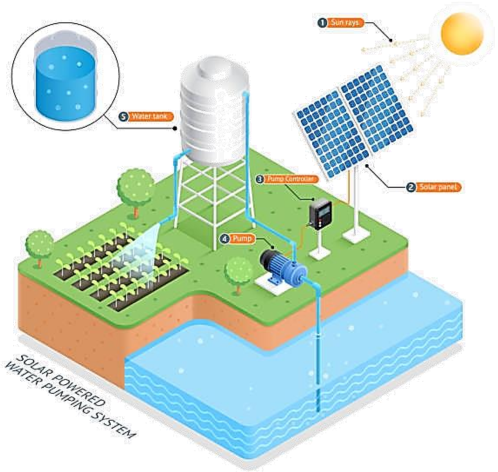
International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

EGU General Assembly 2022



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

Giacomo Falchetta[1,2], Francesco Semeria[3] and Marta Tuninetti[3]

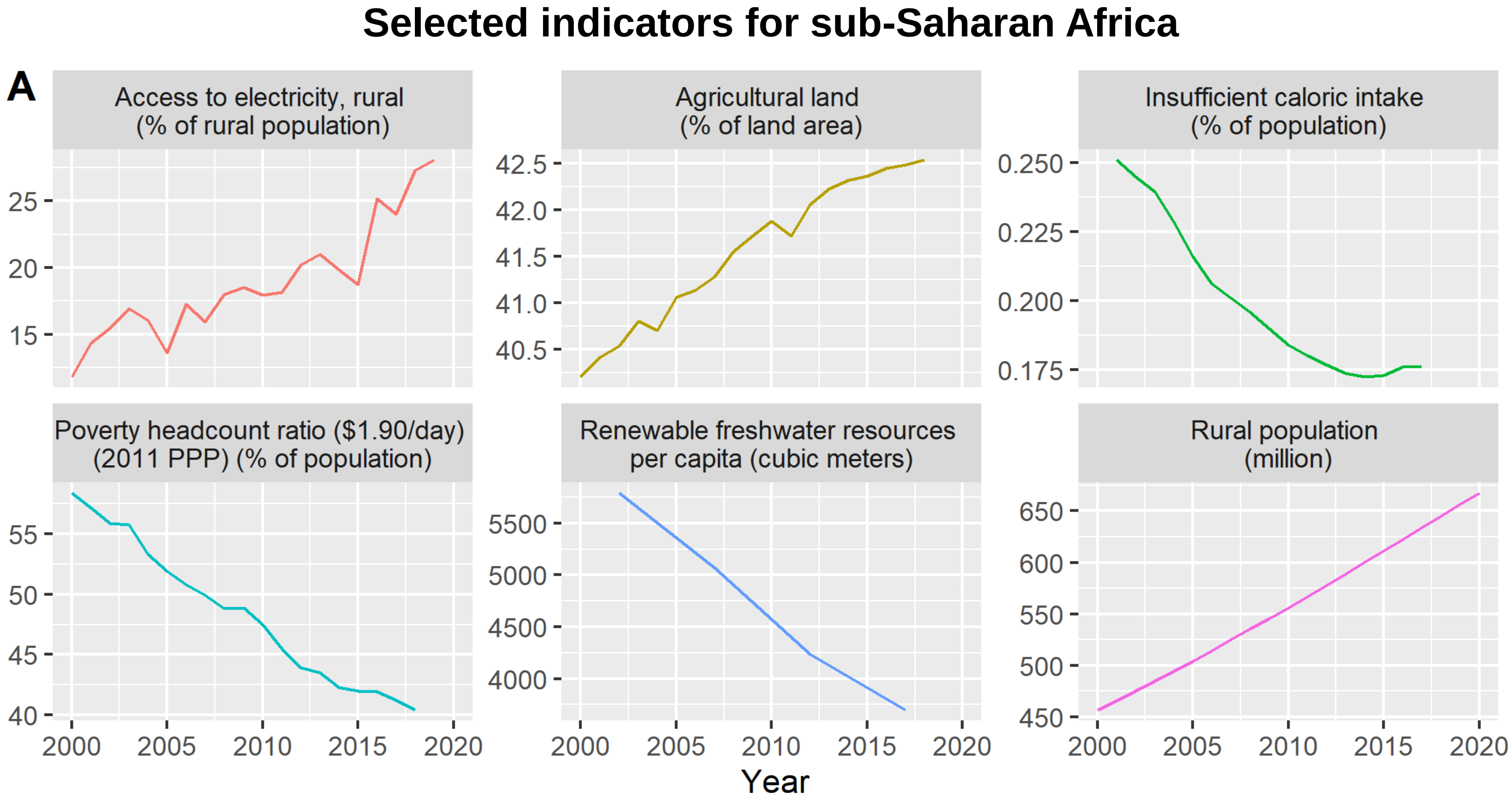
1. IIASA - International Institute for Applied Systems Analysis, Laxenburg, Austria
2. Ca' Foscari University of Venice / RFF- CMCC EIEE, Venice, Italy
3. Polytechnical University of Turin, Turin, Italy

23th May 2022
EGU 2022
Session HS5.1

The LEAP-RE project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

LEAP-RE

Background (i)



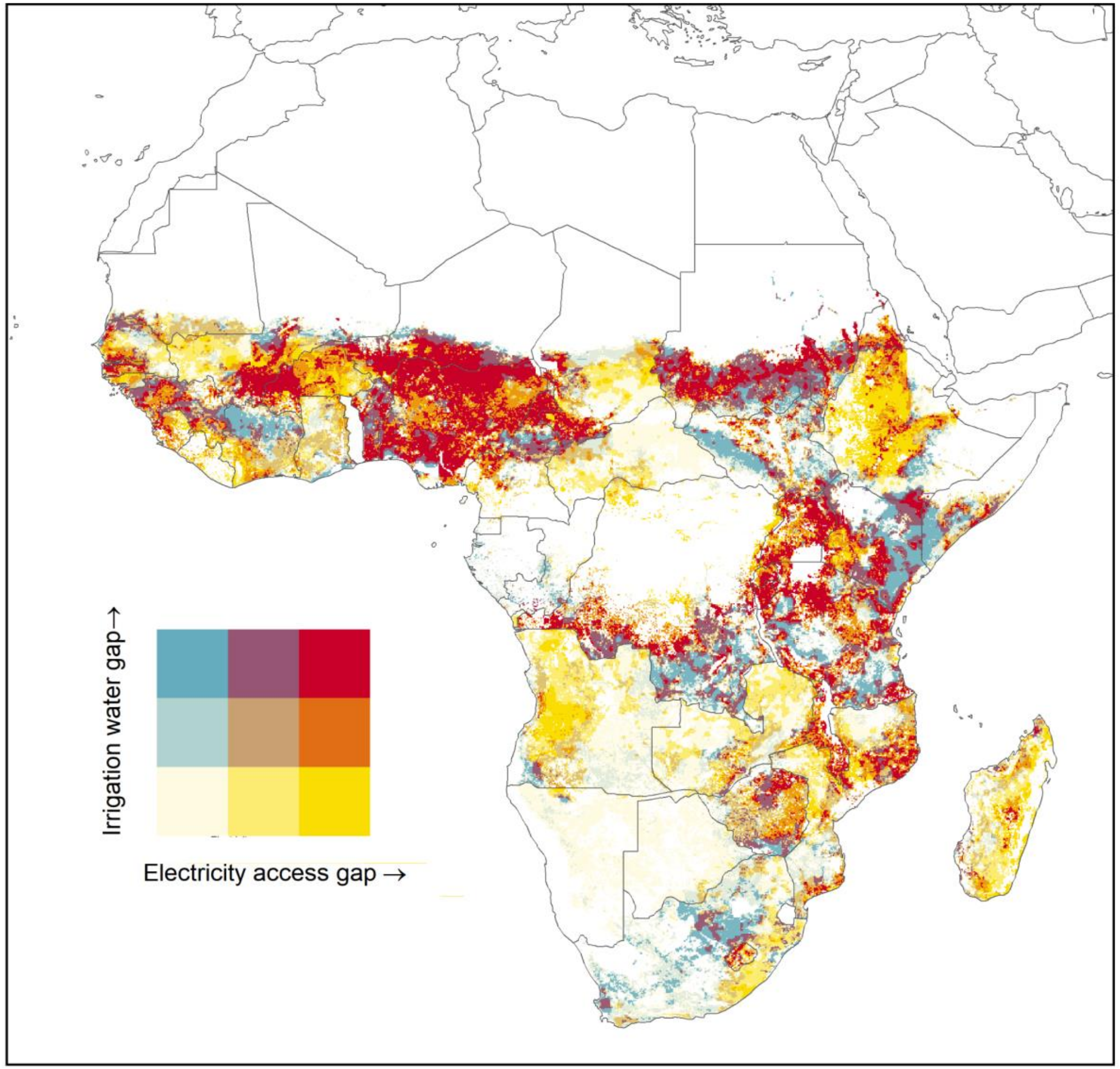
Under baseline trends, most development gaps still **open** (or even larger) by 2030

900+ million by 2050, UN 2019 prospects

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

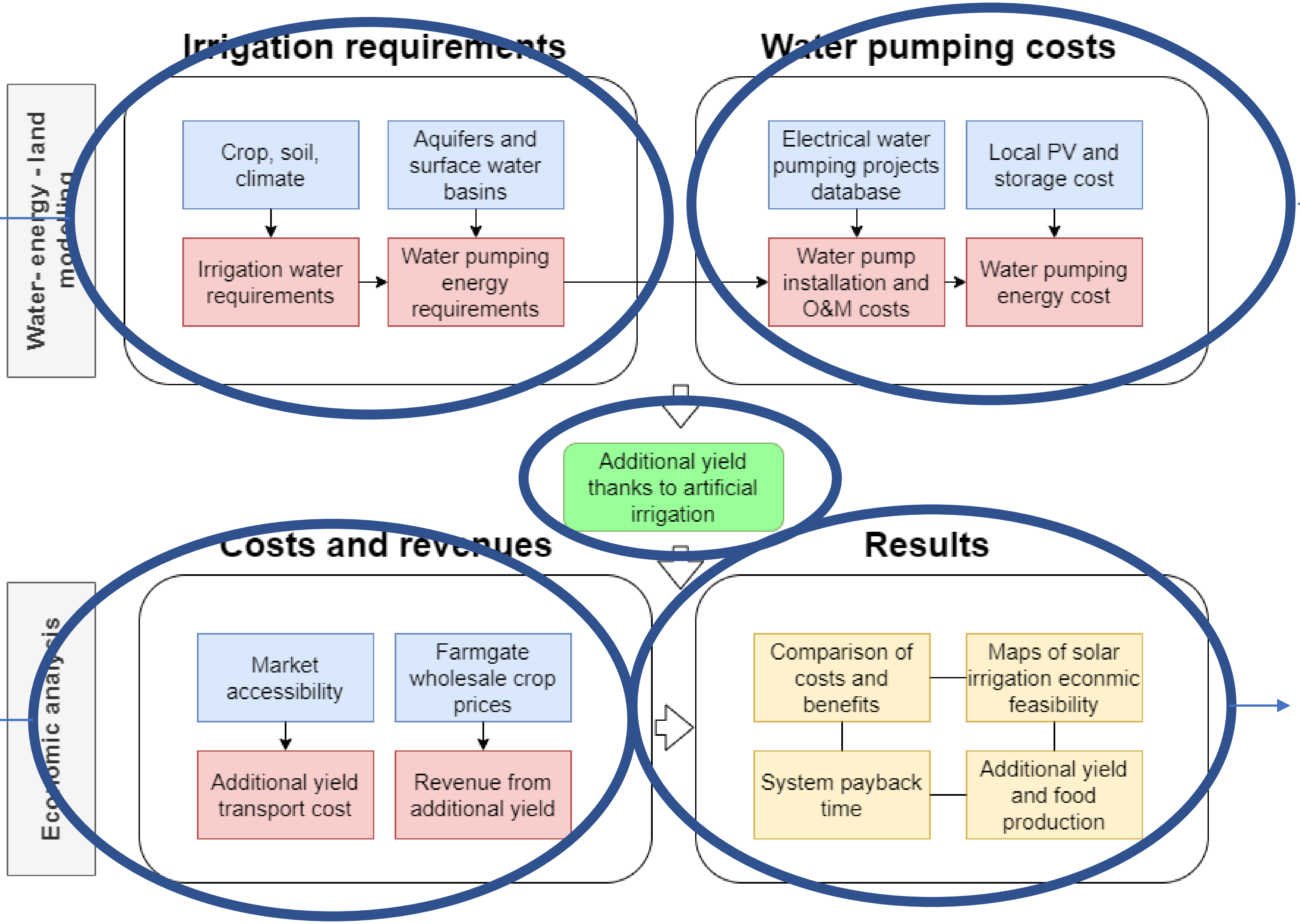
Background (ii)

- **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

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

Local to national insights: <u>where is the largest impact potential for solar irrigation?</u>

Main input data

- **Agricultural land and yield**:

MapSPAM 2017 SSA (19 main crops)

- **Climate:**

CRU TS v4, 1981 – 2020 LTA

WaterCrop evapotranspiration model

- **Surface water and aquifers:**

HydroSheds; MacDonald et al. 2012

- **PV generation potential:**

SOLARGIS

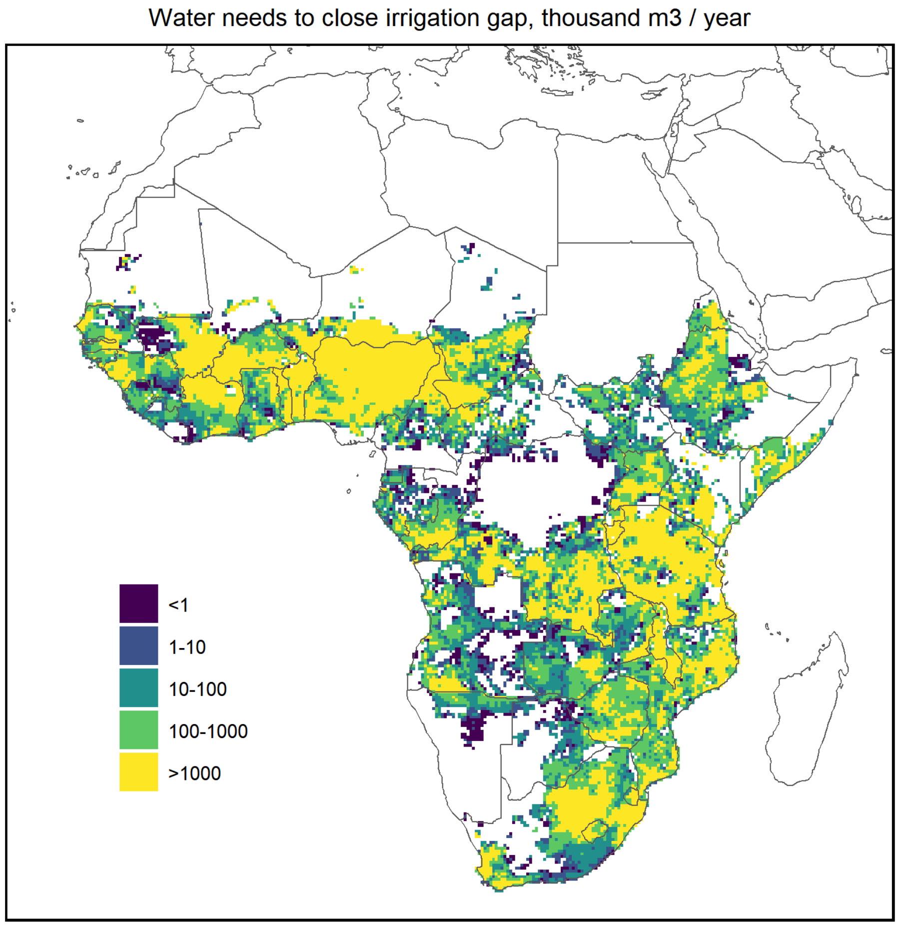
- **PV investment cost:**

Xie et al. 2021

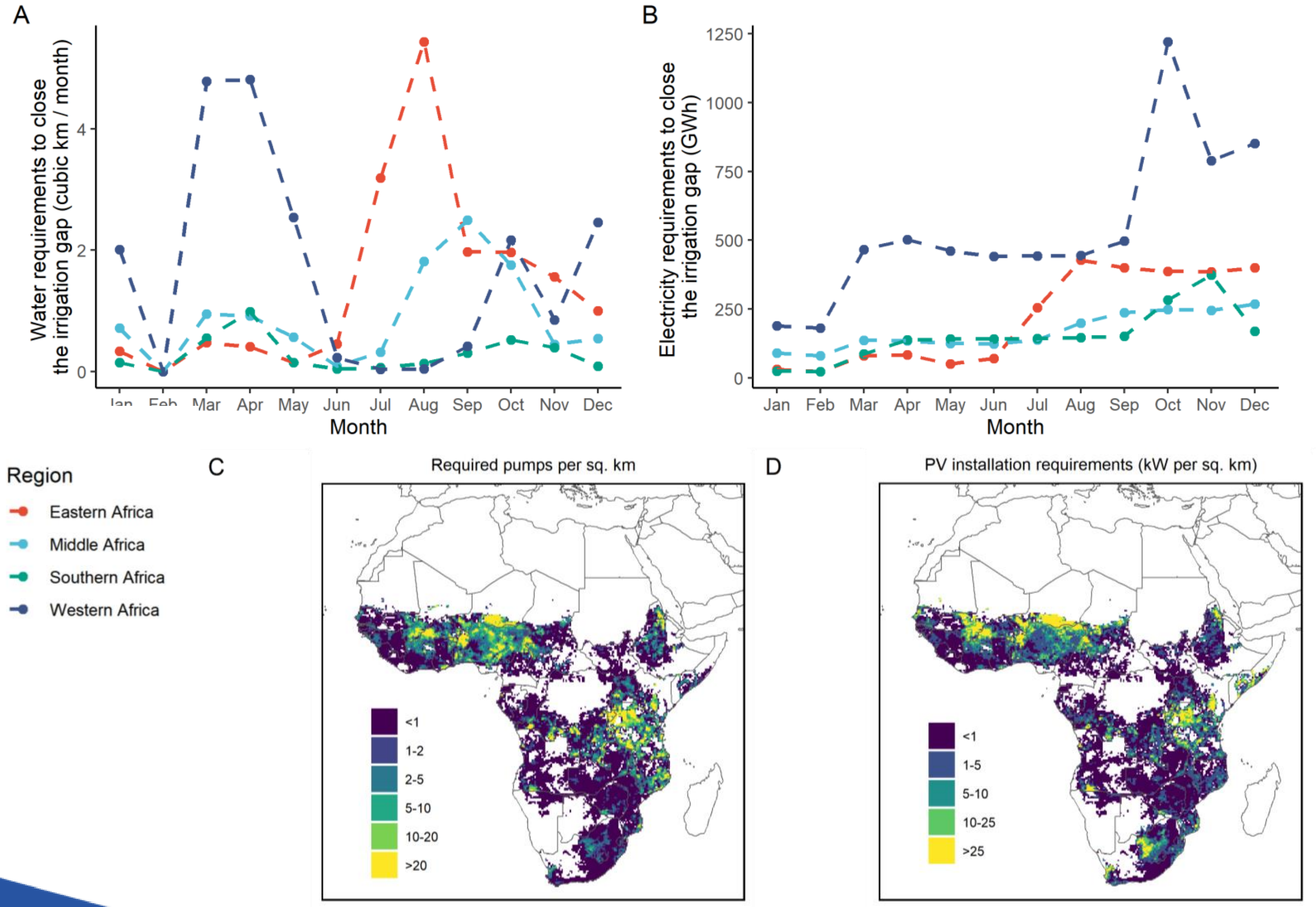
- **Prices:**

FAOSTAT

Spatially-explicit analysis, 0.25 arc-degrees resolution

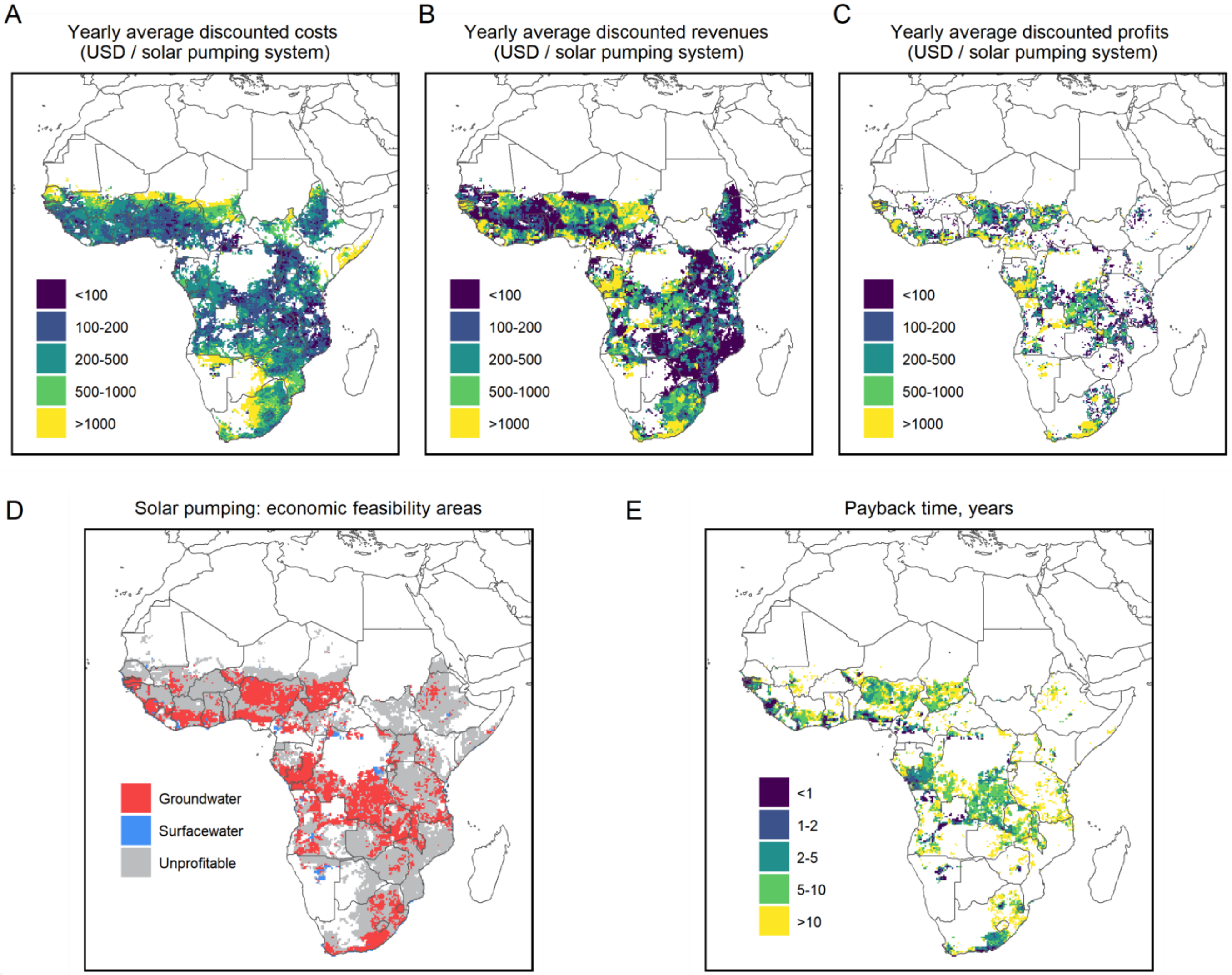


Results (i)



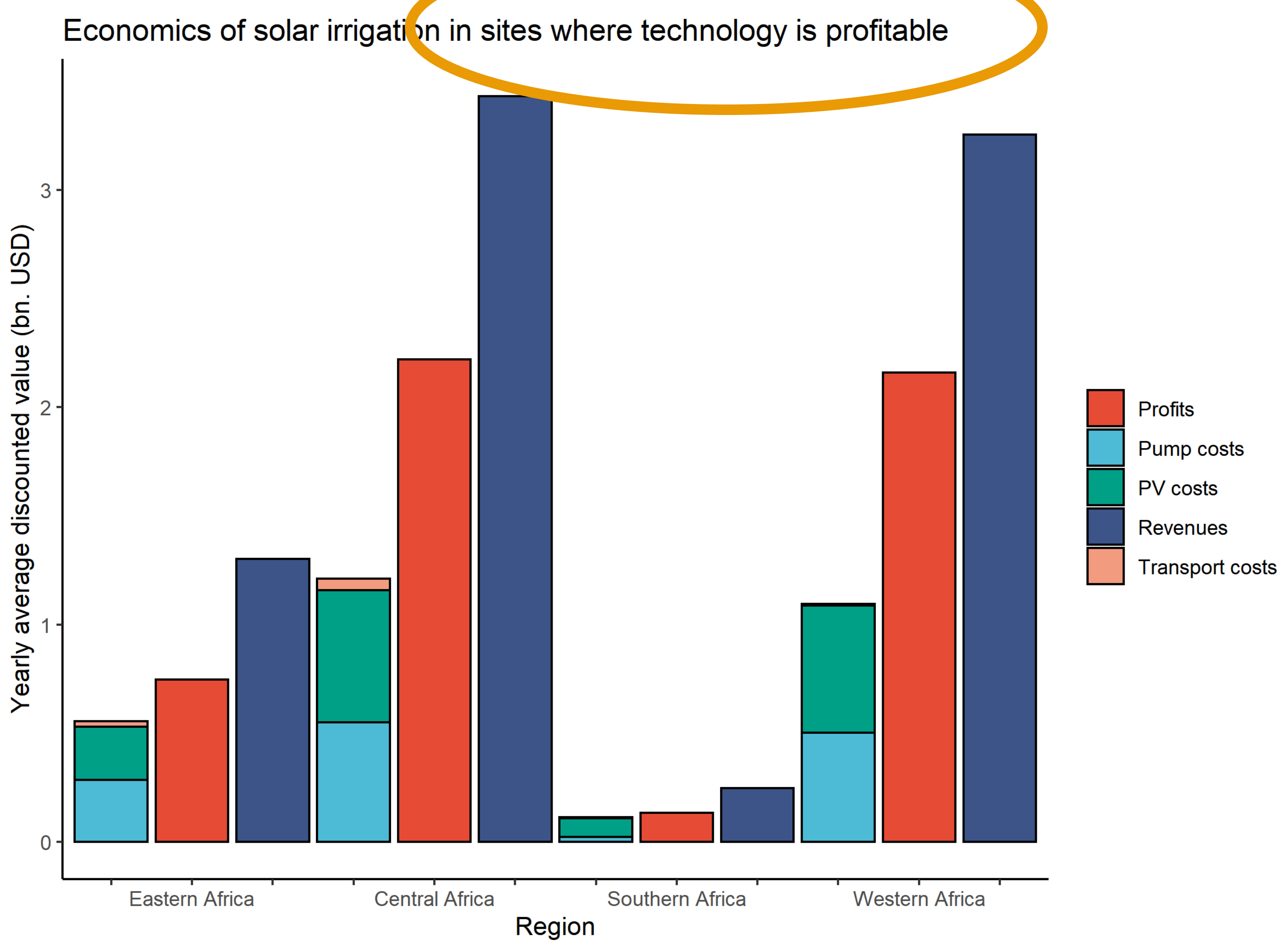
- Local to (sub)regional **irrigation water needs** to close the irrigation gap
- Related **energy needs** to pump water onto the fields
- Required number of **small-scale (1-25 m3/h) water pumps**
- Corresponding standalone **PV capacity** needed to power pumps

Results (ii)



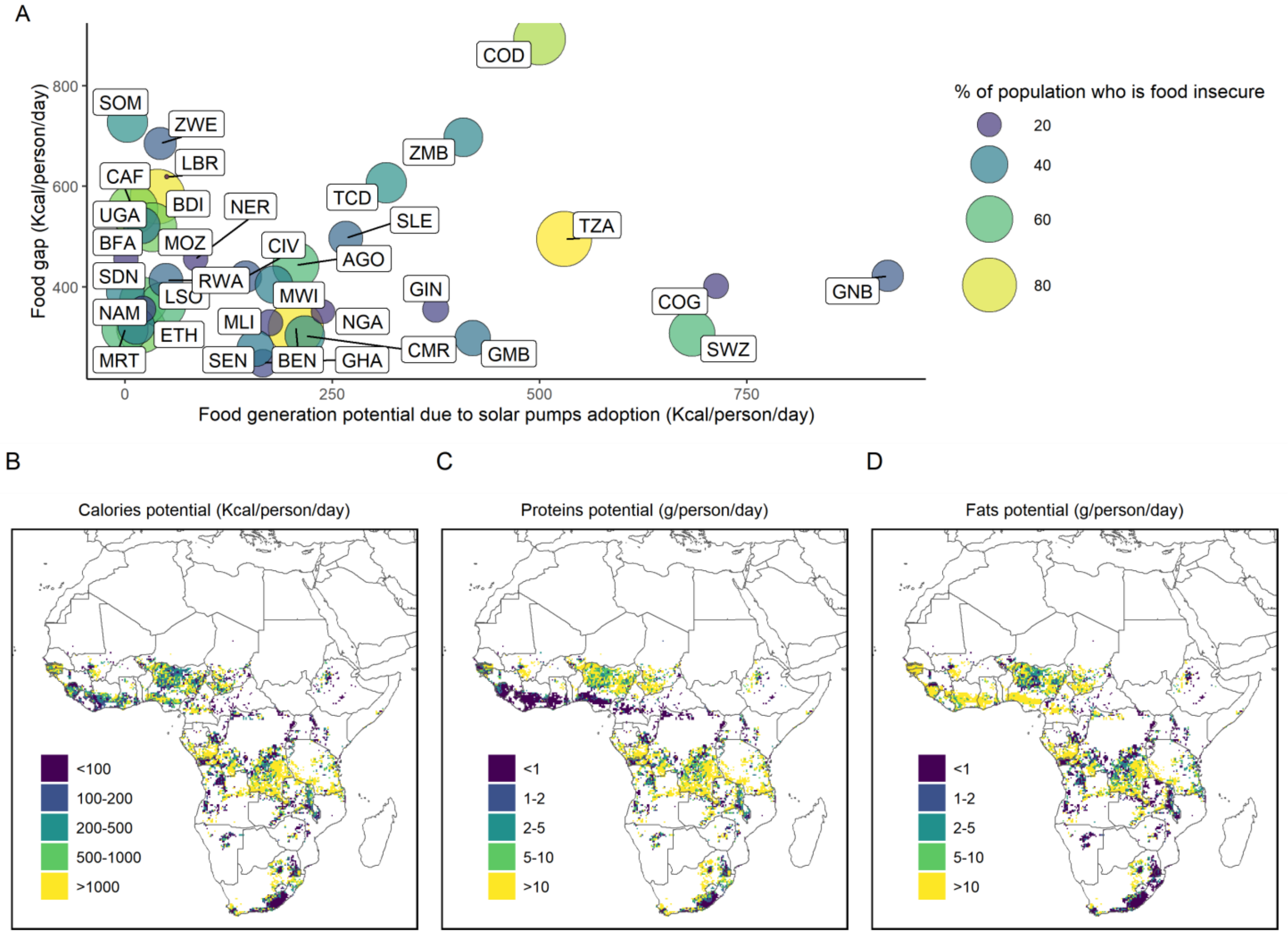
- **Total costs, revenues and profits**
- Dependent on local cropping patter, water needs, water accessibility, costs, crop prices, remoteness...
- **Groundwater** pumping seem to have predominant potential
- Total system **payback time:** in many sites, **below 10 years**
- **NB:** discount rate at 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!
- <u>Future steps</u>: run different scenarios (costs, prices, climate...)

Thank you!

LEAP-RE

The LEAP-RE project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

falchetta@iiasa.ac.at

Contributions, support, and comments from Vittorio Giordano, Edward Byers, Shonali Pachauri, Francesco Laio, and the whole IIASA ECE program