The resilience of shallow groundwater resources in Dangila woreda, northwest Ethiopia to climate variability, increasing abstraction and land use change

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Background

Productive use of groundwater resources for irrigation in sub-Saharan Africa currently remains low but is expected to increase significantly in the near future, potentially providing a widespread poverty reduction. Their accessibility means shallow groundwater resources are most likely to be used by poorer communities, but they are also the most vulnerable to over-exploitation and climatic variability. Recent studies based on climate modelling and remote sensing data have demonstrated the importance of groundwater resources at a broad scale, but there is a scarcity of data to support local management to reduce vulnerability.

Field visits

Prolonged (3-5 week) field visits were conducted for hydrogeological investigations. Two visits coincided with the end of the dry seasons (period of greatest water scarcity) in 2015 and 2017, and another took place at the end of the 2015 wet season.

Physical measurements and sampling for major ion and stable isotope analysis from a developed spring (left) and a rope and washer pump sampling site (right).

Conventional-scale hydrogeological assessment of Africa

The aim of the research is to determine the potential for shallow groundwater resources around Dangila woreda (district) to be used for small-scale irrigation by rural communities, supplementing the existing rainfed agriculture.

Which areas show the greatest potential for sustainable intensification of agriculture through irrigation?

How will climate variability, land use change and increased abstraction impact the shallow groundwater resource and surface water?

Conceptual model

Season and topography govern shallow groundwater levels and flow. Conceptual cross sections during wet and dry seasons are show the seasonally inundated floodplain pasture with crops and dwellings on slopes.

Community-based monitoring

Due to the sparse formal meteorological and hydrological monitoring networks in the region and the lack of groundwater observational data, a community-based monitoring programme was initiated. After initial community workshops, locations were selected for groundwater monitoring, river gauge boards and rainfall gauges. Local observers were trained to collect daily data.

Field site

Area: ~900 km²
Average elevation: ~200 m
Average annual rainfall: ~1600 mm
Population: 160,000 of which 132,000 are rural
Primary source of livelihood: Crop-livestock mixed subsistence farming, rainfed agriculture predominates
Geology: Red clays and loams soils above weathered regolith above Cenozoic basalt and trachyte at 3-15 m

Water table depth below ground (m)

Cumulative frequency curves of river low flows (left) and irrigation potential for four catchments running 200 and 1000 year model runs are ongoing for four catchments running 200 and 1000 year model runs.

Field site

Precipitation map of Ethiopia and map of the modelled catchments

Typical scenery at the field site, showing the seasonally inundated floodplain pasture with crops and dwellings on slopes.

Conceptual cross sections during wet and dry seasons

The maps have been ground-truthed and provided to local stakeholders.

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