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Can basement aquifers sustain the transition to solar powered pumping?

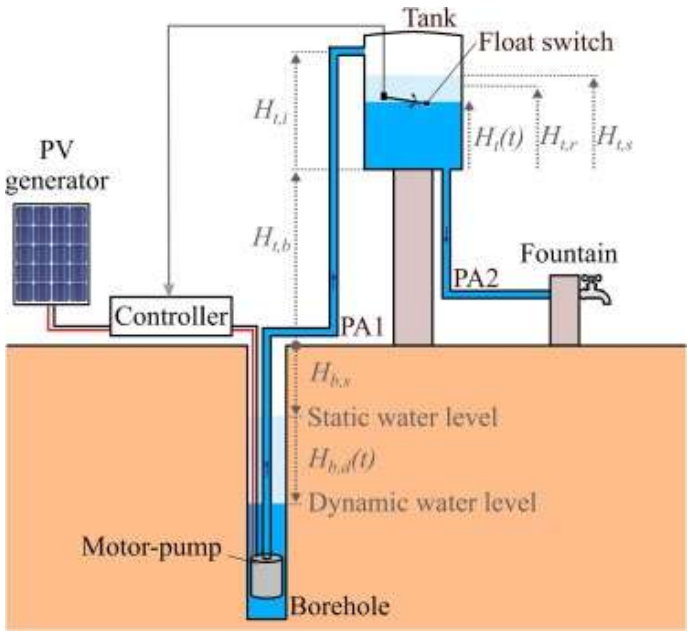
BGS British Geological Survey

Contents

- Opportunity of Solar Power
- Basement aquifers
- Continental scale analysis
- Village supplies
  - Aquifers
  - Management
- Reflections

https://blogs.worldbank.org/en/water/navigating-opportunities-and-risks-solar-irrigation

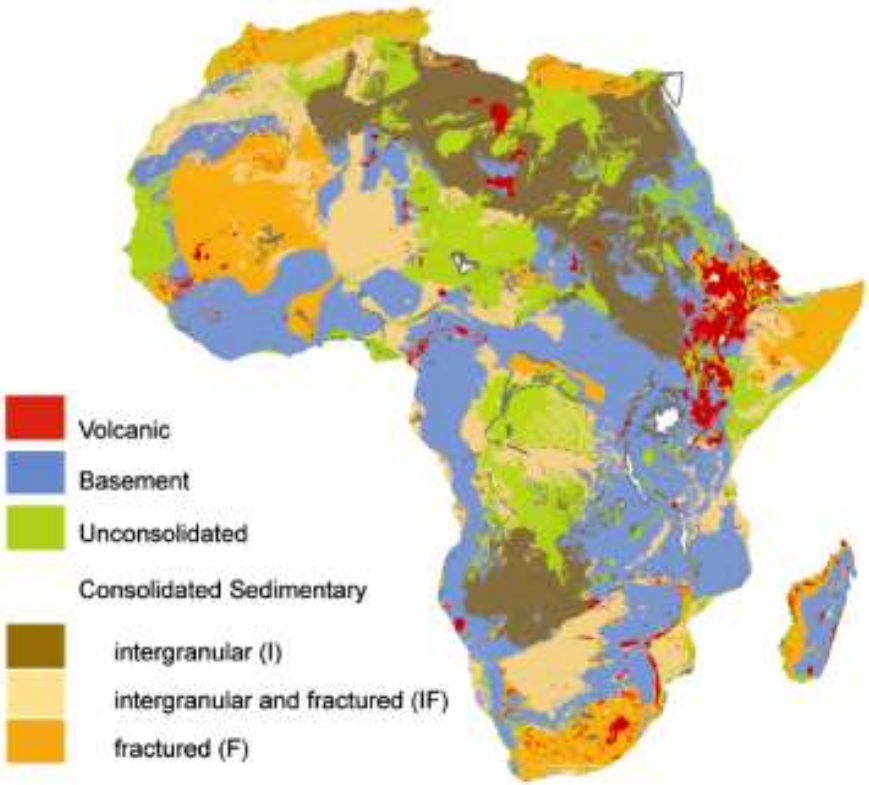
Solar pumping



https://doi.org/10.1016/j.apenergy.2019.03.035

- Pumping from photovoltaic energy
- Depends on irradiance and ambient temperature
- Pump usually to a header tank and then gravity distribution to standpipes, or direct for irrigation
- Pump sizes often 100 – 3000 watts
- Solar panel costs have been falling dramatically to $0.25 per Watt
- Estimated 0.5 – 1 million systems in S Asia

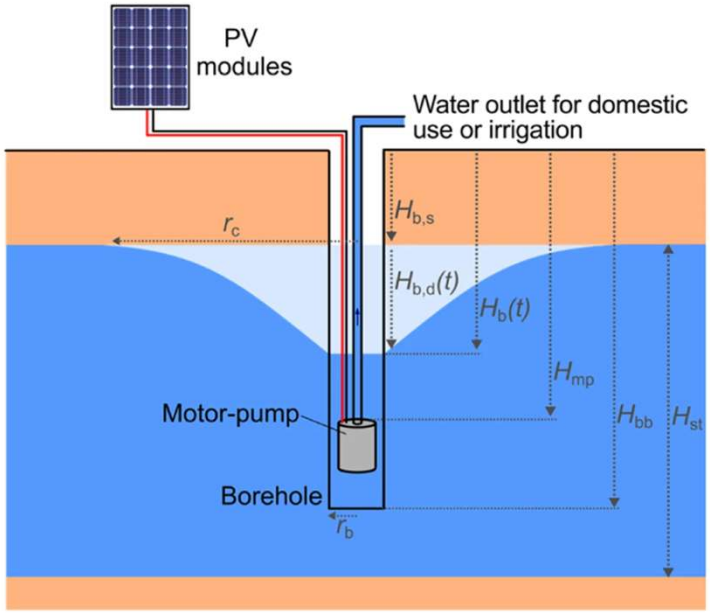
Basement Hydrogeology



https://iopscience.iop.org/article/10.1088/1748-9326/7/2/024009

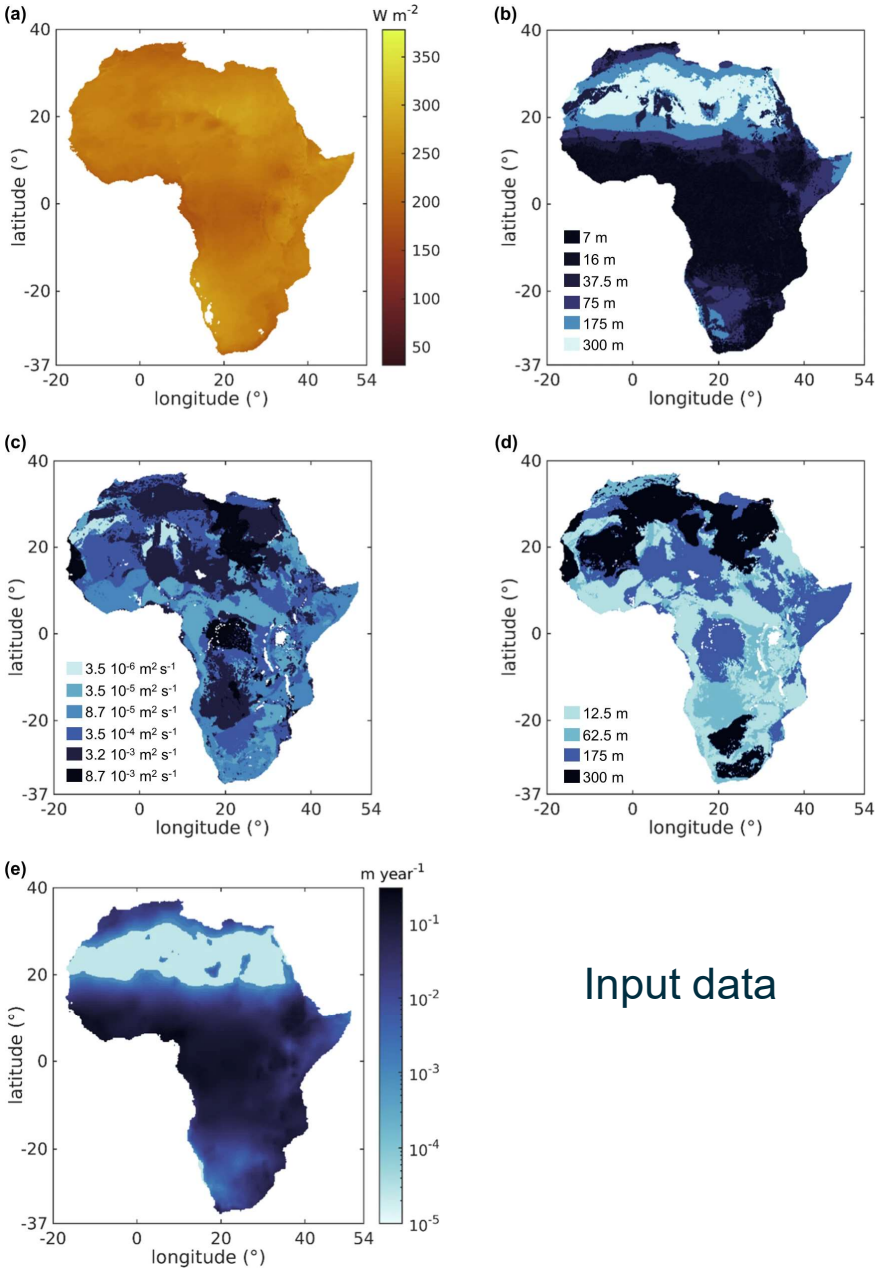
- 40% of people in sub-Saharan Africa live on basement rocks
- Yields generally low – but can also be high in places
- Permeability depends on weathering, lithology and presence of fracturing
- Typology approach – useful for sub dividing basement

Modelling yields from solar



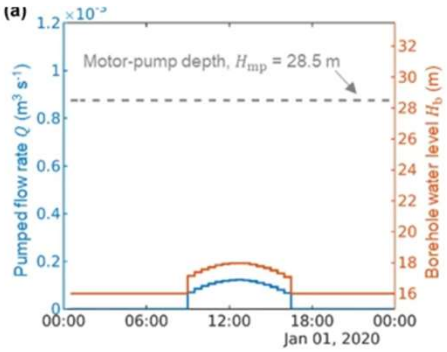
https://www.nature.com/articles/s43247-023-00695-8

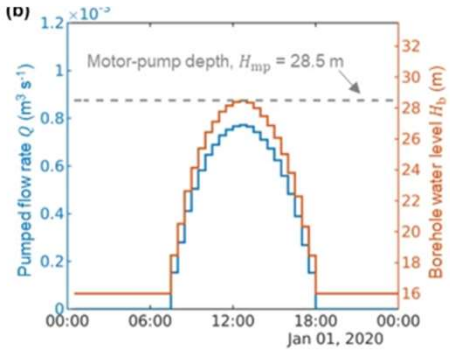
Model modules:
atmosphere, PV solar, hydraulic, aquifer, pump

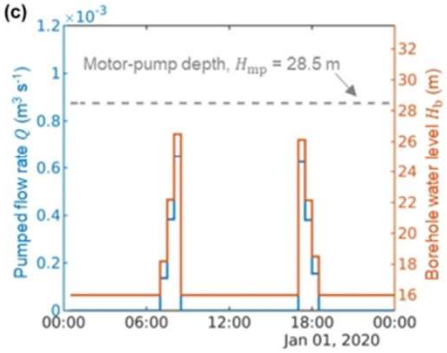


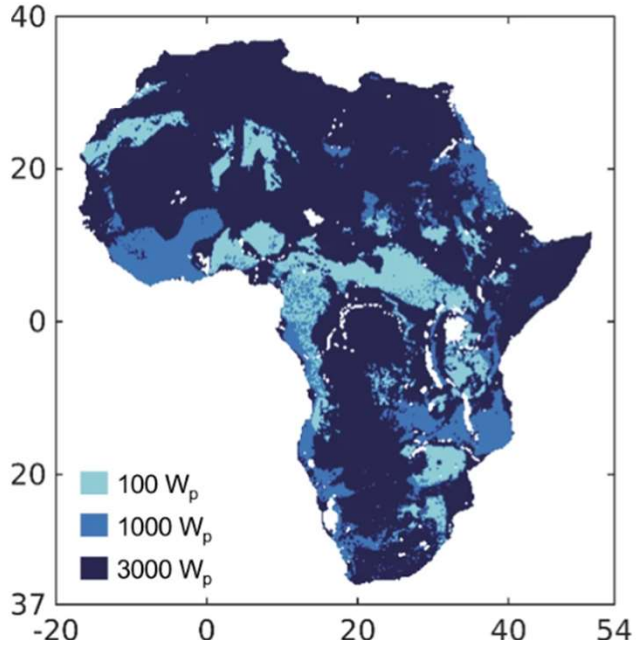
Input data

Optimum solar pumping





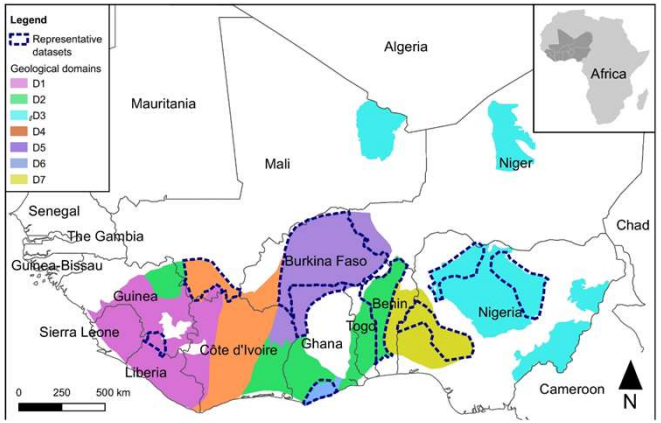




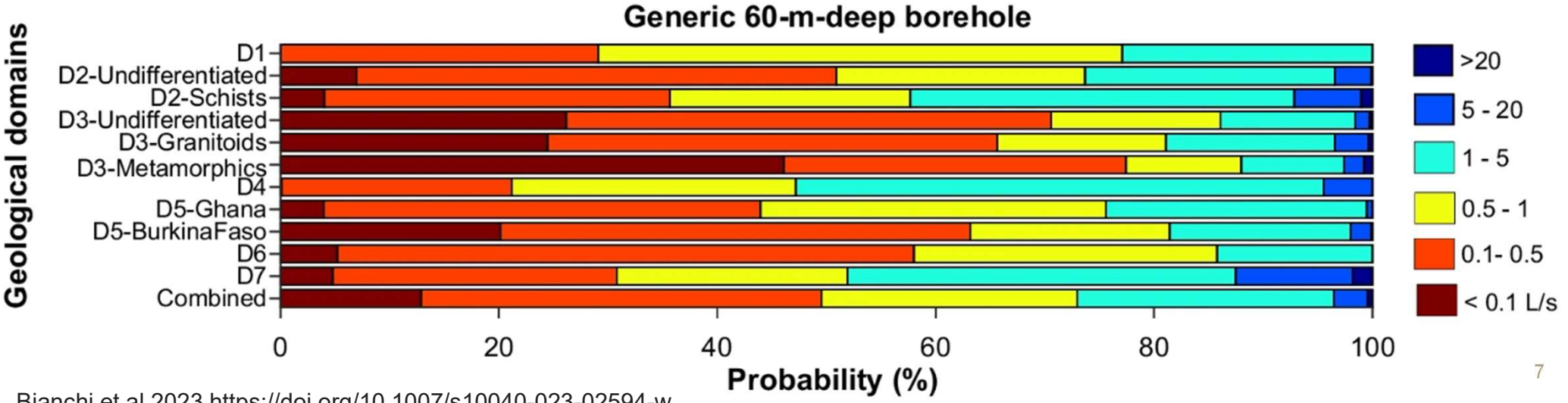
- Geology more important than irradiance
- Pump and scheme size matters

https://www.nature.com/articles/s43247-023-00695-8

Stochastic modelling of basement borehole yields

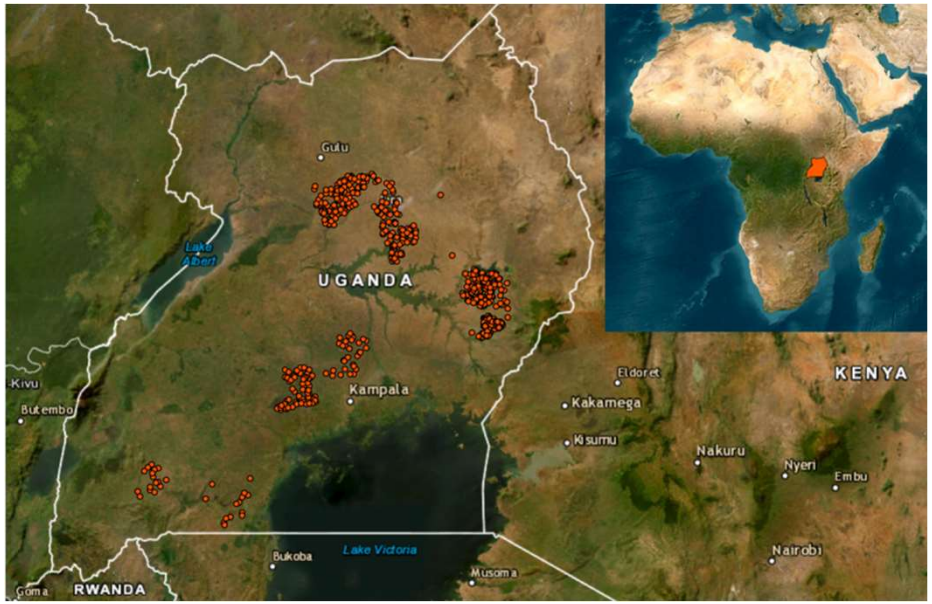


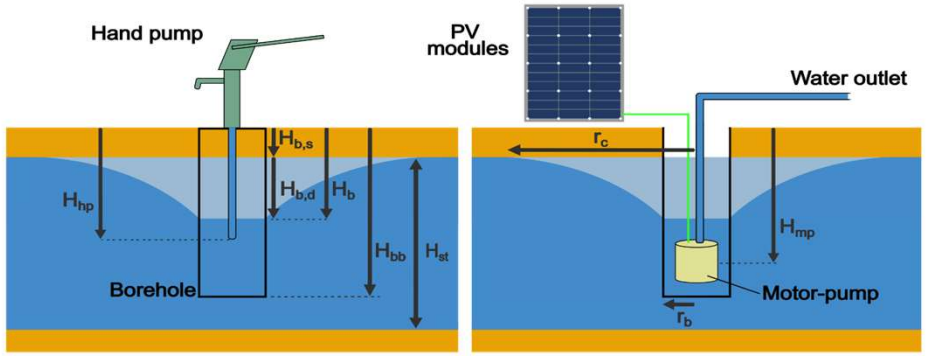
- Different domains identified based on geology, weathering depth to water etc..
- Modelled using Bianchi et al 2020
- Validated using data for each domain
- Results for generic 60 m deep borehole



Bianchi et al 2023 https://doi.org/10.1007/s10040-023-02594-w

Individual Sources





- Data from UPGro Hidden Crisis
- Work published by Michel Owor et al on transmissivity data
- Transmissivity generally low
- Data on water levels, transmissivity and water strikes and completion
- A model developed of pumping with hand pumps and different sizes of solar powered pumps

In progress

Management lessons from hand pump research

- **Going with the grain**: the use of existing community groups, institutions, and processes – entrenching inequalities? https://doi.org/10.1016/j.worlddev.2020.105286
- **The challenges of district support** finance, motivation, accountability technical skills https://doi.org/10.1016/j.worlddev.2020.105286
- **worldviews shape local water management arrangements and their outcomes** – challenges of how this is operationalised (Cleaver et al. 2021)
- **Cascading pressures and communities under high water stress** with routine sharing of water points, increased conflict due to poor functionality https://doi.org/10.1088/1748-9326/ab282f

Summary

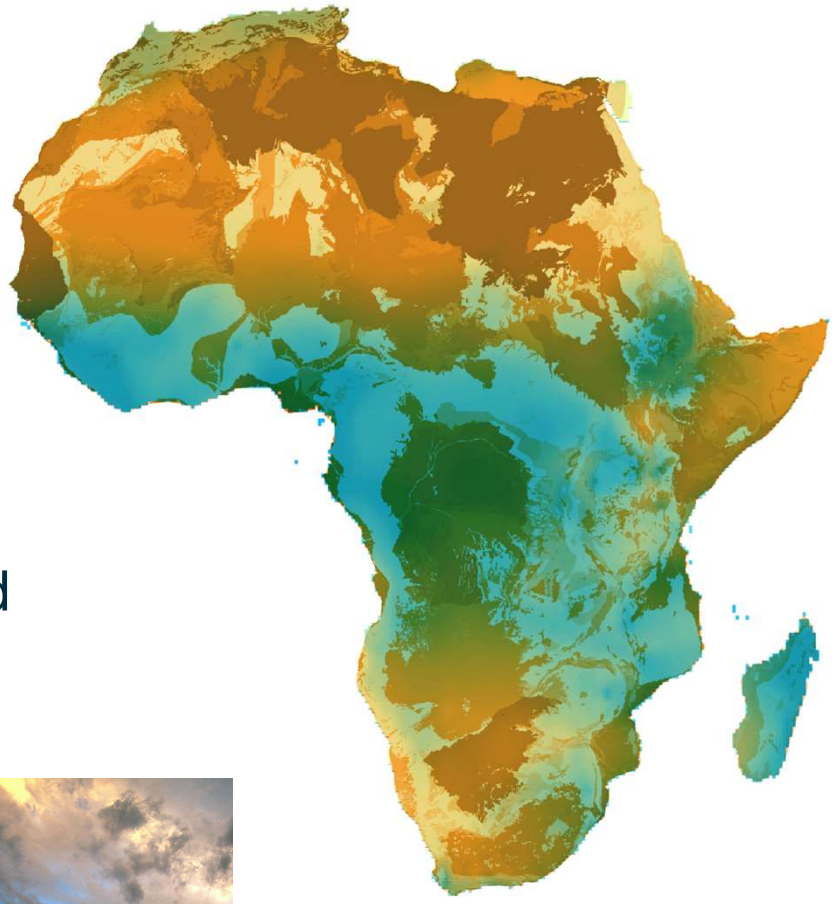
Technology getting there – lots of promise

It’s going to happen !

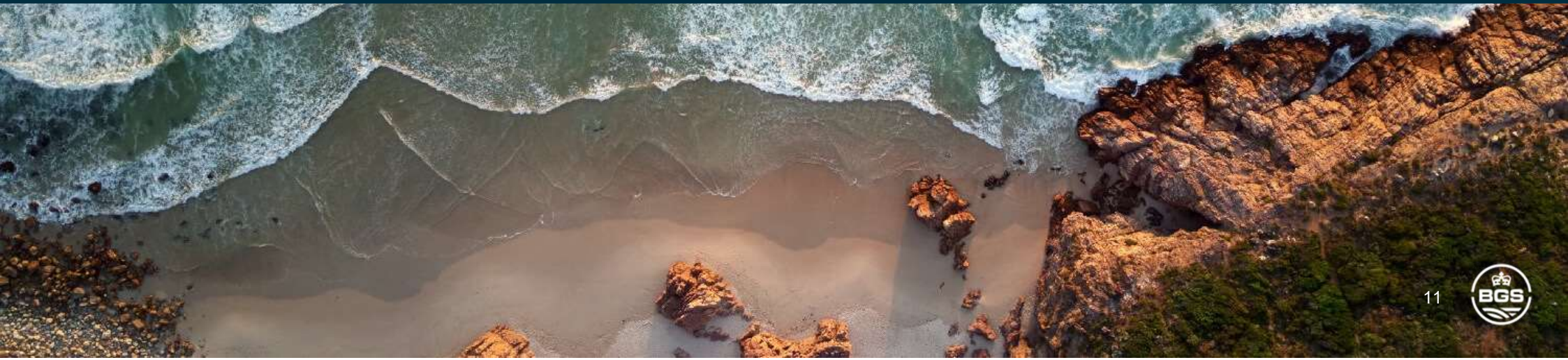
Geology often limiting factor –

A mixed model will work best

Much more research needed on sustainability and management



How does this technology help provide water for the 400 million without a even a basic water supply?



Opinion
Access to water

The solar pump revolution could bring water to millions of Africans but it must be sustainable and fair

Alan MacDonald

Supported by

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About this content

Mon 9 Sep 2024 12.00 CEST

Share

Solar power could enable 400 million Africans without water to tap into groundwater aquifers. However, we must ensure smaller projects do not lose out in the rush for new technology

Solar-powered pumps supplying irrigation and drinking water to Zingiziwa village in Malawi. Improved technology can allow groundwater resources to be easily overexploited and depleted. Photograph: Jörg Böthling/Alamy

It's a truly dreadful irony: for many of the 400 million people in sub-Saharan Africa who lack access to even a basic water supply, there is likely to be a significant reserve in aquifers sitting just a few metres