MODELLING SHALLOW GROUNDWATER RESOURCES FOR SMALL-SCALE IRRIGATION IN ETHIOPIA

Geological Survey of Ethiopia

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Background

Shallow groundwater resources in sub-Saharan Africa have significant potential for use in local-scale irrigation. Due to the fragmented and localised nature of these groundwater resources, it is essential that they are understood and managed locally. The resource assessment part of the AMGRAF project combines field surveys and modelling with community-based monitoring to support planning and adaptive management of shallow groundwater and surface water resources.

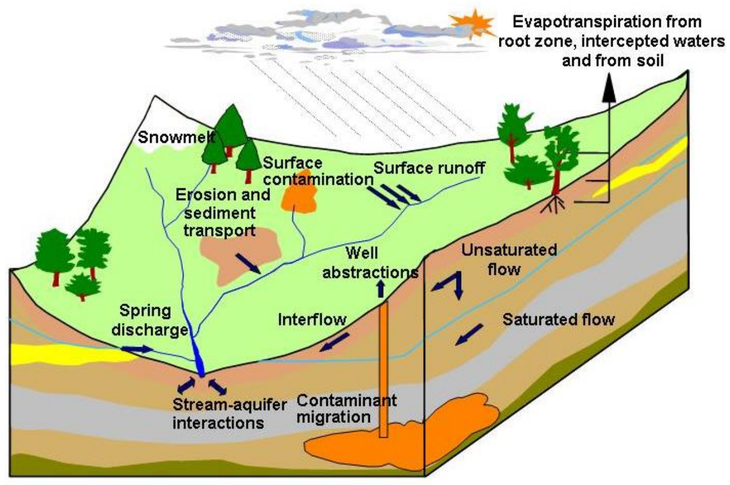
Methods

A: Community-based local monitoring (rainfall, river levels/flows, groundwater)

B: Field hydrogeological survey (geology, well/spring inventories, local knowledge, level/flow/water quality measurements and sampling, geophysical cross-sections), and assembly of existing hydrometric data

C: Physically-based spatial integrated groundwater – surface water modelling

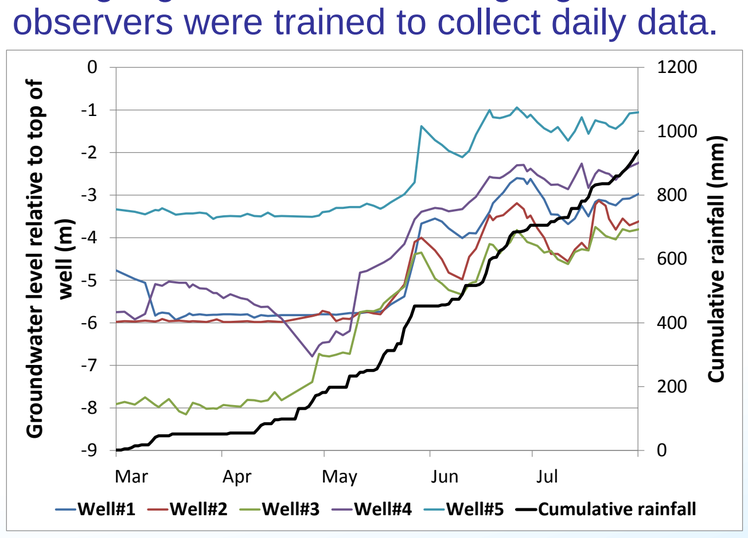
D: Derived simple water balance models and monitoring strategies for adaptive resource planning and management



Shetran integrated groundwater-surface water catchment modelling system (www.research.ncl.ac.uk/shetran)

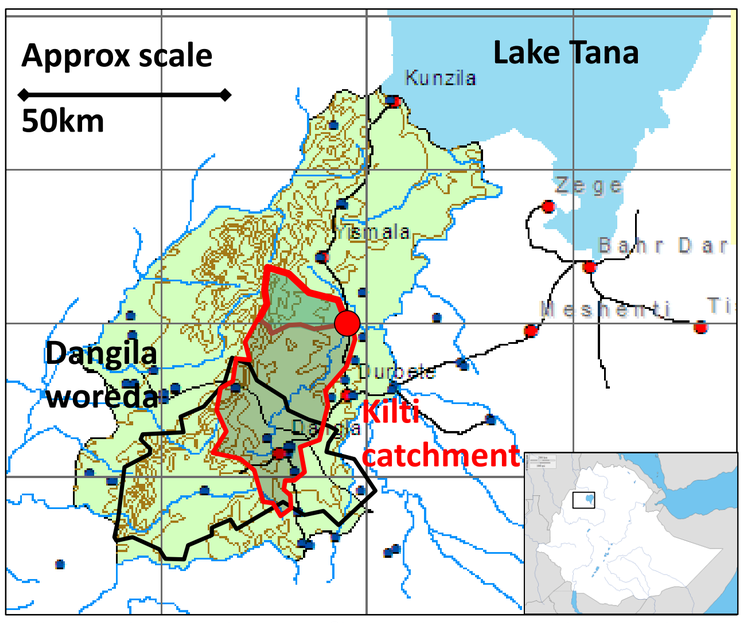
A: Community-based monitoring

After initial community workshops, locations were selected for groundwater monitoring, river gauge boards and a raingauge. Local observers were trained to collect daily data.



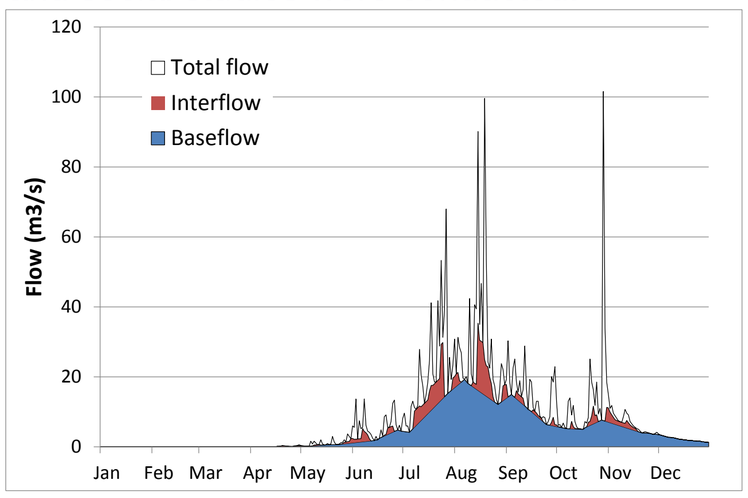
Community-monitored groundwater levels and cumulative rainfall in Dangeshta kebele, showing responses during the early part of the wet season.

B: Field surveys and hydrometric data



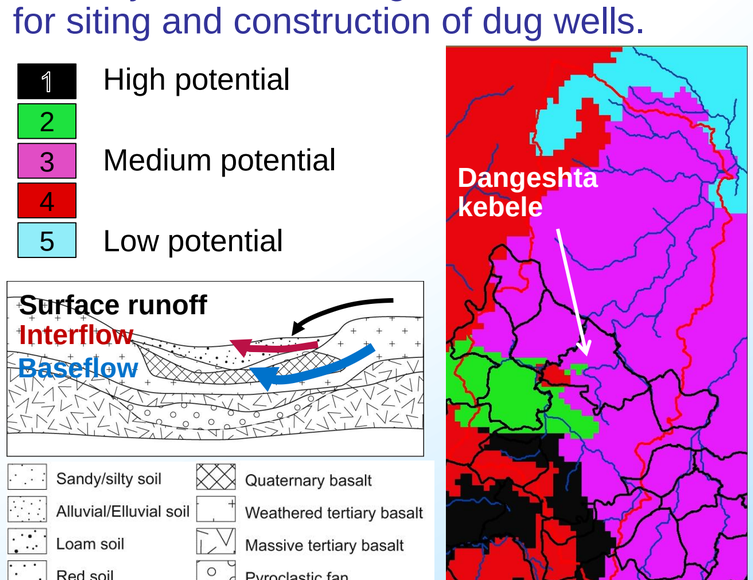
Kilti catchment (660 km^2) overlapping with Dangila woreda administrative area

The Dangila woreda is drained by 4 tributaries of 2 major river basins, requiring upstream-downstream governance. The Kilti river catchment includes the Dangeshta kebele where monitoring by communities and social studies were conducted.



Observed hydrograph at Kilti outlet for an example year (1997), with interpreted flow regimes

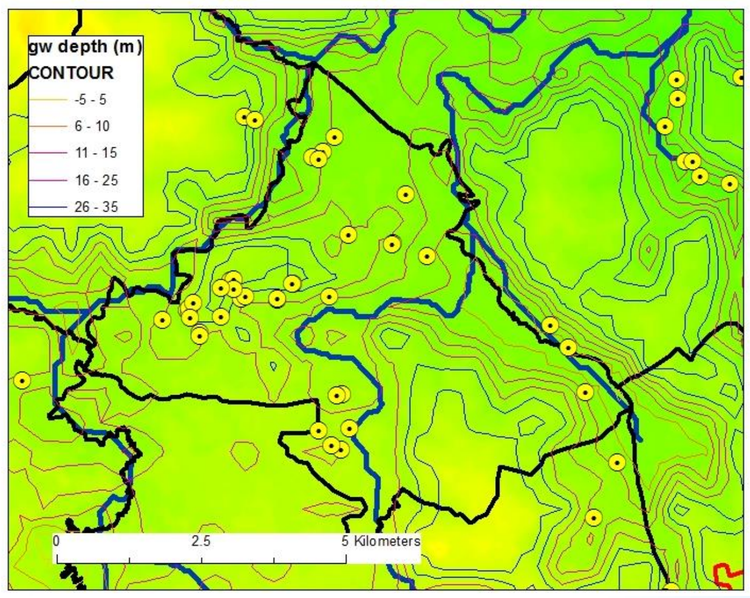
Sandy soils and alluvium in valleys overlie Quaternary and Tertiary basalts, fissured in their upper layers. The shallow groundwater availability is very heterogeneous due to the occasional presence of massive basalt near to the surface and the variable fracturing intensity. These form significant difficulties for siting and construction of dug wells.

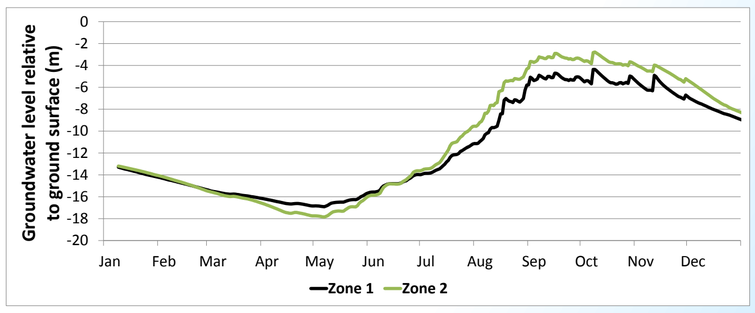


Groundwater potential zones, with typical hydrostratigraphic cross-section showing interpreted flow pathways

C: Modelling studies

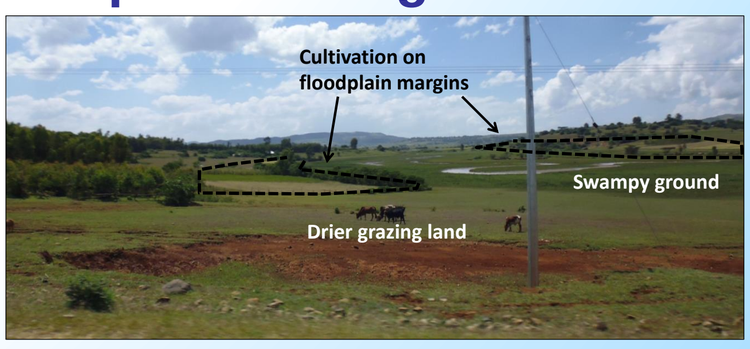
A Shetran model of the Kilti catchment has simulated groundwater levels and river flows for a historical period of 1997-2003. The model parameterisation is based on the hydrogeological interpretation of an active system of soils and alluvium up to 6.5m thick in valley floors, over fissured basalts up to 35m thick providing baseflows.





Detail of simulated groundwater depths from SHETRAN model, showing locations of dug wells, and example simulated groundwater levels at locations in Zones 1 and 2

D: Implications for adaptive management



Present land uses may need to be adapted to make effective use of available groundwater and surface water conditions

- Resource assessments have demonstrated the potential for shallow groundwater use for irrigation in valleys.
- Detailed modelling links local and catchment-scale groundwater – surface water dynamics and interactions, and can be used to assess climate influences
- The study has shown the feasibility, value, and necessity for using local community-based monitoring
- Simpler water balance models and community monitoring can be used with appropriate governance systems for local adaptive resource management

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