Probing the impacts of climate change on household water supply in Mozambique

Jeff C. Ho[1] (jeffho@stanford.edu) & Jenna Davis[1,2]

[1]Department of Civil & Environmental Engineering, Stanford University, Stanford, CA
[2]Woods Institute for the Environment, Stanford University, Stanford, CA

Stanford University

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Background

The impacts of climate change on water resources are predicted to be felt most acutely in Sub-Saharan Africa (Costello et al., 2009). Climate change is projected to reduce surface water and groundwater resources in dry, subtropical regions, and the major impacts are expected to be felt disproportionately by the rural poor and by women moreso than men (IPCC WGII, 2014). Despite these predictions, however, **no studies have looked at climate change impacts at the household level.** As argued by the IPCC, "more studies are needed, especially in developing countries, on the impacts of climate change on water quality, and of vulnerability to and ways of adapting to those impacts."

Goal

To explore the extent to which climate change could impact household water supply for households in rural and peri-urban Mozambique. Specifically, **climate change is expected to extend the dry season of no or very low flows** in semi-arid areas (IPCC WGII, 2007).

> How might a lengthening of the dry season impact household water use?

Methodology

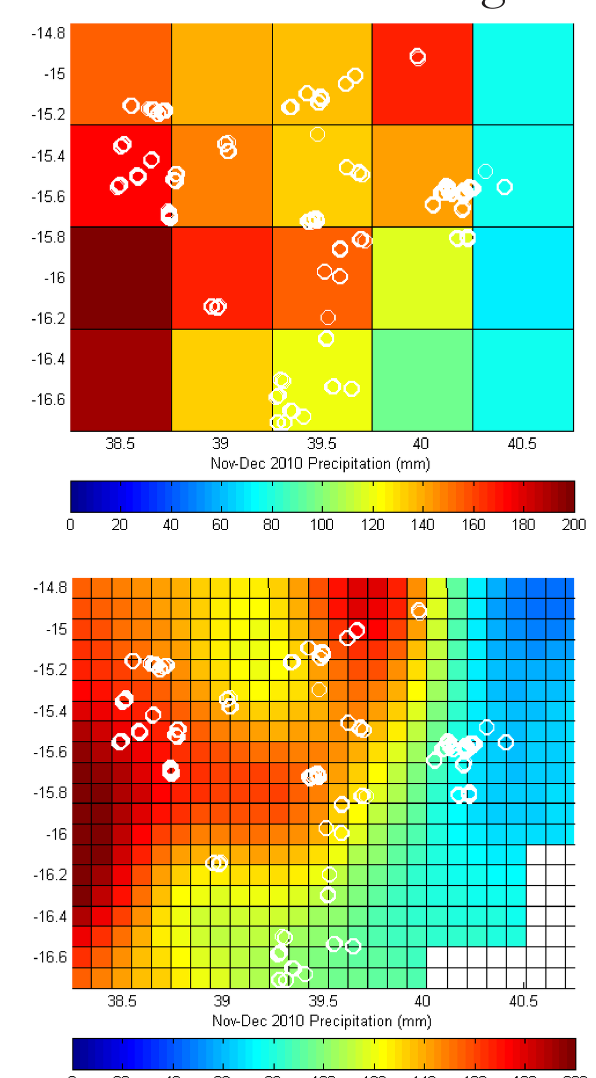
We perform a **case study using household survey data** in the Nampula province of Mozambique. 1,606 households (HHs) were surveyed in July 2011 on the monthly usage of their water supply sources:

- *What is your primary source?*
- *During which season do you use this source? (Dry/Wet/Both/All year)*
- *During which months of the year is this source used?*
- *(Repeated for secondary and tertiary sources)*

We further **examine correlations between climate variables and water fetching descriptors** using Ordinary Least Squares (OLS) regression. The purpose of this analysis is to explore whether HH variability in water fetching is associated with temperature and precipitation.

We use a **Geostatistical Inverse Model (GIM)** to downscale 0.5 degree resolution temperature and precipitation data from the Global Historical Climatological Network (~50km resolution) to 10km resolution. **Assuming a linear spatial covariance model** (i.e., values close together are statistically correlated based linearly on distance), the GIM "un-averages" the coarse resolution data **to obtain a finer resolution.** Similar techniques have been used widely to obtain finer-scale estimates of other spatially correlated parameters, including hydraulic conductivity, water table height, and elevation.

GIM downscaling

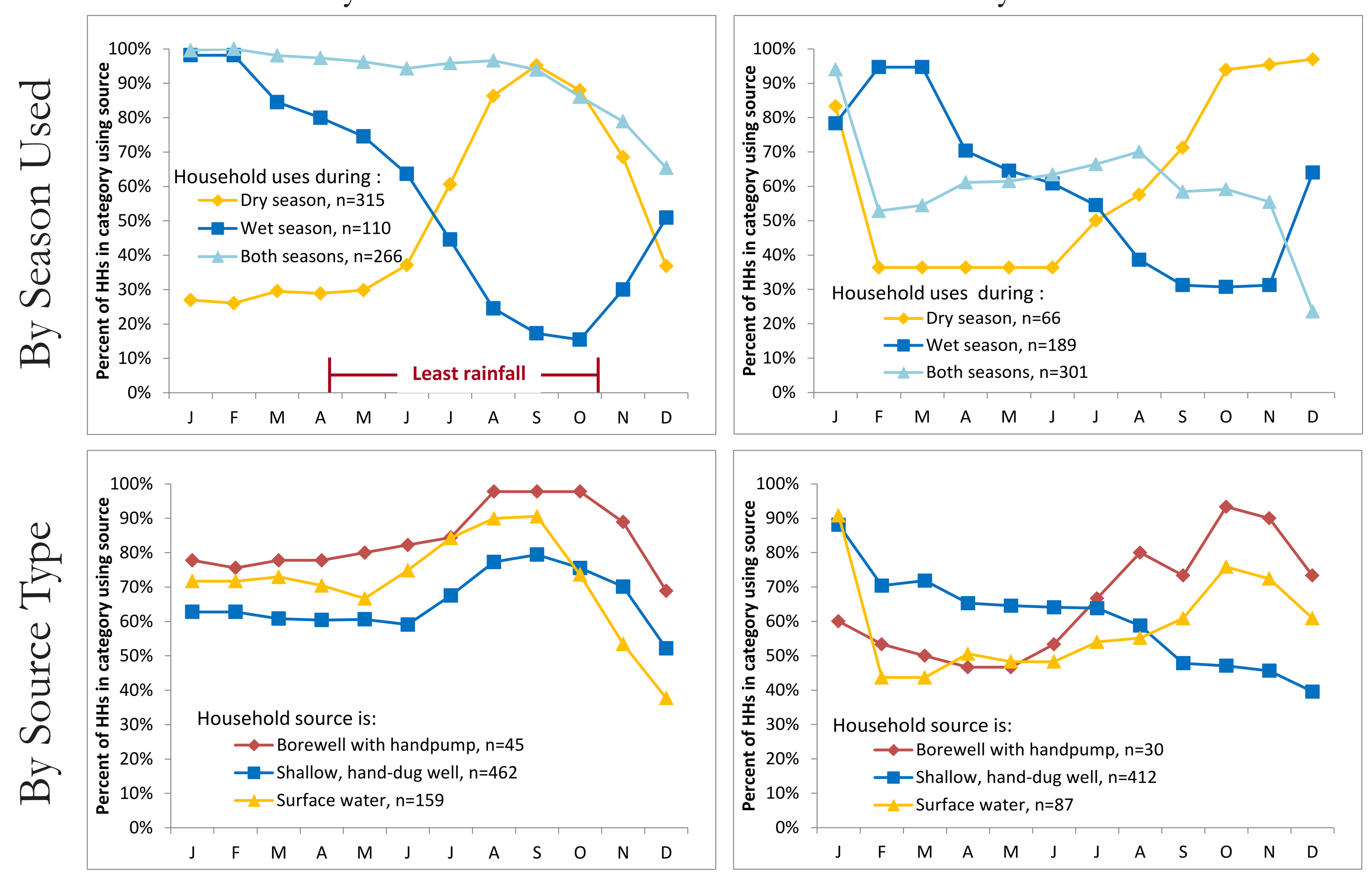


Coarse (top) vs. fine (bottom)
White circles are HH clusters

Monthly Usage Impacts

We infer the impacts of a lengthening of the dry season by first exploring the extent to which dry/wet season distinctions are observable in the data. **Looking at percentage of HHs using sources by month**, we answer the following questions:

1. How does primary/secondary water source usage vary by season? (top plots)
2. How does primary/secondary water usage vary by source type? (bottom plots)

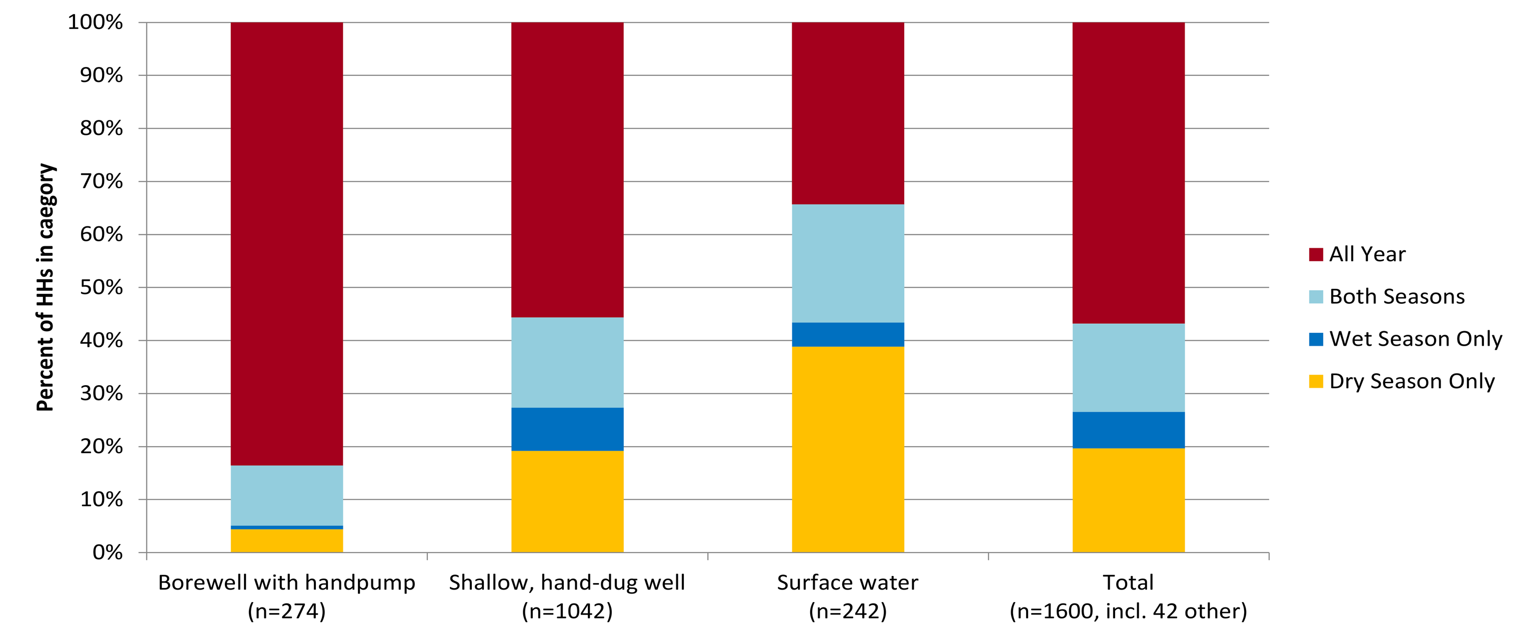


Primary sources used in the dry season lag months with least rainfall by two months (top left plot), and dry/wet season distinctions are clearly observable in the monthly usage data. Moreover, **sources used in the dry season are used by a declining percentage of HHs as the dry season lengthens** (top left). This effect occurs for all primary source types (bottom left).

Secondary source usage peaks one month later than primary source usage (top right), with **surface water usage increasing as shallow well usage decreases late into the dry season** (bottom right).

Source Type Impacts

Dry season lengthening should impact households whose primary source is used only during the dry season. In our sample, certain source types were more likely to be used only during certain seasons. For example, **surface water sources are more likely to be used in the dry season.**



Water Fetching Impacts

Significant correlations were found between temperature/precipitation and number of sources, fetching trips per week, and water fetching walk time/wait time/distance.

The direction of effect for both variables is as expected, with **less precipitation and higher temperature associated with more sources, longer walk times, further water sources, and fewer trips per week**.

Ordinary Least Squares R^2	Prior dry season total precipitation	Prior dry season avg. temperature
Self-reported fetching trips per week	0.04***	0.04***
GIS-estimated distance to source	0.02***	<0.01
Self-reported walk time	0.01***	0.02 ***
Number of sources	<0.01***	0.04***
Self reported wait time	<0.01	<0.01
HH water quantity in LPCD	<0.01	<0.01

***significant at the 0.01 level

Conclusions

Based on a lengthening of the dry season, climate change is likely to:

- **Shift households to alternative sources** of water supply, potentially with decreased water quality
- **Increase the burden of water fetching** through increased time costs.

Both of these outcomes would **decrease the gains made in the last two decades** toward increased access to improved rural water supply.

Future Work

- **Improve downscaled climate estimates** for more accurate depictions of temperature and precipitation
- Expand correlation analysis to **include more households and more source types** across a variety of different countries
- **Identify which households face greater vulnerability** to climate impacts for specific targeting of adaptation strategies
- **Observe whether or not a rural water supply intervention** reduces susceptibility to this impact of climate change

References

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- **IPCC, 2014,** Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, XXX pp.
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