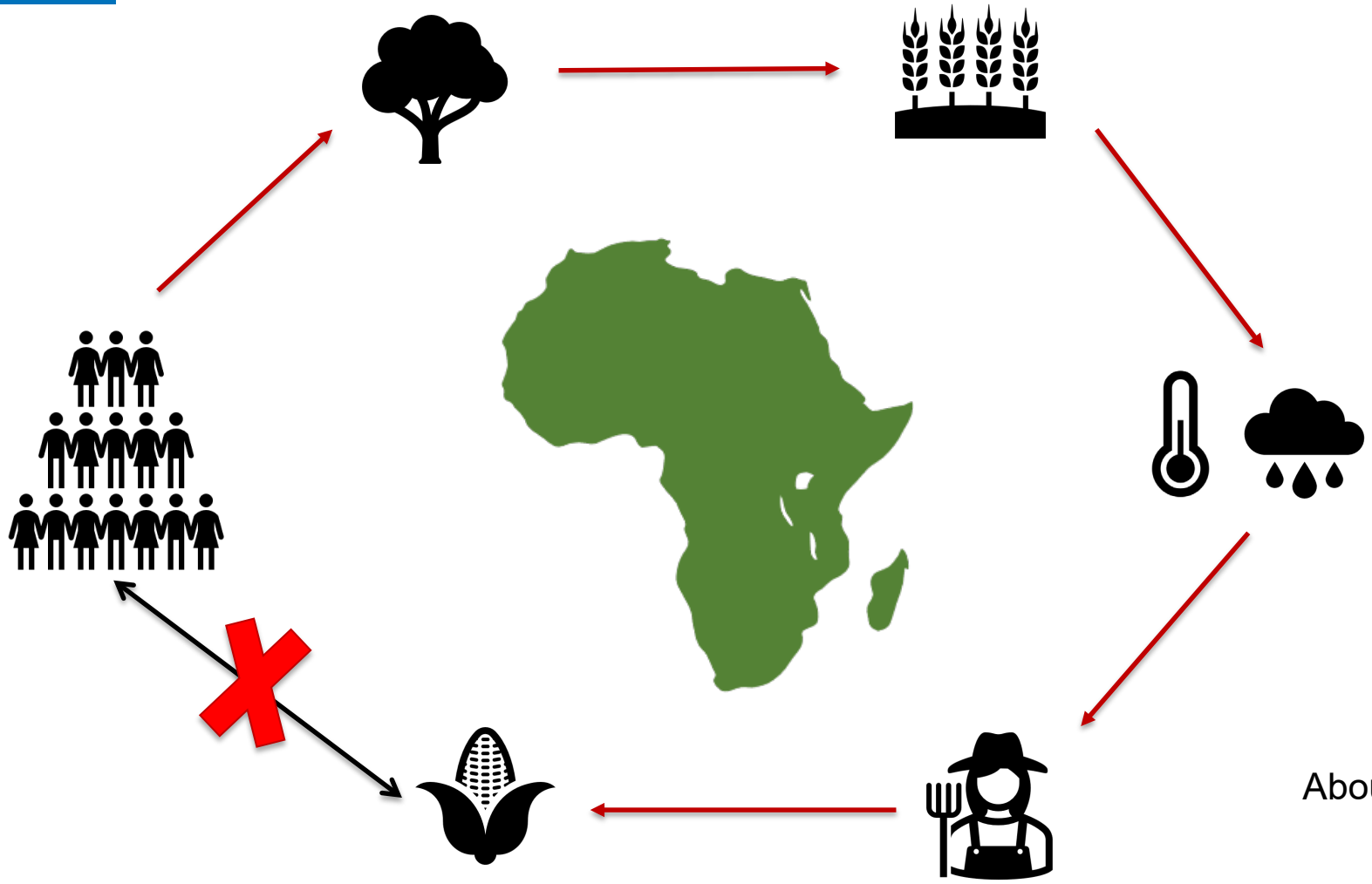
EGU General Assembly 2022

What is at stake?

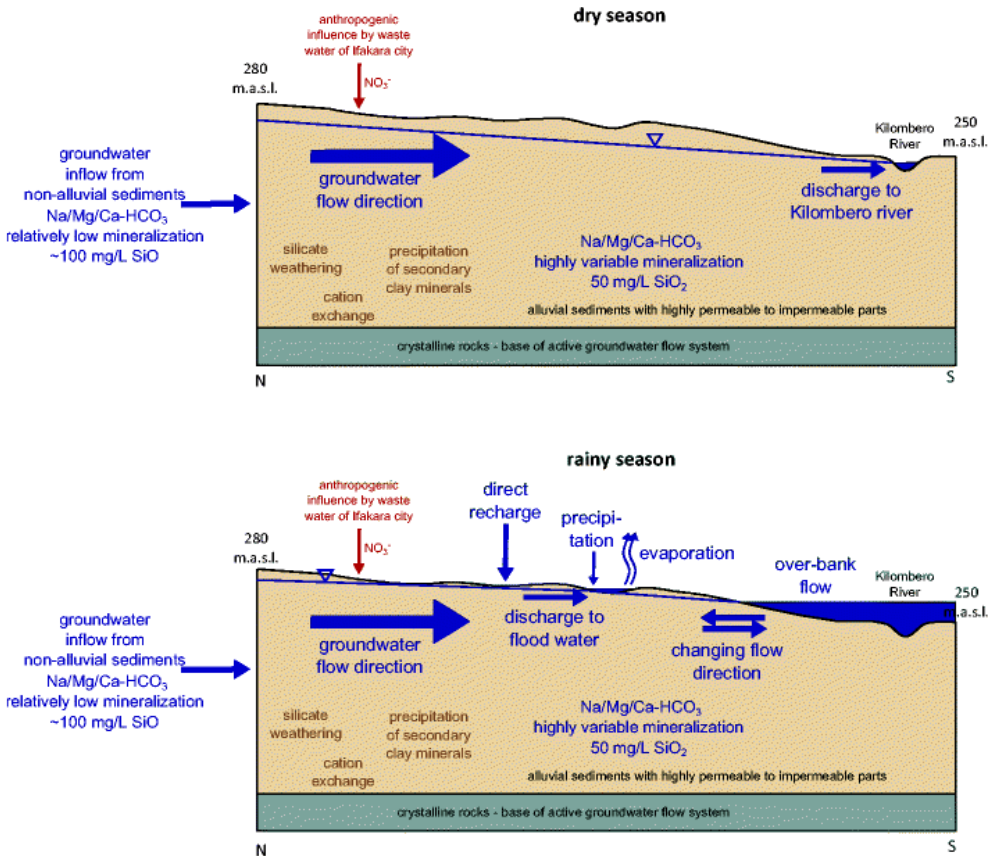


Sustainable intensification & diversification

Seasonal Floodplain Wetlands

About 2.5% of the land area of sub-Saharan Africa!

Seasonal floodplain wetlands



Burghof, et al. Development of a hydrogeological conceptual wetland model in the data-scarce north-eastern region of Kilombero Valley, Tanzania. Hydrogeol J 26, 267–284 (2018). https://doi.org/10.1007/s10040-017-1649-2

- Wet season (rice cultivation)
- Limited dry season cultivation due to water (un)availability and variability

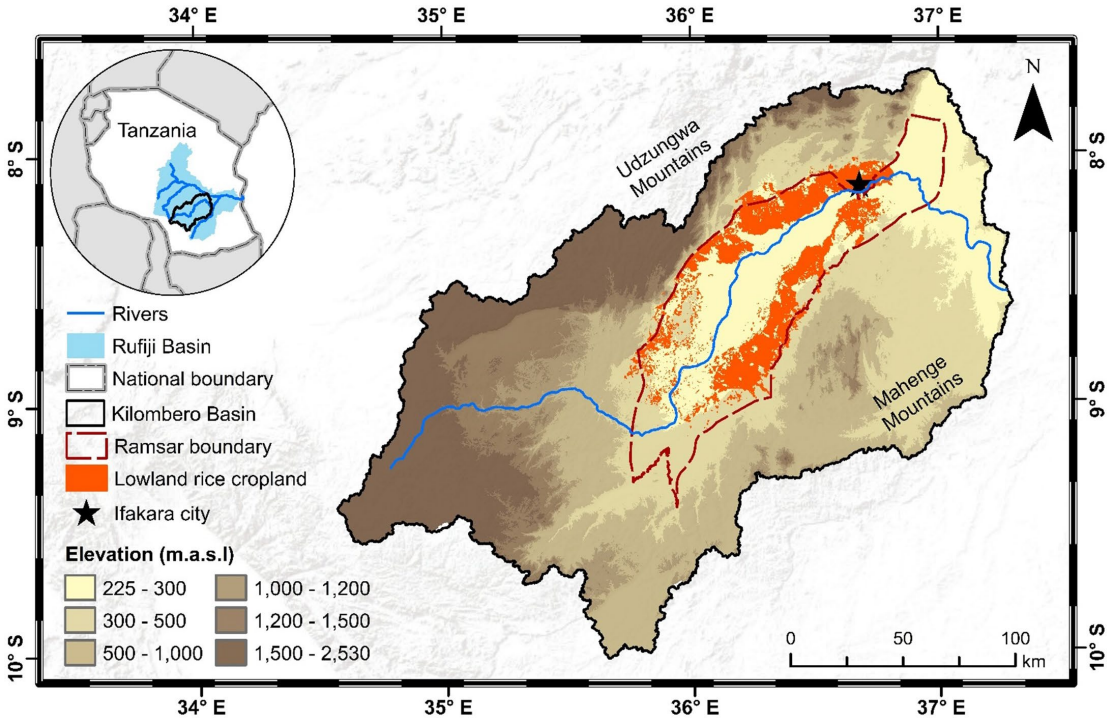
Expanding cropland area and irrigation use of blue water?
But … is it affordable? feasible? successful?

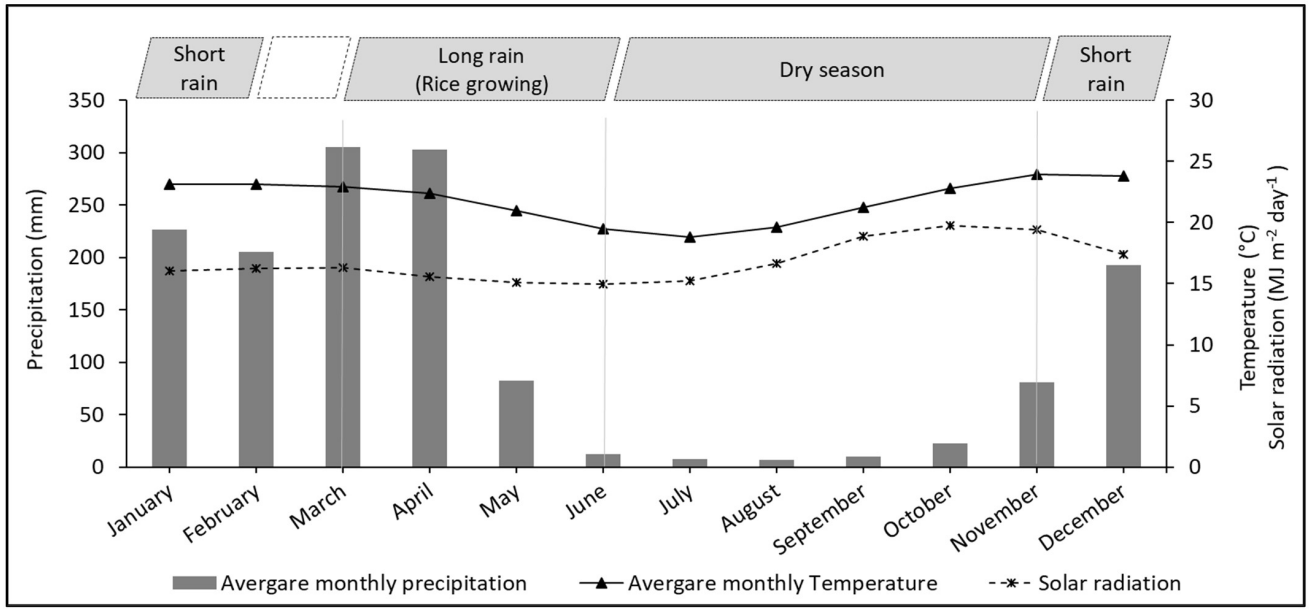
The potential of using green water stored in the soil before rice planting (pre-rice niche) and after rice harvest (post-rice niche).

Where, when, and how reliable is green water availability for crop production beyond the wet season?

A methodological approach to analyze the green water availability and variability using open-access gridded datasets.

Where?





- Kilombero Floodplain: 8,000 km^2
- A Ramsar site
- 9% of rice production in Tanzania

- Dry season: June–October
- Short rain: November–January
- Long rain wet season (rice cultivation): March–May

How did we proceed?

1. Land cover analysis

- Identifying a reliable product to extract the cropland layer
- Evaluated: ESA-CCI, MCD12Q1, WaPOR & CGLS-LC. Reference datasets: GFSAD & ESA-CCI-S2
- Compare with reference datasets; compare with previously reported values; cross comparison

2. Soil moisture condition

- Identifying the pre- and post-rice niches and their associated risks and opportunities for cultivation
- Actual and potential evapotranspiration (AET and PET) MOD16A2GF
- Calculating the absolute and relative evaporative stress indices

3. Green water availability

- Quantifying the multiyear intra-annual green water availability for a long time series
- AET: WaPOR & SSEBop; NDVI: MOD13Q1
- Create an ensemble mean AET dataset and aggregate AET of the niches

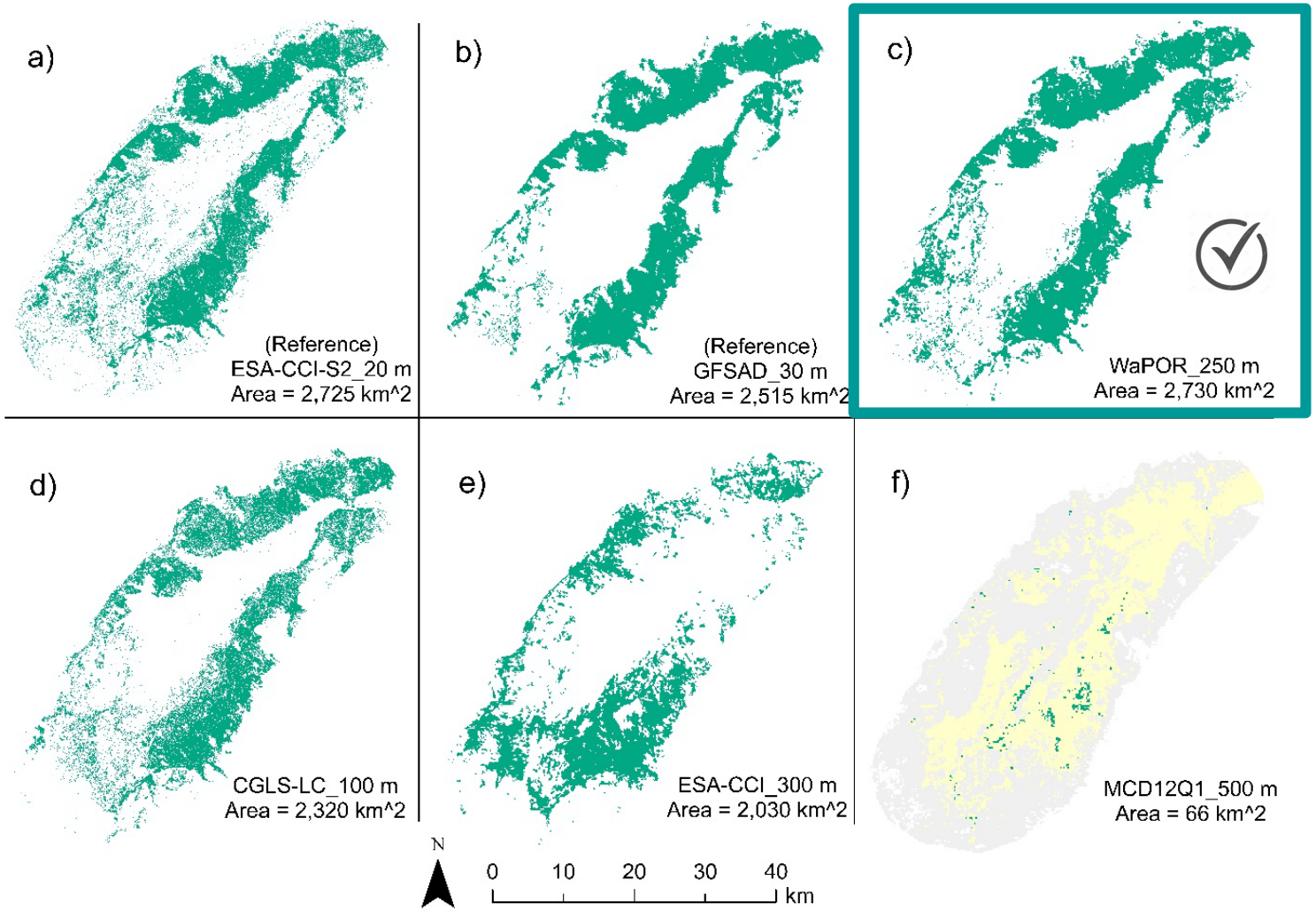
Aim

Optional data input

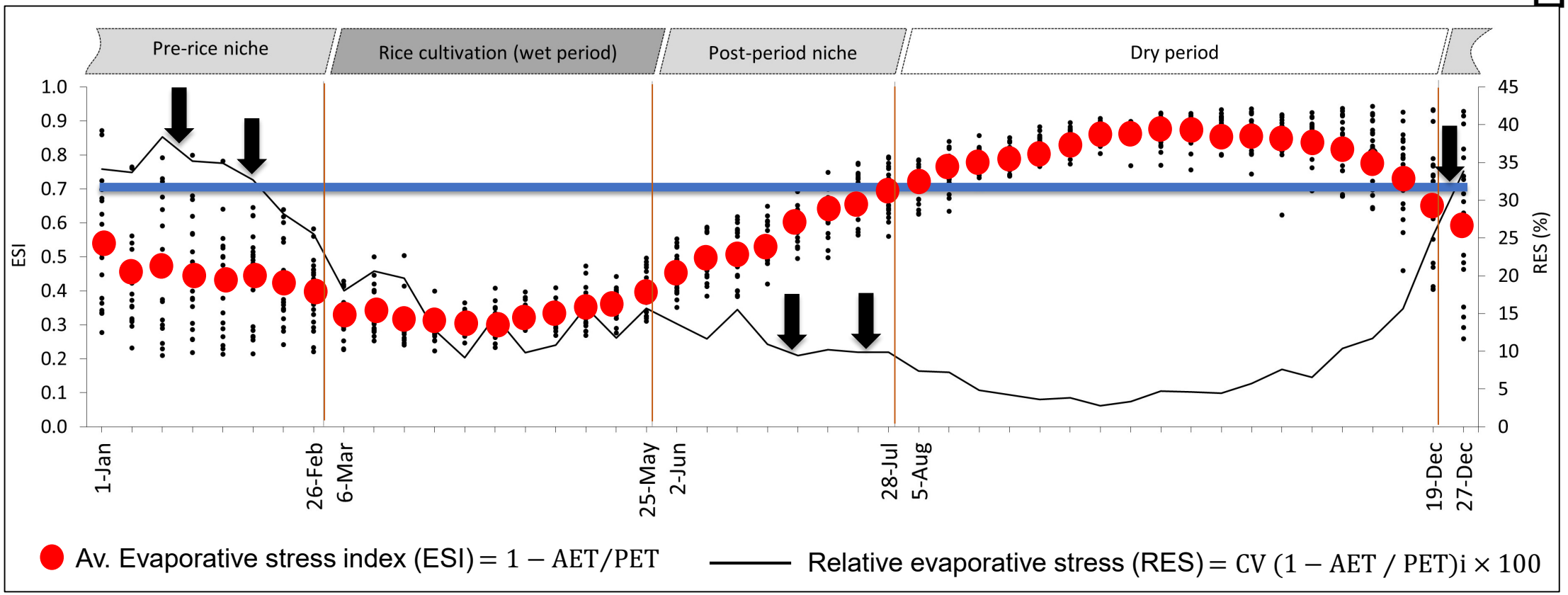
Processing step

Land cover analysis:

- → **Land cover datasets must be evaluated before use for each individual case study**
- → **Lowland rice is difficult to differentiate from wet savanna grassland**
- → **The need for operational and temporally dynamic land cover products**



Soil moisture condition: how stressed and how variable (2000-2019; 8-day timestep)?



- **Pre-rice from late December to end of February (70 days)**
- **Post-rice from late May to end of July (65 days)**

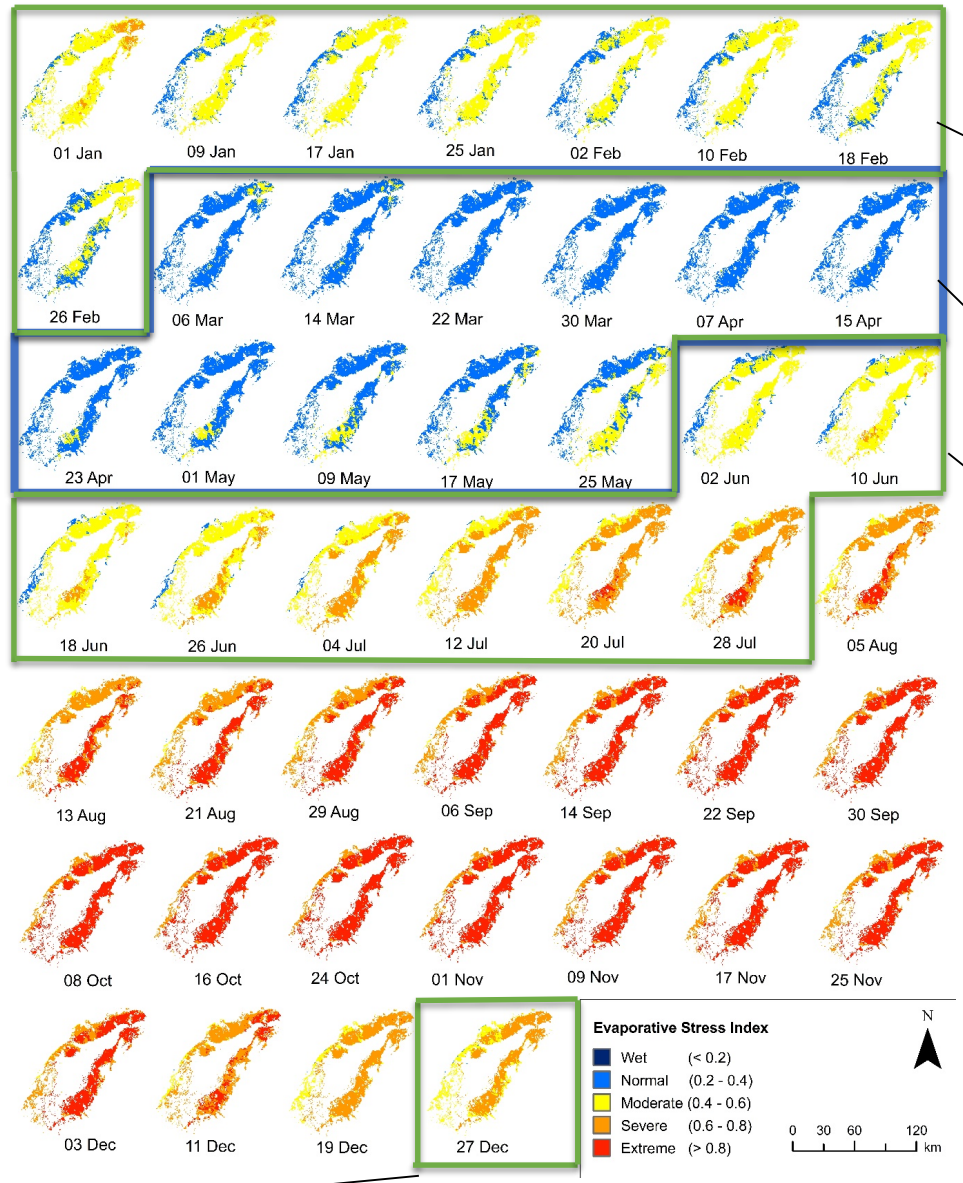
More than half of the total cropped area can be cultivated in the dry season in Kilombero!

- **The pre-rice niche is highly variable and associated with risks**
- **The post-rice niche is quite stable**

Soil moisture condition: how stressed?

Evaporative stress index $= 1 - \mathrm{AET}/\mathrm{PET}$

- **Pre-rice from late December to end of February (70 days)**
- **Post-rice from late May to end of July (65 days)**



Pre-rice niche

Rice cultivation

Post-rice niche

Pre-rice niche

Soil moisture condition: how variable?

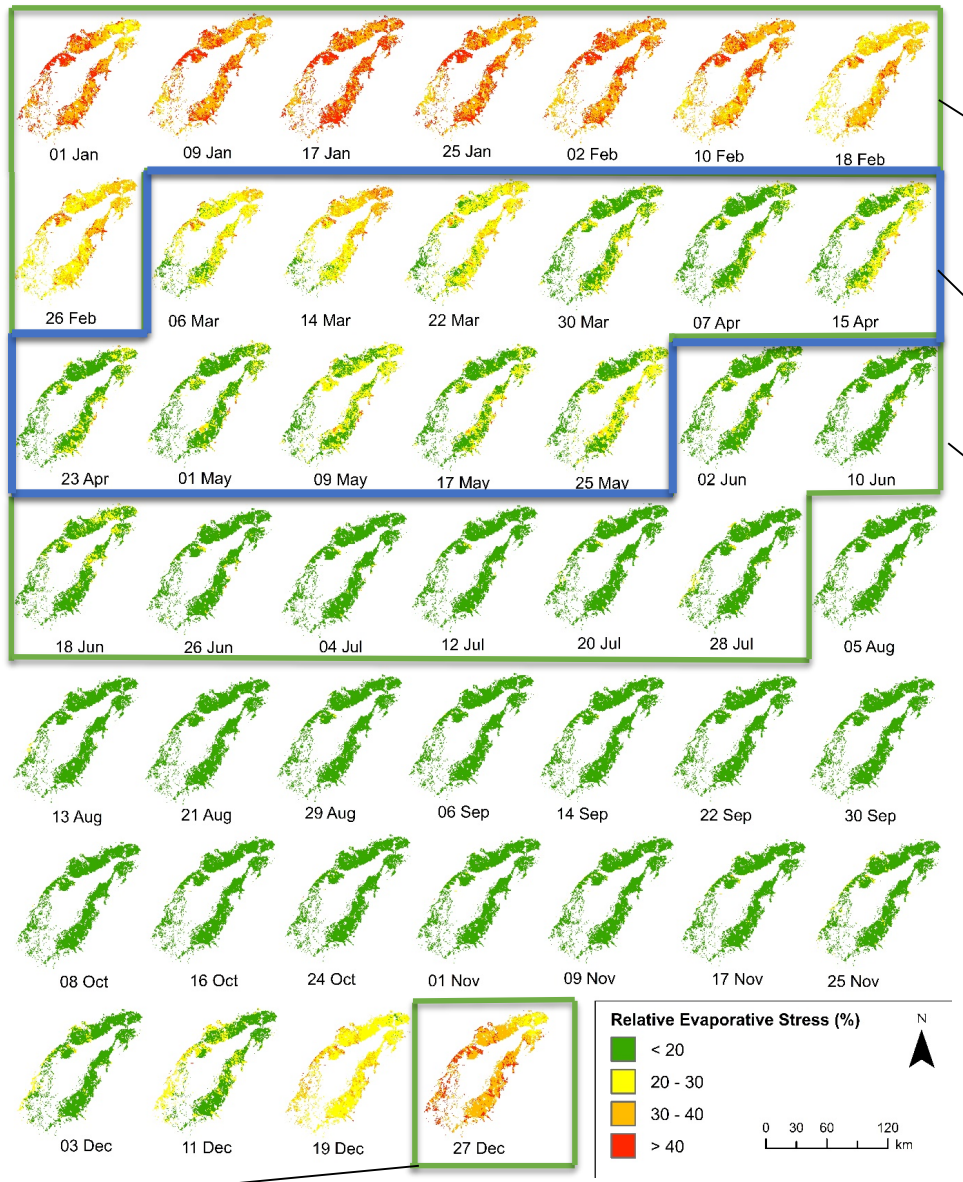
Relative evaporative stress $= \mathrm{CV}\,(1 - \mathrm{AET}\,/\,\mathrm{PET})\mathrm{i} \times 100$

- **The pre-rice niche is highly variable and associated with risks**

  → need to establish supplemental irrigation practices

- **The post-rice niche is quite stable**

  → recession cropping practices, also with supplemental irrigation in areas where soil dry faster



Pre-rice niche

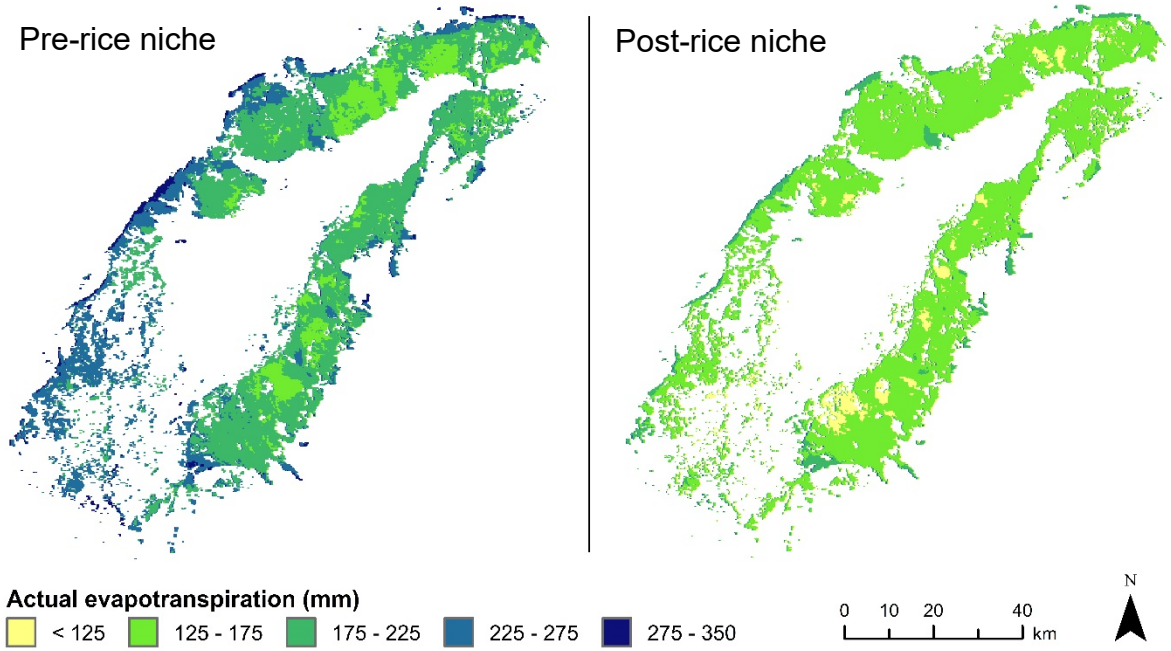
Rice cultivation

Post-rice niche

Pre-rice niche

Green water availability:

- Wet season = 30–40 mm/10-day
- Pre-rice niche = 20–40 mm/10-day
- Post-rice niche =10–30 mm/10-day



- **Water availability suffices for short-cycled dry season cropping** → green manure, vegetables, maize, and forage legumes
- **Opportunity to maximize the production with minimal impacts** → shifting the nonproductive soil evaporation to productive transpiration
- **AET occurs from the topsoil profile** → more green water is available in deeper soil profiles

Final remarks:

- Green water cultivation can improve smallholder food security and resilience in seasonal floodplain wetlands.
- Green water interannual variability, not availability, is the main challenge in the pre-rice niche.
- Flood-recession cropping in the post-rice niche provides substantial opportunities for crop production.
- We recommend using locally produced/calibrated datasets whenever possible.
- Diversification options depend on crop functional traits (e.g., rooting depth, harvested product, and growing duration), soil moisture conditions, rice planting time, and proximity and availability of markets.
- Field experiments, stakeholder analysis and aspiration mapping are needed to identify future site-specific farming strategies.
- More investments, guided by the proposed framework, should be made available to improve floodplains rainfed systems.

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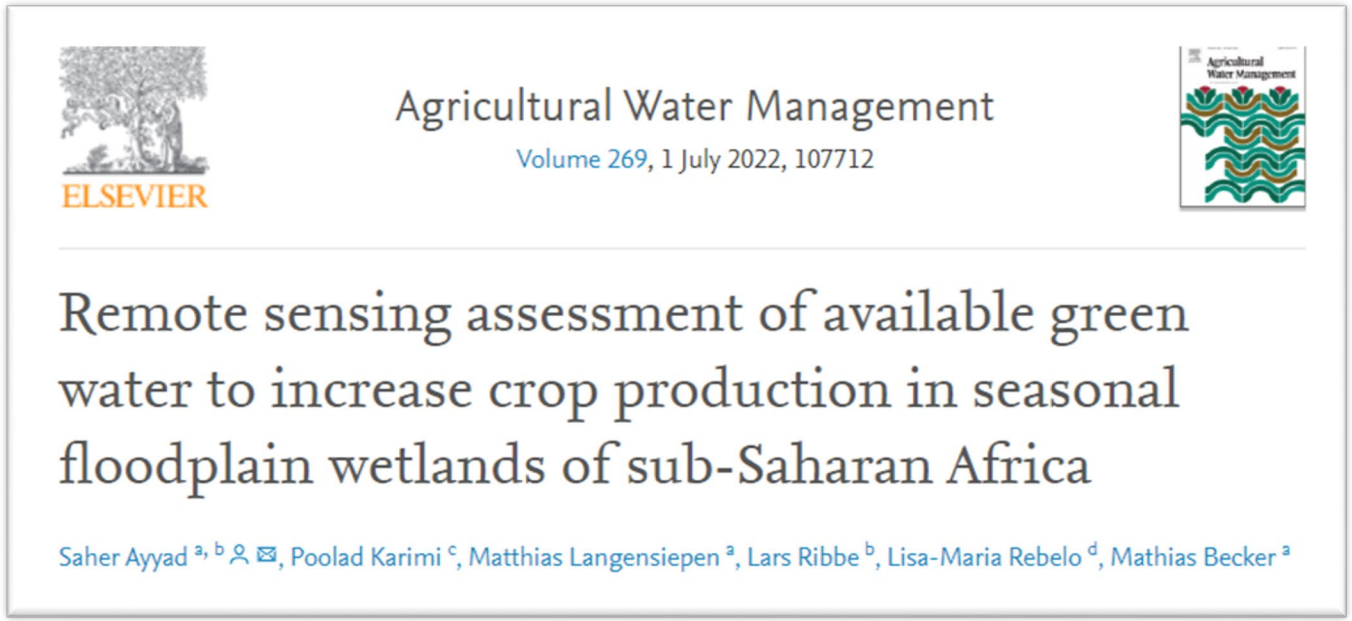
Thank you for your attention!

Interested in knowing more? Have a look at our article …



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Remote sensing assessment of available green water to increase crop production in seasonal floodplain wetlands of sub-Saharan Africa

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INRES Institut für Nutzpflanzenwissenschaften und Ressourcenschutz

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