Quantifying the economic feasibility of solar irrigation in sub-Saharan Africa

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Background (i)

Selected indicators for sub-Saharan Africa

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Access to electricity, rural (% of rural population)

Agricultural land (% of land area)

Insufficient caloric intake (% of population)

Poverty headcount ratio ($1.90/day) (2011 PPP) (% of population)

Renewable freshwater resources per capita (cubic meters)

Rural population (million)

Under baseline trends, most development gaps still open (or even larger) by 2030

900+ million by 2050, UN 2019 prospects

Figures: Falchetta (2021)
Data: World Bank, FAO
Background (ii)

- Spatially overlapping irrigation water access and energy access gaps in large parts of sub-Saharan Africa

- Potential for leveraging synergies? But complex underlying dynamics

- Need for an integrated framework to assess if and where solar irrigation is economically feasible and can have a positive development impact.
Methods

Spatio-temporal profile of irrigation water needs, given local supply constraints (Tuninetti et al. 2015)

Spatio-temporal profile of pumping energy needs and PV+battery sizing

Local to national insights: where is the largest impact potential for solar irrigation?

Spatio-temporal distribution of system costs (PV, pump, transport to market) and benefits (revenues, food, excess power output)

Additional yield thanks to artificial irrigation

Comparison of costs and benefits
Maps of solar irrigation economic feasibility
System payback time
Additional yield and food production

Market accessibility
Additional yield transport cost
Revenue from additional yield

Crop, soil, climate
Aquifers and surface water basins
Irrigation water requirements
Water pumping energy requirements

Electrical water pumping projects database
Water pump installation and O&M costs
Water pumping energy cost
Local PV and storage cost
Main input data

- **Agricultural land and yield:** MapSPAM 2017 SSA (19 main crops)
- **Climate:** CRU TS v4, 1981 – 2020 LTA
- **Surface water and aquifers:** HydroSheds; MacDonald et al. 2012
- **PV generation potential:** SOLARGIS
- **PV investment cost:** Xie et al. 2021
- **Prices:** FAOSTAT
Results (i)

- Local to (sub)regional **irrigation water needs** to close the irrigation gap
- Related **energy needs** to pump water onto the fields
- Required number of **small-scale (1-25 m3/h) water pumps**
- Corresponding standalone **PV capacity** needed to power pumps
Results (ii)

- **Total costs, revenues and profits**

- Dependent on local cropping pattern, water needs, water accessibility, costs, crop prices, remoteness...

- **Groundwater** pumping seem to have predominant potential

- Total system **payback time**: in many sites, **below 10 years**

- **NB:** discount rate at 15%
Results (iii)

- Pump and PV costs: similar share of total costs
- Transport costs: negligible
- Yearly total costs: less than half of yearly total revenues
- Potentially significant macroeconomic impact of solar irrigation
Results (iv)

- **Food security** co-benefits
- Calories, proteins and fats generated thanks to increased production due to irrigation gap closure...
- ...compared to current food gap
- In some large countries, e.g. Tanzania and DR Congo, food gap nearly closed!
Conclusions

• Solar irrigation not only shows large technical feasibility in SSA, but also has economic potential to be installed and bring positive development impacts
• Nigeria + West Africa, and southern DRC (300+ million people) are areas of strong potential
• Important food security co-benefits → yield growth can have important impact on food insecurity!
• Future steps: run different scenarios (costs, prices, climate...).
Thank you!

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