Groundwater and rural water supply functionality in Africa:

Implications for solar water pumping

Solar Water Pumping Workshop

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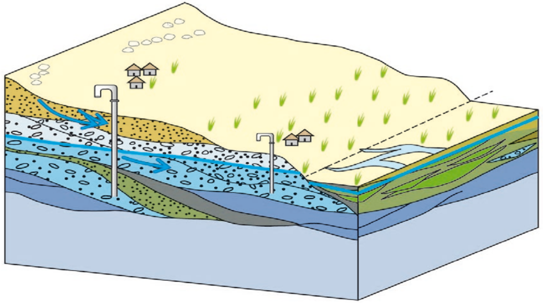
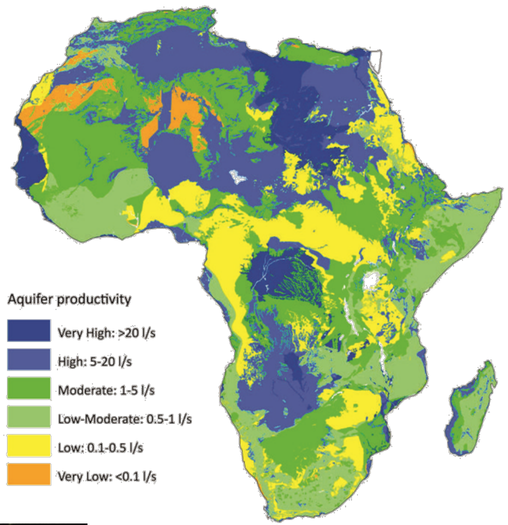
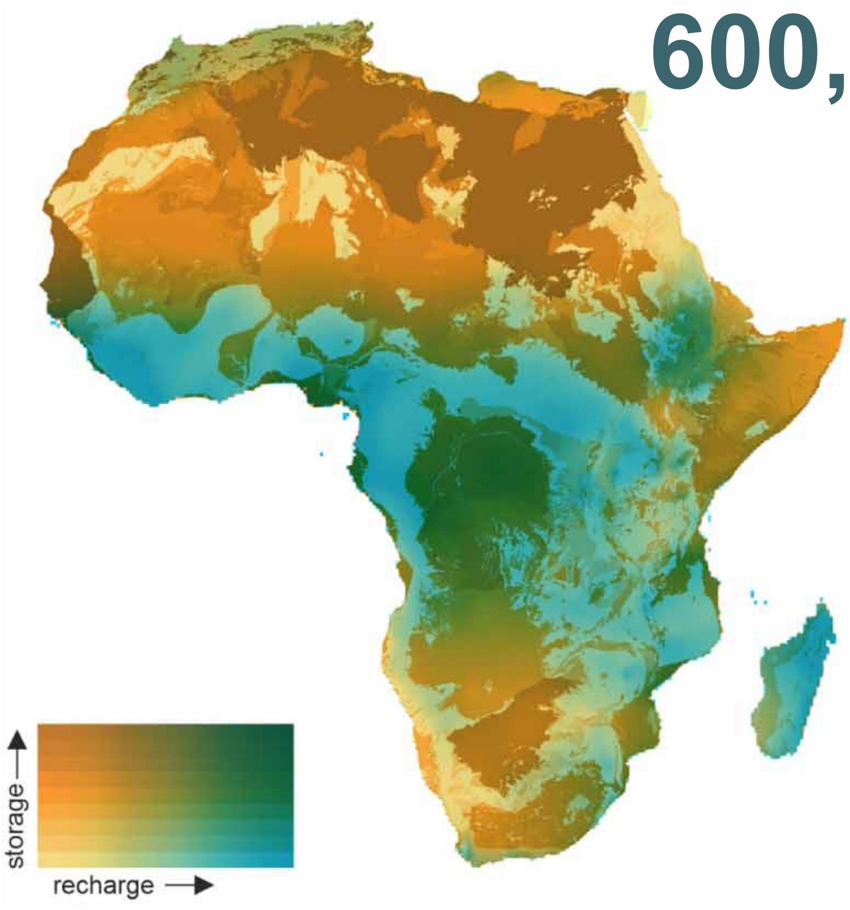
Overview

- Groundwater in Africa
- Groundwater and rural water supply resilience in East Africa
- Functionality of rural groundwater supplies in East and Southern Africa
- Implications for solar pumping in Africa





Groundwater in Africa



600,000,000,000,000,000 litres

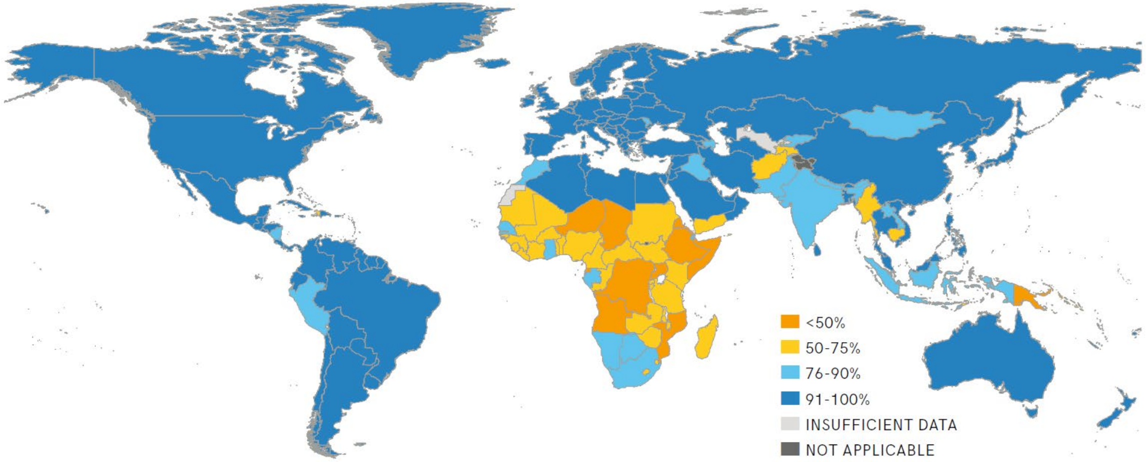
> 30x annual rainfall

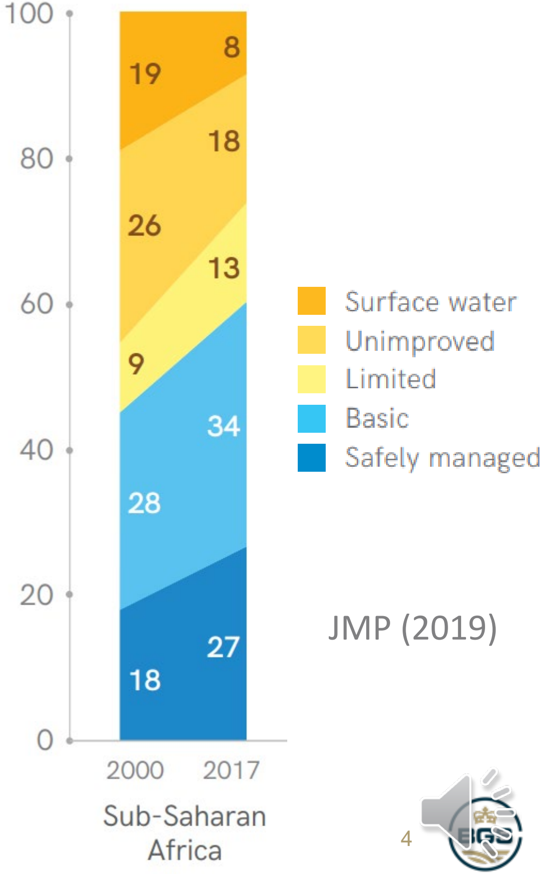
> 20 x surface water storage

MacDonald, Alan M., et al. "Mapping groundwater recharge in Africa from ground observations and implications for water security." *Environmental Research Letters* 16.3 (2021). https://doi.org/10.1088/1748-9326/abd661

Evolution of rural water supply in Africa

- MDG to SDG – improved water supply to safely managed water supply.
- Safely managed drinking water is an improved water source that is accessible on premises, available when needed and free from contamination.
- Gradual move away from technologies such as handpumps to solar and other types of reticulated and piped systems.

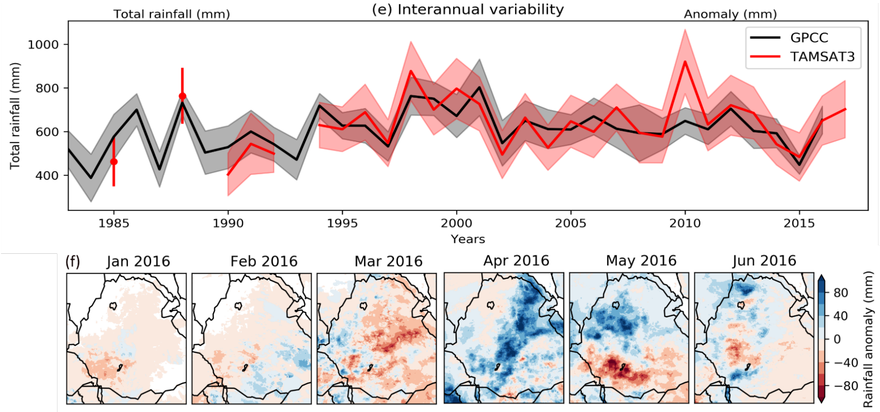


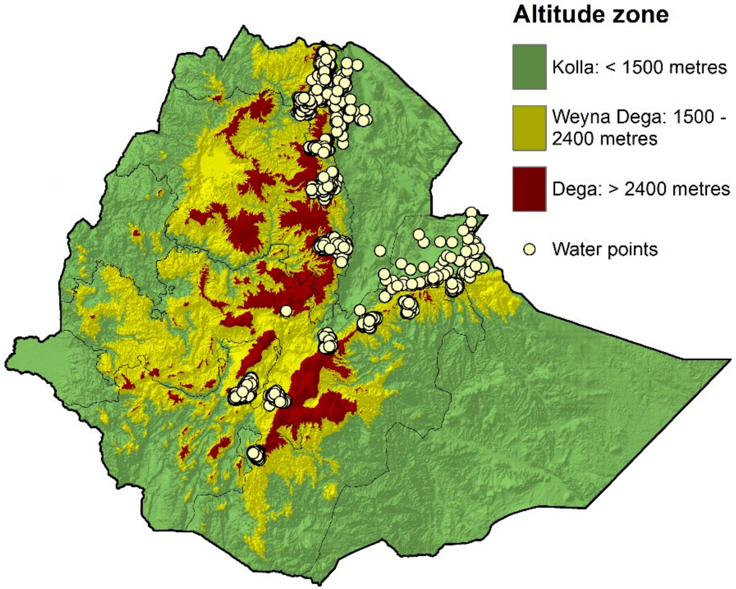


JMP (2019)

Groundwater supply resilience to drought

- Severe drought in Ethiopia in 2015-16
- 10 million people rely on aid.
- Water source monitoring:
  - functionality of 5196 water points.
  - 676 motorised systems in the dataset and rough 10% of these are solar pumps.

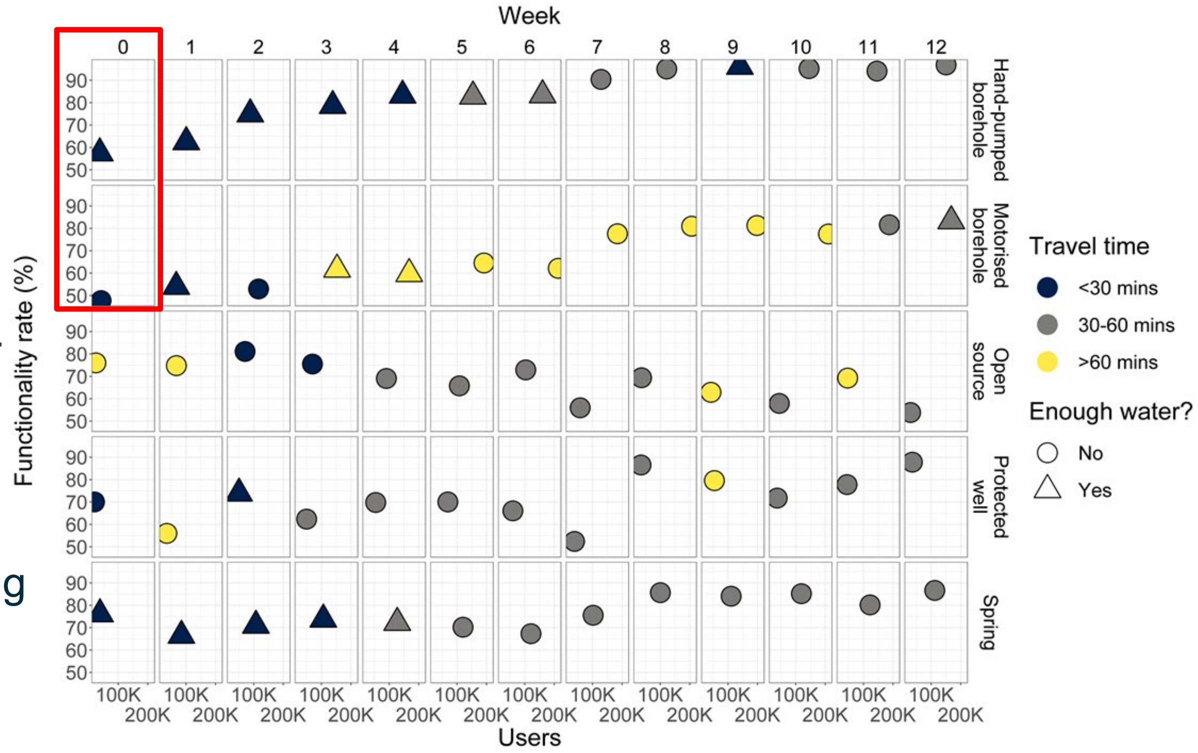




MacAllister, D.J., et al. Comparative performance of rural water supplies during drought. Nat Commun 11, 1099 (2020). https://doi.org/10.1038/s41467-020-14839-3

Summary of temporal impact of drought

- Access to groundwater via handpumps and motorised boreholes essential.
- Handpump and motorised boreholes:
  - did not fail on a large scale.
  - increased functionality due to operation and maintenance.
  - crucial for water supply.
- Motorised systems (including solar):
  - lower functionality than handpumps.
  - less accessible.
  - inadequate water quantity.
  - very high number of users.



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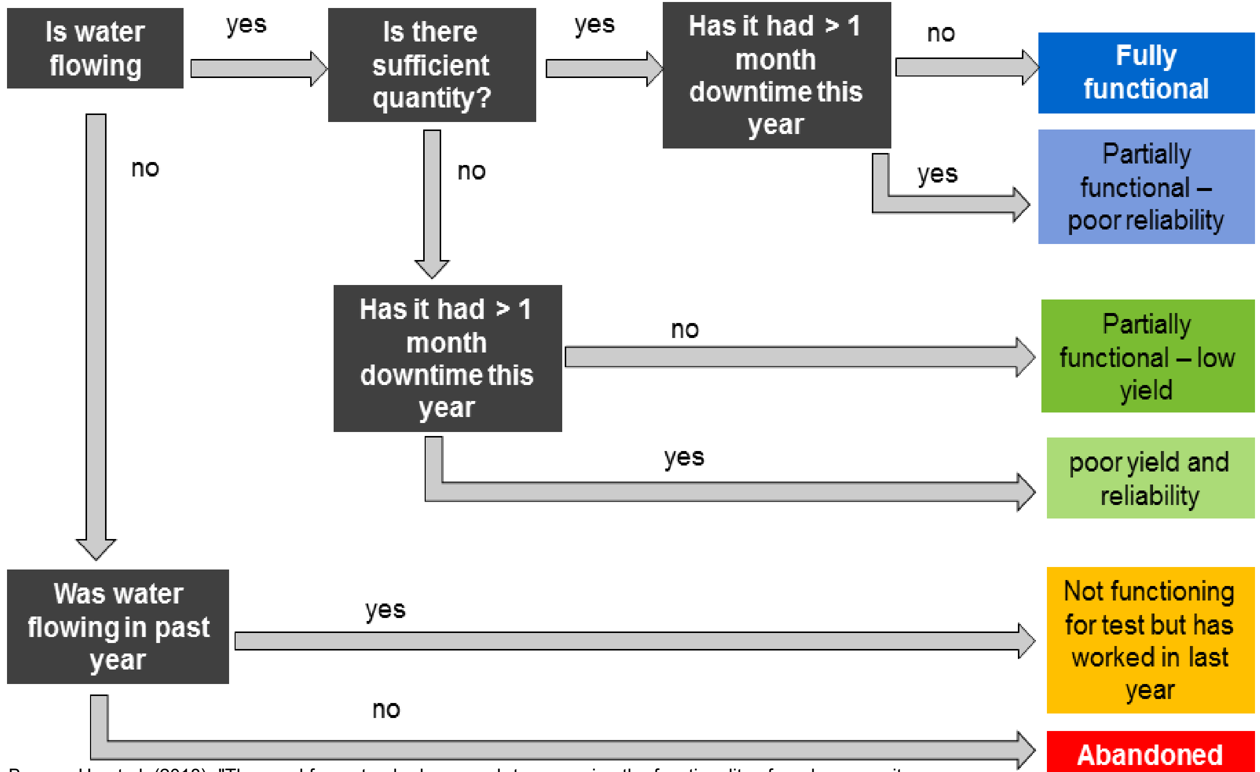
Hidden Crisis: unravelling failures for future success

- 15 – 40% of rural water supplies (RWS) are non-functional at any time.
- Interdisciplinary research Ethiopia, Malawi, Uganda:

1. Define the functionality of boreholes and water committees.
2. Apply to Uganda, Ethiopia and Malawi to explore current status – SURVEY 1 – 600 boreholes
3. Interdisciplinary analysis to understand underlying reasons for functionality status – SURVEY 2 – 150 boreholes

Definition of functionality



Bonsor, H., et al. (2018). "The need for a standard approach to assessing the functionality of rural community water supplies." Hydrogeology Journal **26**(2). https://doi.org/10.1007/s10040-017-1711-0

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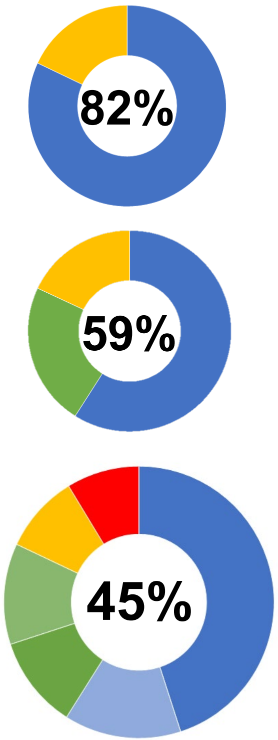
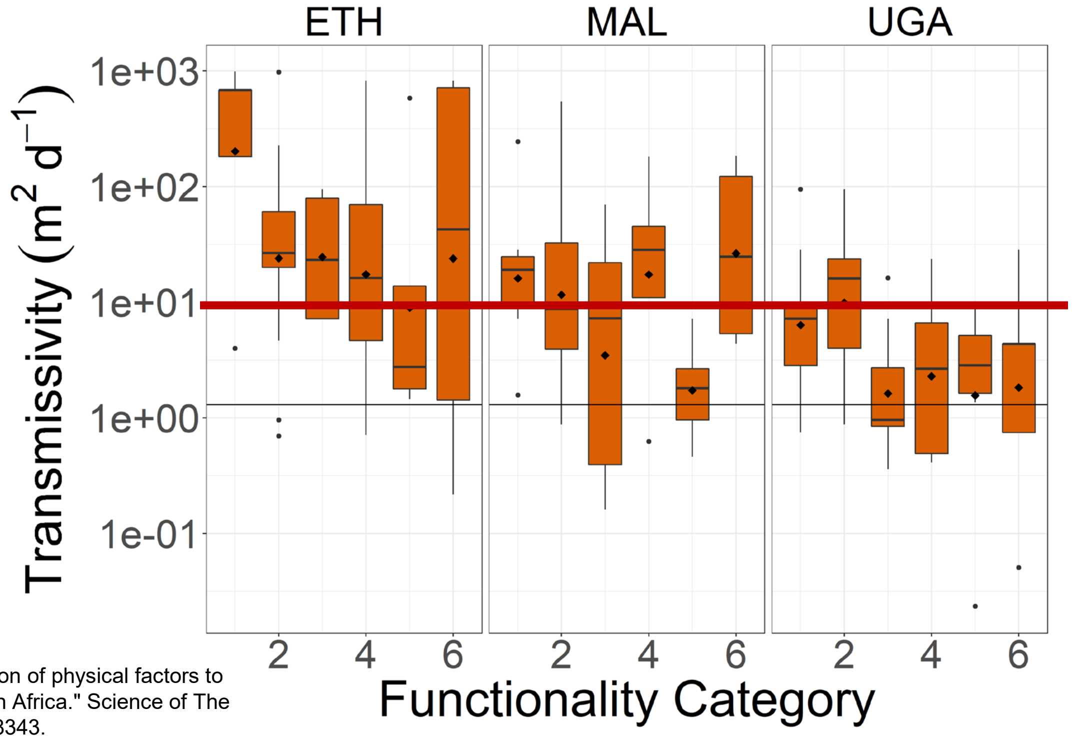
Ethiopia



Kebede, S., et al. (2017). "UPGro Hidden Crisis Research Consortium. Survey 1 Country Report, Ethiopia." http://nora.nerc.ac.uk/id/eprint/516998/

Hydrogeology – aquifer pumping test

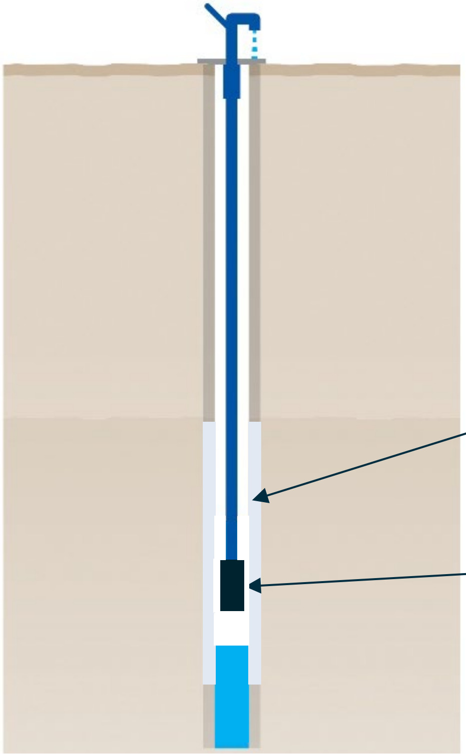
- Transmissivity problematic in Ethiopia and Uganda respectively.
- Transmissivity results have implications for larger reticulated systems (e.g. solar pumps).

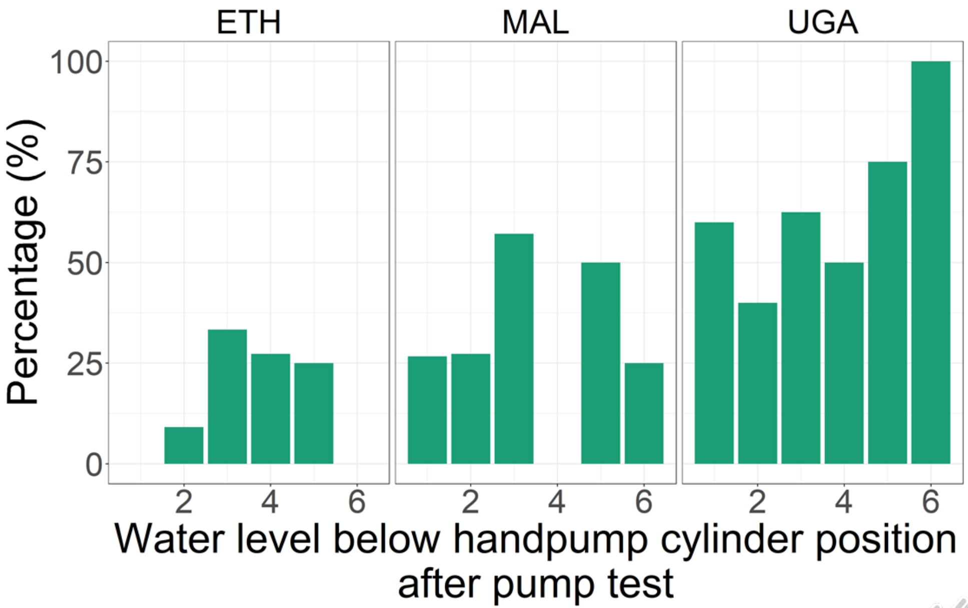


MacAllister, D. J., et al. "Contribution of physical factors to handpump borehole functionality in Africa." Science of The Total Environment 851 (2022): 158343.
https://doi.org/10.1016/j.scitotenv.2022.158343

Borehole construction and configuration – CCTV survey

- Due to design or maintenance flaws, risk of water dropping below cylinder at many sites.
- In dry season this means handpump cannot extract water.





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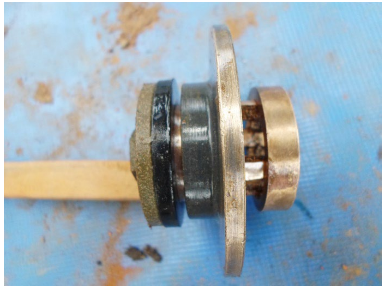
Handpump component condition – engineering survey

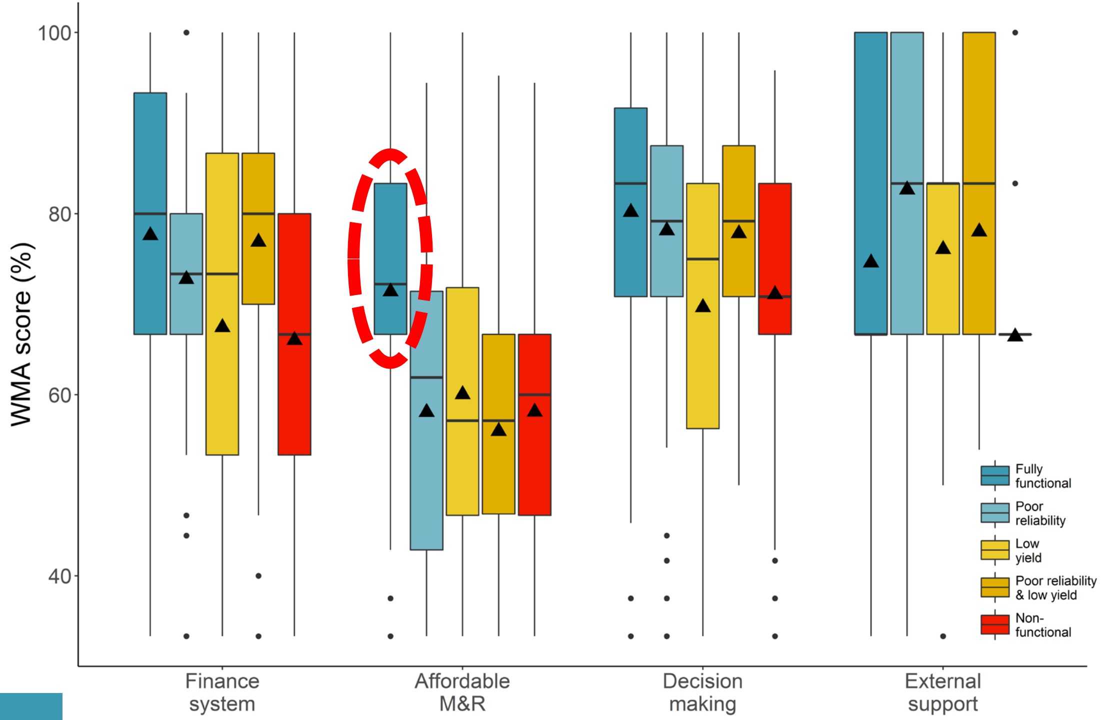
- IM2 rising main:
  - Ethiopia:
    - 60% thickness below spec. (3.25 mm ±0.2 mm)
    - 55% galvanising thickness below spec. (70- 80 μm)
    - c.50% corroded.
  - Uganda:
    - 65%
    - 90%
    - > 80%

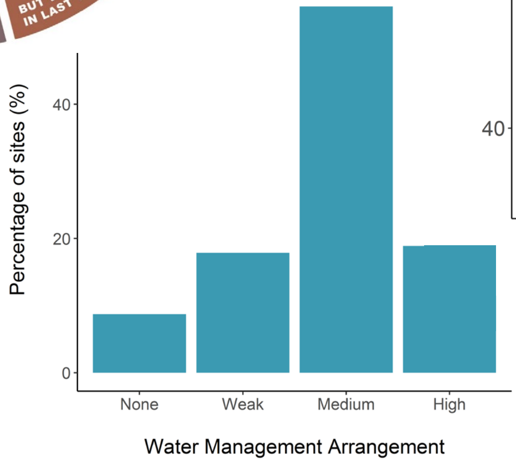






Management – focus group, interviews and transect walks





Whaley, L., et al. "Evidence, ideology, and the policy of community management in Africa." Environmental Research Letters. (2019)
https://doi.org/10.1088/1748-9326/ab35be

Conclusions and implications for solar pumping in Africa

- Groundwater is a vast, untapped and resilient water resource in Africa.
- Millions of people still lack access to improved water supply in Africa.
- Groundwater provides a reliable and resilient form of improved rural water supply.
- Thus, huge potential for development of solar pumping for rural water supply in Africa.
- Experience from handpump investigations provide lessons and highlight challenges for development of solar water supply:
  - Hydrogeology
  - Borehole siting and construction
  - Maintenance
  - Management
  - Functionality
- Consideration of the full range of physical (and social) characteristics of functionality can:
  - Increase the likelihood of success of new technologies, e.g. solar pumping.
  - improve access to water and resilience of communities including via increased use of solar pumping technologies.

THANK YOU

Any questions?

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