INITIATIVE ON
NEXUS Gains

An Online Tool for Sizing Groundwater-fed Solar Irrigation Systems in Sub-Saharan Africa

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April 18, 2023

Overview

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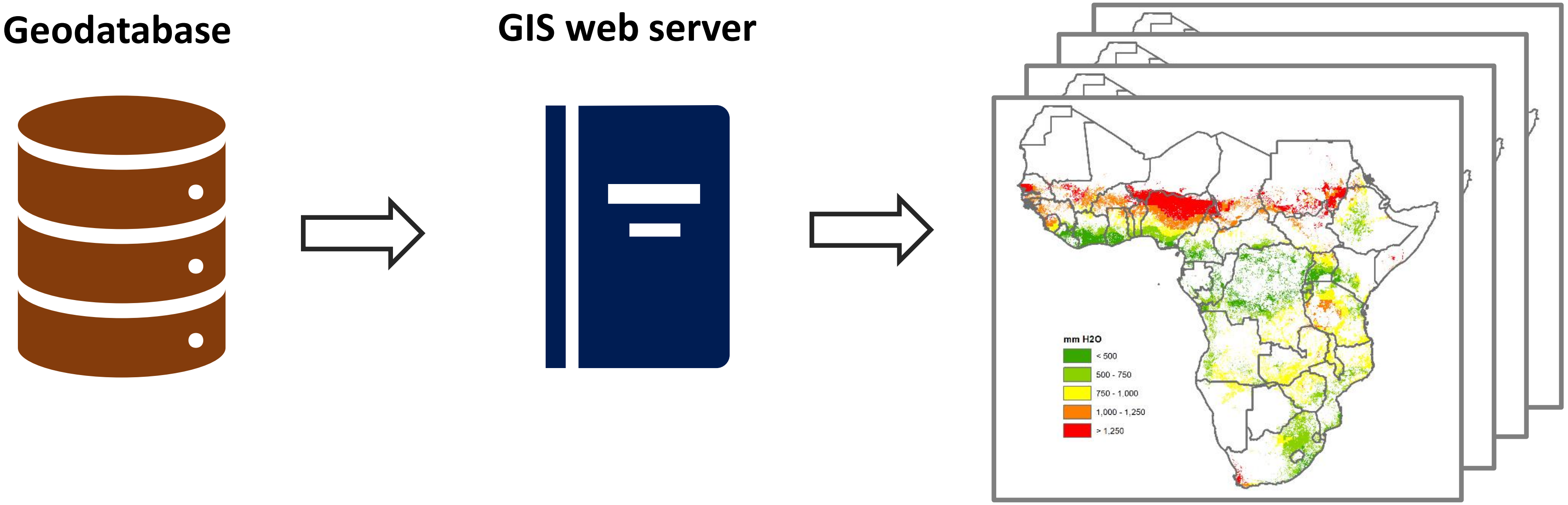

- To provide spatial analysis functions for solar irrigation system sizing
- Target users: policy makers, international donors, private investors and farmers

Background

Earth's Future

Research Article | Open Access

Volume 9, Issue 4
April 2021
e2020EF001611

Solar or Diesel: A Comparison of Costs for Groundwater-Fed Irrigation in Sub-Saharan Africa Under Two Energy Solutions

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First published: 06 February 2021 | https://doi.org/10.1029/2020EF0

SECTIONS

Abstract

Sub-Saharan Africa has long been beset with food insecur
Expanding irrigated agriculture can help boost food produ
requires energy for accessing water, especially in groundw
compared economic performance of groundwater pumpi
energy solutions: solar photovoltaic (PV) and diesel fuel. W
of the power units of two pumping systems for a range of
scenarios and mapped their relative cost-effectiveness ov
Africa. As a renewable and clean energy source, solar ene
attention and there is keen interest in investing in solar PV
of irrigated agriculture. Results of this study provide insigh
promoting solar irrigation in sub-Saharan Africa.

1 Introduction

Sub-Saharan Africa, a region of 23 million km^2 and home to m
long been beset with food insecurity (FAO & ECA, 2018). This
attributed to the suboptimal performance of its agricultural s
underdeveloped irrigated agriculture in the region. Currently

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REVIEW DRAFT | MARCH 20

UNLOCKING THE POTENTIAL OF FARMER-LED IRRIGATION DEVELOPMENT IN CENTRAL AND NORTHERN NIGERIA: WHAT DOES IT TAKE?

Estimates from a combined biophysical-socioeconomic analysis

Hua Xie, Petra Schmitter, A E Obayelu, Kato Edward, Claudia Ringler, Bedru Balana

The potential for profitable groundwater irrigated area development is 5.04 million hectares in Nigeria, almost all of it locate in the country's central and northern states. To develop this vast area, granular water budgets, financial service provisio and support to grow sustainability of production will be needed.

FARMER-LED IRRIGATION: WHAT AND HOW

Energy and Economic Growth
Applied Research Programme

Working Paper: Identifying energy solutions to support development of irrigated agriculture in Ethiopia

This working paper presents early findings from a country-level planning analysis that aims at identifying energy solutions to support the development of irrigated agriculture in Ethiopia. An integrated energy and irrigation planning framework is developed for this goal. Groundwater irrigation development potential and the recommended cost-effective energy solutions across the country are mapped.

Analysis setting

- Crop

  - ❑ Maize
  - ❑ Wheat
  - ❑ Rice
  - ❑ Sorghum
  - ❑ Millet
  - ❑ Tomatoes
  - ❑ Onions
  - ❑ Chickpeas
  - ❑ Common beans
  - ❑ Cowpeas
  - ❑ Sugarcane
  - ❑ Banana

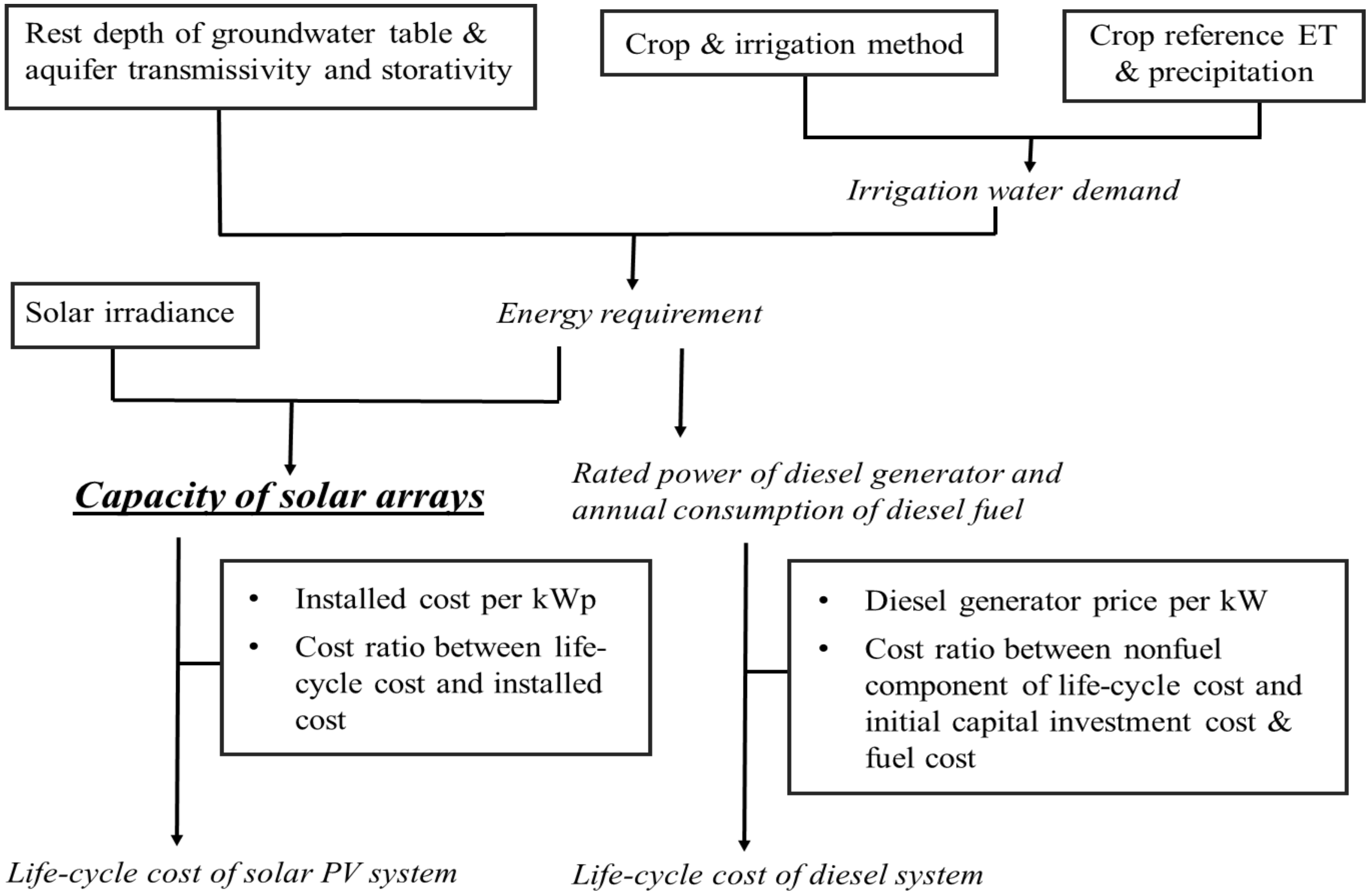
- Growing season

  - ❑ Rainy season
  - ❑ Dry season

- Irrigation method

  - ❑ Flood irrigation
  - ❑ Drip irrigation

Solar sizing: Model



Xie et al. (2021)

Base maps

Data type	Source
Solar irradiance	PVGIS (https://ec.europa.eu/jrc/en/pvgis)
Precipitation	CHIRPS (https://www.chc.ucsb.edu/data/chirps)
Reference ET	CRU (https://crudata.uea.ac.uk/cru/data/hrg/)
Aquifer properties	British Geological Survey (https://www2.bgs.ac.uk/groundwater/international/africangroundwater/mapsDownload.html)
Groundwater irrigation suitability	IFPRI

Groundwater Irrigation Suitability for Maize in Sub-Saharan Africa

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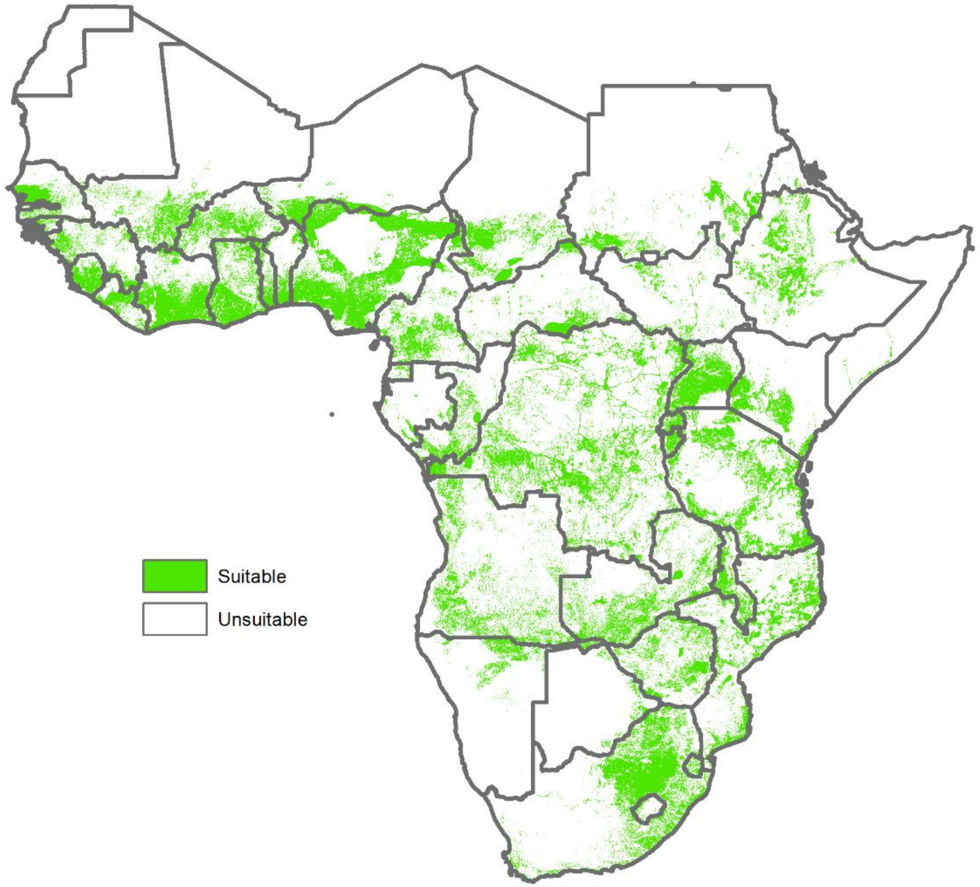


Category	Inclusion criteria	Data source
Cropland extent	Cropland percentage > 0	1 km global IIASA-IFPRI cropland percentage map (Fritz et al., 2015)
Slope	< 8%	Shuttle Radar Topography Mission (SRTM) digital elevation data
Groundwater depth	< 50 m	British Geological Survey digital groundwater maps of Africa (MacDonald et al., 2012)
Groundwater productivity	> 0.1 liter/second	British Geological Survey digital groundwater maps of Africa (MacDonald et al., 2012)
Agro-climatically attainable yield	> 0 under irrigation	IIASA-FAO Global Agro-ecological Zones (GAEZ) (Fischer et al. 2012)

Xie et al. (2021)

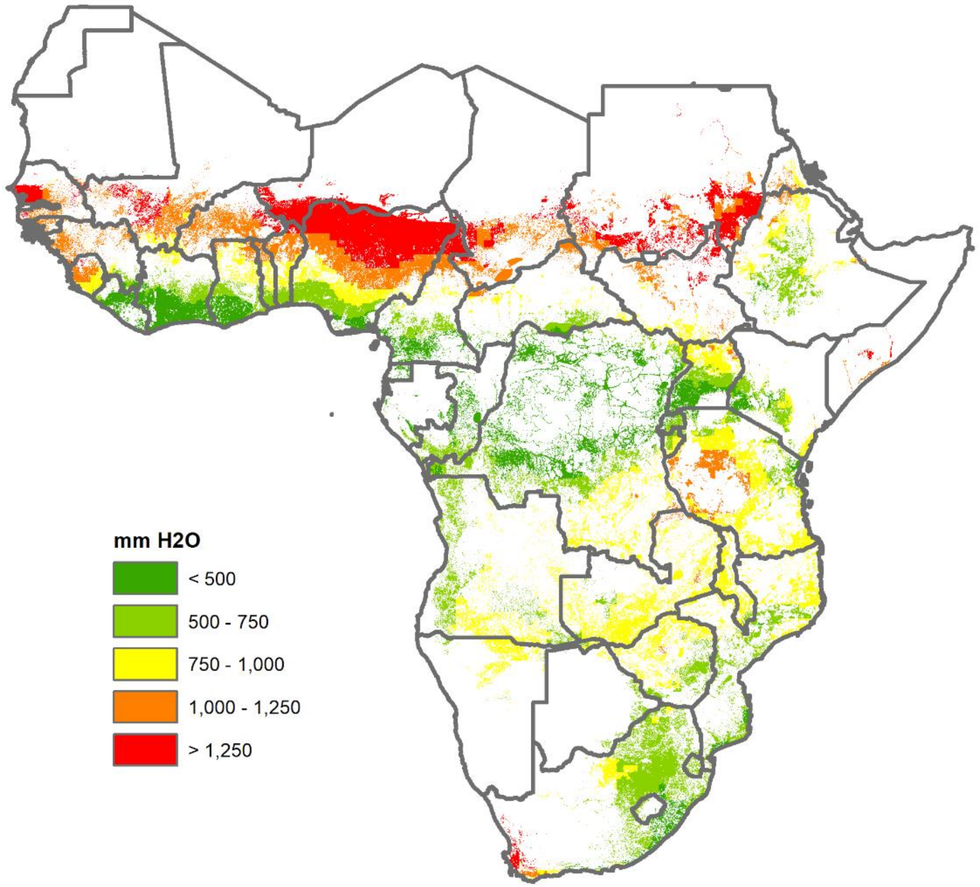
Input parameters

	Parameter	Value
Solar power unit	**Useful life of solar panel**	15 years
	Installed cost of solar module	US$ 2.0/Wp
	Maintenance cost of solar module	2%
Diesel generator and diesel fuel	Price of diesel generator	US$ 300/kW
	Useful life of diesel generator	10 year
	Annual maintenance cost of diesel generator	15% of the initial capital cost
	Diesel price	USD 0.69/liter
Pump	Price of pump	USD0.7/Watt
	Useful life of pump	10 year
	Annual Maintenance cost of pump	5% of the initial capital cost
Farm size		1 hectare
Borehole	Capital cost of borehole development	US$1,100 (groundwater depth <7m) US$2,200 (groundwater depth: 7-25 m)
Discount rate		12%

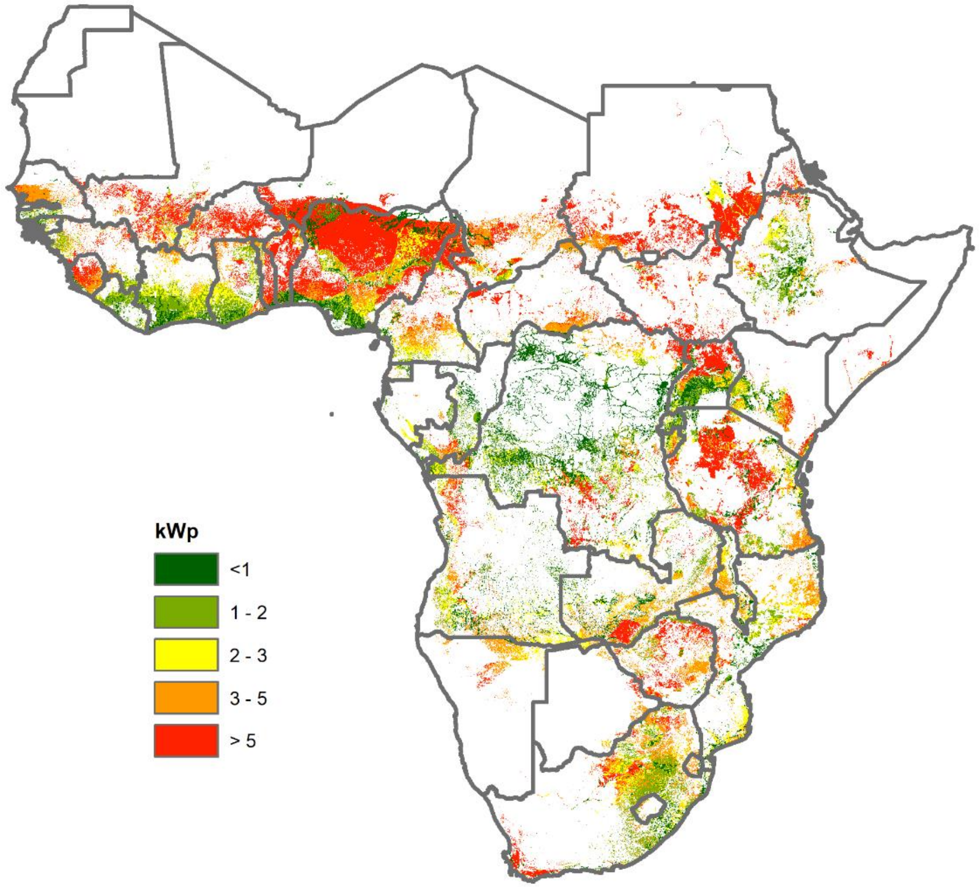
Xie et al. (2022)

Solar sizing: Results

Irrigation water demand(mm H_2O)



Size of solar module (kWp)

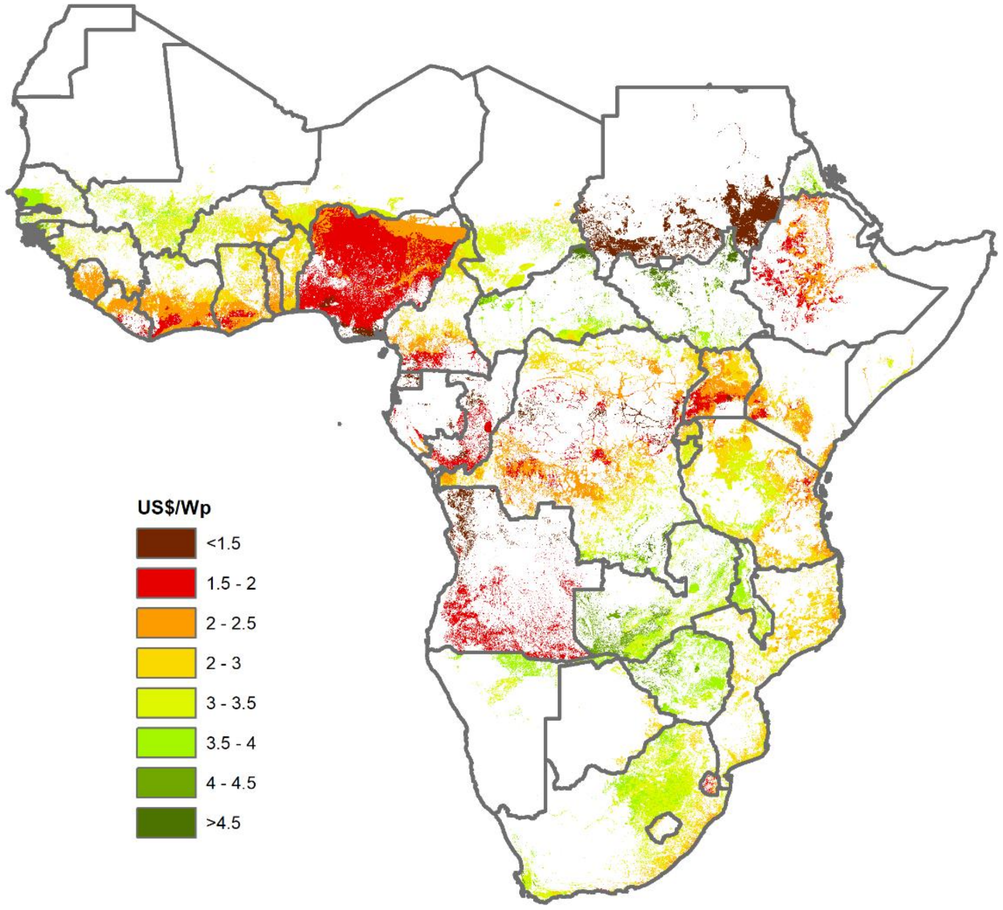


Maize + dry season + flood irrigation

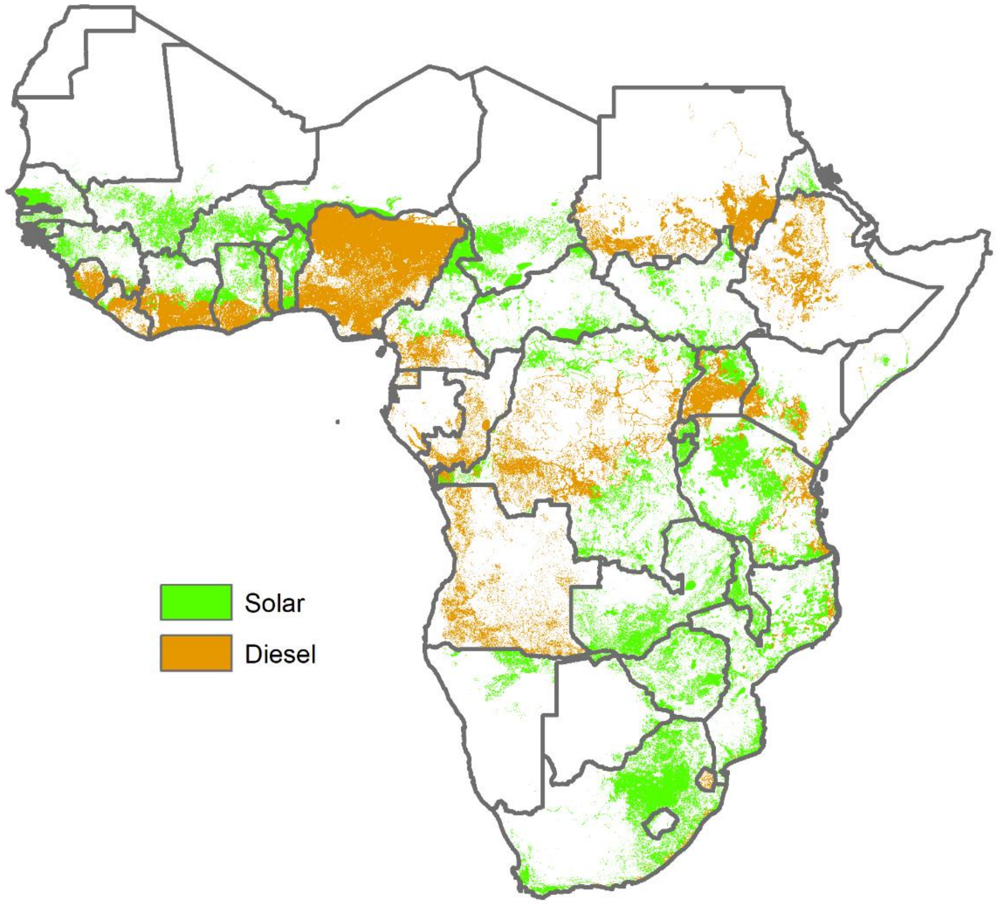
Xie et al. (2021)

Solar sizing: Results

Breakeven cost (USD/Wp)



Reclassified (USD 2.5/Wp)



Maize + dry season + flood irrigation

Xie et al. (2021)

Next steps

1. User interface design

2. GIS web service programming

3. Climate change impact assessment

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