Suitability mapping - Solar pump irrigation Ethiopia

1. Introduction

An assessment and mapping has been carried out in Ethiopia in order to identify the potential and opportunities for agricultural water management (AWM) interventions in terms of small-scale irrigation through **PV solar pumping**, notably:

- Suitability and sustainability.
- High potential regions.
- Promising areas for business models.

2. AWM solutions

The methodology was structured as follows:

(1) A framework was developed using open source Geographic Information System (GIS) software to identify scaling opportunities of solar (PV) irrigation in Ethiopia.

(2) The framework uses solar irradiation, landscape features, water and groundwater availability as well as market access.

(3) Five different scenarios were developed based on groundwater and/or surface water accessibility (Table 1).

(4) Smallholder farms of 1 ha require a maximum solar power < 1kW. The model was tested for two solar pumps requiring a minimum irradiation of 0.5 kWh m^{-2} and 1 kWh m^{-2} with a suction head limitation of 7-8 m (S2 & S4) and 30 m (S1 & S5), respectively.

Table 1: The factors considered in the multi-criteria model based on five different scenarios.

	Groundwater		Surface water	Groundwater & surface water	
Data	**S1**	**S2**	**S3**	**S4**	**S5**
Solar irradiation	√	√	√	√	√
Slope	√	√	√	√	√
Proximity to roads	√	√	√	√	√
Groundwater (0-7m)	-	√	-	√	-
Groundwater (0-25 m)	√	-	-	-	√
Aquifer productivity	√	√	-	√	√
Groundwater storage	√	√	-	√	√
Proximity to river	-	-	√	√	√
Proximity to small reservoirs	-	-	√	√	√
Proximity to town	√	√	√	√	√

3. Potential beneficiaries

- Solar photovoltaic (PV) technologies are a promising technology for smallholder farming systems.
- With the growing demand for small-scale irrigation solutions to decrease household vulnerability to climate shocks, solar photovoltaic (PV) based irrigation is showing promise in farmer field trials.
- There is high interest to scale PV based water lifting technologies.
- A potential area of 6.8 10^3 ha could be irrigated using solar PV water lifting in Ethiopia.

4. Main results

- Analyses in Ethiopia showed that the suitability of solar PV pumps overlapped on average with 9% (96 10^3 ha) of Ethiopian irrigated and 18% (3,739 10^3 ha) of rainfed land.
- In those areas, results show that groundwater and water resources are available and could be potentially lifted through solar PV based pumps for either supplementary irrigation in the rainy season or to support smallholder agriculture during the dry season.

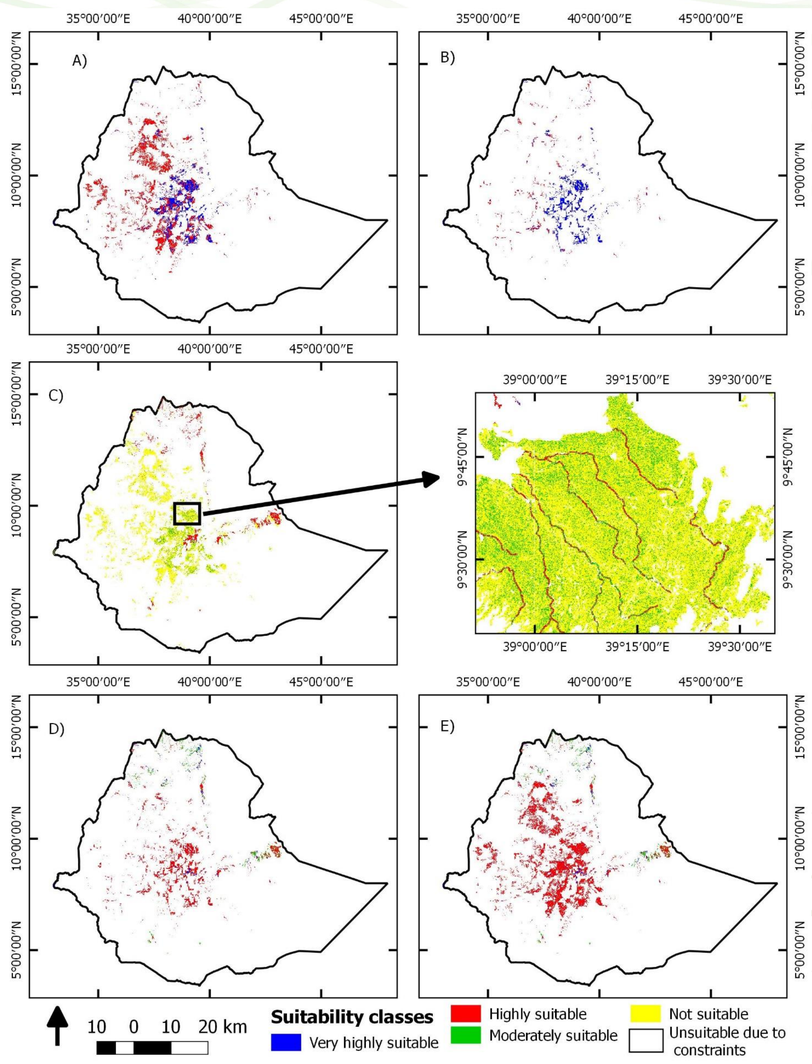

Figure 1: Suitability maps for Ethiopia (left) and Ghana (right): A) Scenario 1; B) Scenario 2; C) Scenario 3; D) Scenario 4 and E) Scenario 5

Farmers in Lemo, SNNPR, Ethiopia growing multiple crops - vegetables, fruit, coffee - with a PV solar pump. The pumps are also used for multiple purposes when installed at the homestead.

Table 2: Suitable area for solar based pump irrigation following five scenarios per region in Ethiopia (10^3 ha).

	Ethiopia				
Region	**Total suitable area (10^3 ha)**				
	S1	**S2**	**S3**	**S4**	**S5**
Addis Ababa	2	0.6	0.2	0.7	2
Afar	8	8	2	8	8
Amhara	1,776	371	202	446	1,834
Beneshangul Gumuz	21	5	0.5	5	21
Gambella	16	8	0.4	9	16
Harar	0.4	0.4	0.8	0.7	0.7
Oromiya	3,337	1,443	463	1,716	3,569
SNNPR[1]	1,077	282	41	298	1,087
Somali	10	8	154	125	125
Tigray	57	51	272	143	147
Total	**6,304**	**2,177**	**1,136**	**2,751**	**6,810**

Suitability maps are part of a **multi-criteria framework** within a **business model approach** to identifying AWM Solutions. These interrelated components are the basis for business model development:

- Suitability mapping
- Environmental sustainability
- Institutional, policy and regulatory context
- Finance mechanisms
- Technology supply chain
- Economic sustainability

5. Conclusions

- Large potential exists for solar PV based irrigation in Ethiopia (6.8 10^3 ha) that would enable smallholder farmers to improve resilience with a climate-smart technology.
- Ensuring environmentally sound sustainable expansion of solar based irrigation requires higher resolution information on groundwater and surface water resources.
- Market development will be crucial in realizing the solar based irrigation potential, particularly targeting smallholder farmers with feasible and profitable investments in such technologies.
- Suitability mapping should be integrated into planning for overall sustainable irrigation development in SSA, and more specifically, to evaluate possible investments in solar pump business models.

This poster is based on: Schmitter, P., Kibret, K.S., Lefore, N., Barron, J., 2018. Suitability mapping framework for solar photovoltaic pumps for smallholder farmers in sub-Saharan Africa. Applied Geography 94: 41-57

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