Resilience of rural groundwater supplies during drought in Ethiopia

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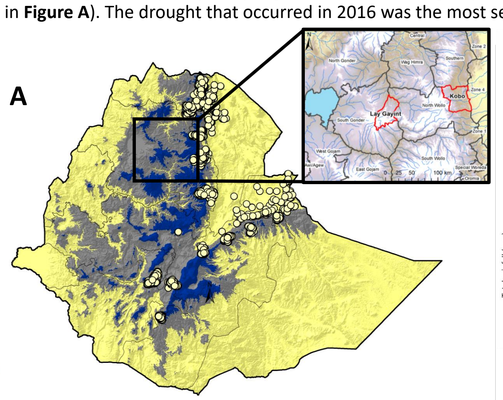
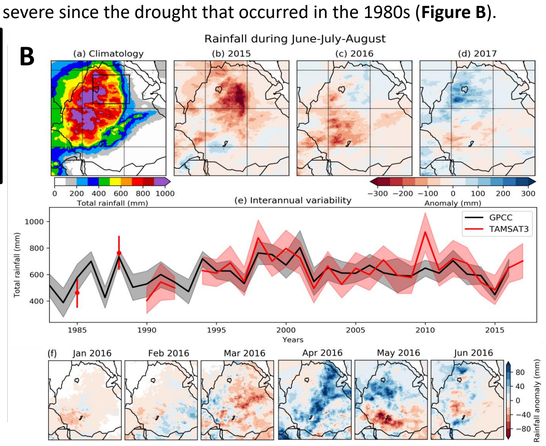
1. Introduction

During the El Nino drought in Ethiopia in 2015-16 significant effort was made to monitor the performance and use of different rural water source types. Here we present the results from two complimentary studies on water source performance during the drought. The first study used data from a real-time monitoring programme, conducted by UNICEF, of 5196 rural water points from across Ethiopia (**Figure A**), focused on functionality, usage and access. The second study focused on a much smaller sample of 51 water points but conducted a more in-depth analysis of water source performance using high frequency water level monitoring, water quality sampling and detailed focus group discussions in two areas of Ethiopia (Kobo and Lay Gayint, see panel in **Figure A**). The drought that occurred in 2016 was the most severe since the drought that occurred in the 1980s (**Figure B**).

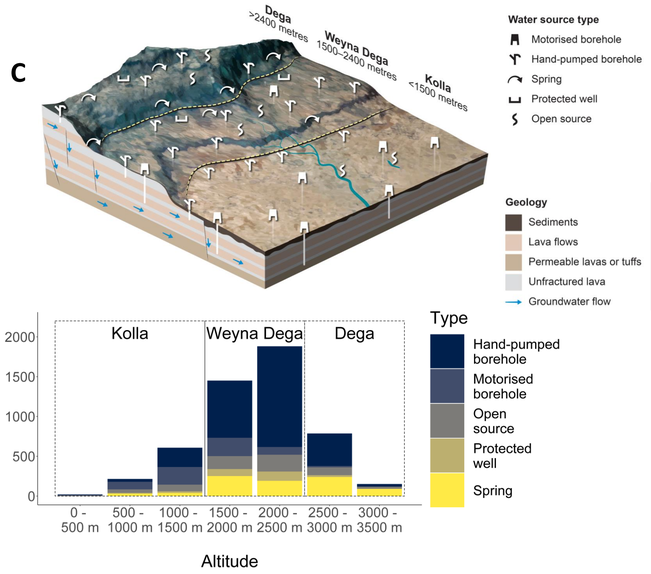




2. Methododolgy

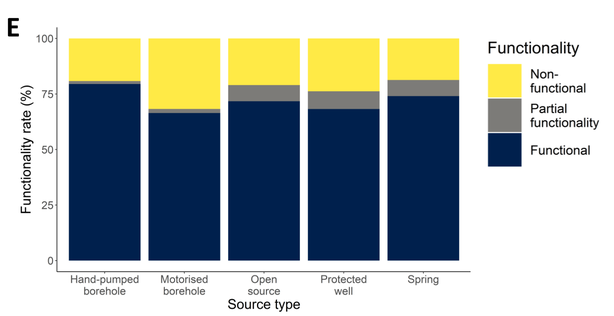
In the large scale water source monitoring survey, which included 5196 individual water points, data was collected from January to May 2016 following the severe 2015-16 El Nino drought in Ethiopia. Information was collected weekly by trained enumerators using questionnaires to gather quantitative and qualitative data on water point performance (functionality, usage and access). The surveys were conducted using a mobile monitoring platform called Akvo Flow. Data from different water source types were captured, including: hand pump boreholes, motorised boreholes, open sources, protected hand-dug-wells and springs (**Figure C**). Due to the influence altitude has on rainfall within Ethiopia we used the three altitude zones (Kolla, Weyna Dega and Dega) as a framework to analyse the comparative performance of different water source types during the drought (**Figure D**) and to assess in what areas water supplies and users experienced most severe pressure.

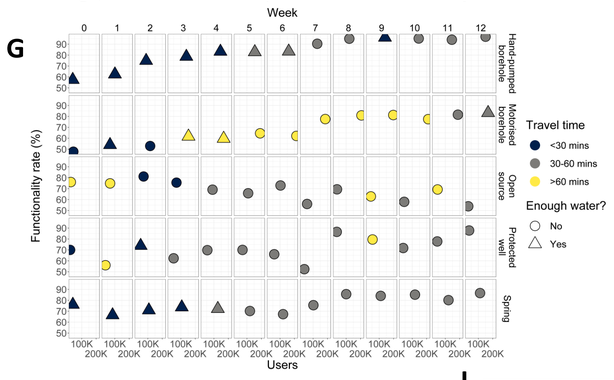
In the more focused study 19 hand-dug-wells, boreholes and springs were equipped with high frequency groundwater level monitoring equipment over a two year period to assess their performance including during the El Nino drought, and the subsequent two rainy and dry seasons. Ten hand-dug-wells, five shallow boreholes (40–100 m deep) and four springs were instrumented with pressure transducers to measure water levels every 15 minutes. To measure changes in water quality, Thermo-tolerant Coliforms (TTCs) were measured for 17 hand-dug-wells, 15 shallow boreholes and 19 springs every 2 months. Semi-structured interviews were carried out with focus groups in each Kebele (sub district). The Focus Groups comprised a mixture of wealth groups. The discussions focused on experience of water supply during a normal year and the El Niño drought, and the impacts experienced by different parts of the community during a normal dry season, and during times of water scarcity.

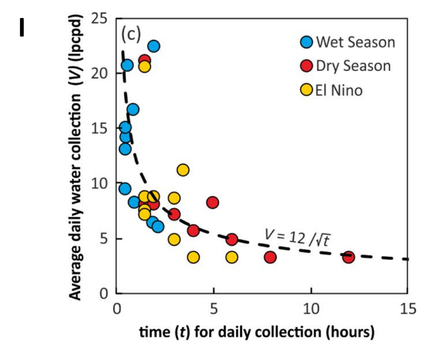


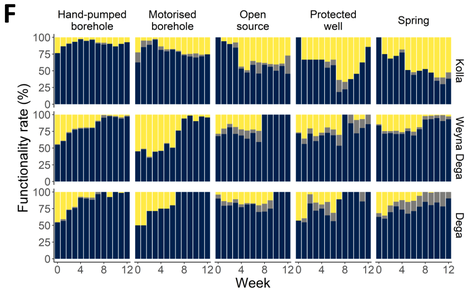
3. Results

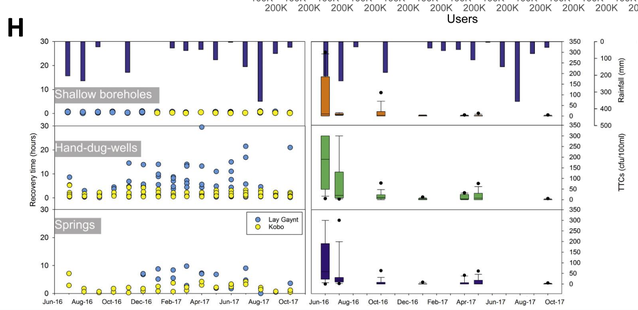
Figure E shows overall functionality of each water source type. **Figure F** shows functionality by altitude area and in each week, functionality increases for hand-pumps and motorised boreholes were due to a responsive and proactive maintenance programme. **Figure G** shows functionality, overall user numbers, average travel time and whether users felt they had enough water for each water source type. **Figure H** shows the performance of shallow boreholes, hand-dug-wells and springs measured by the time to recover to 50% of morning rest water level, monthly rainfall is also shown. Summary TTC measurements at different times of the year for all measured sources are shown on the right. **Figure I** shows the relationship between volume collected and time to collect water. **Figure J** shows a summary of impacts experienced in communities due to water shortage. Green is no or minimal impact; orange is significant impact associated with behaviour change; and red is severe impacts associated with major behaviour change.











J

Kebele	Main Source	L per person per day			hours collecting			Changed behaviour				Impacts				Health impacts		
		wet	dry	El Nino	wet	dry	El Nino	Change source	Continue Hygiene	Men collecting	Collect at night	Queing conflict	Missing meals	Education	Migration	Scabies	diarrhoea	Malnutrition
Kobo 2	River	8	8	8	1	3	5	Y - close	yes	No	No	Yes	Yes	Increase	Normal	Yes	Yes	Yes
Kobo 3	BH	21	8	8	0.5	1.5	1.5	No	reduce	No	No	Yes	No	None	Normal	Yes	Yes	Yes
Kobo 7	HDW	13	21	21	0.5	1.5	1.5	No	yes	No	No	Severe	No	Late	Inward	Yes	No	Yes
Kobo 9	Spring	22	11	11	2	3.5	3.5	Y - cattle	reduce	Yes	Yes	Severe	Yes	Absent	Increase	Yes		
Kobo 10	HDW	15	7	6	0.5	1.5	4	Y - cattle	reduce	No	No	Yes	No	Late	None	Yes	No	No
Kobo 29	Spring	14	7	7	0.5	1.5	3	Y - far	reduce	No	No	Yes	Yes	Late	Less	No	Yes	No
LG 4	Spring	17	8	8	1	2	2	No	yes	No	No	Yes	Severe	Late	Increase	No	No	
LG17	HDW	10	5	5	0.5	3	6	Y - far	yes	Yes	Yes	Yes	Yes	Late	Increase	Yes	No	Yes
LG 24	Spring	6	3	3	2	4	8	Y - far	None	Yes	Yes	Severe	Severe	Absent	Severe	Yes	Yes	Yes
LG 26	Spring	6	3	3	2	6	12	Y - far	None	Yes	Yes	Severe	Severe	Absent	Severe	Yes	Yes	Yes
LG 29	Spring	6	3	3	2	6	12	Y - far	None	Yes	Yes	Severe	Severe	Absent	Severe	Yes	Yes	Yes

4. Key Findings and Conclusions

The key findings from our two complimentary studies are:

- Functionality of rural water sources was low at the onset of drought.
- Real-time monitoring allowed targeted maintenance and repair.
- External support for maintenance led to higher water source functionality, particularly hand-pumps and motorised boreholes.
- Hand-pumps had highest functionality (75%), were most accessible and showed little change in daily recovery times throughout the drought.
- Motorised boreholes had lowest functionality (60%) but were crucial for large numbers of people, particularly in lowland (Kolla) areas.
- Many springs dried up completely forcing people to travel further to collect water.
- Hand-dug-well performance was variable, in the highlands recovery times were long and many dried out; those in the plain provided good supply through the drought.
- All sources showed evidence of contamination during the heavy rain at the end of the drought, but boreholes equipped with handpumps were least contaminated.
- Water use declined to 3 – 5 litres per-capita-per-day as water sources failed and collection times increased., water use for hygiene was sacrificed and poorer households used consistently less water.
- Increased collection times (up to 12 hours) led to violent conflict, missed meals, reduction in school attendance and farm activity and increased health impacts.

In conclusion, while the drought had significant impact on peoples access to water and daily lives, access to reliable groundwater improved drought resilience. Hand-pumped-boreholes were the most reliable water supply. Monitoring and maintenance were crucial for keeping hand-pumps and motorised boreholes working. Ensuring continued access to groundwater via multiple sources and technologies (primarily hand-pumps and motorised boreholes), supported by responsive and proactive maintenance, increases water supply and community resilience to drought in rural Ethiopia.

5. References

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