Adaptive shallow groundwater management in Africa: linking regional and local scale resource assessments

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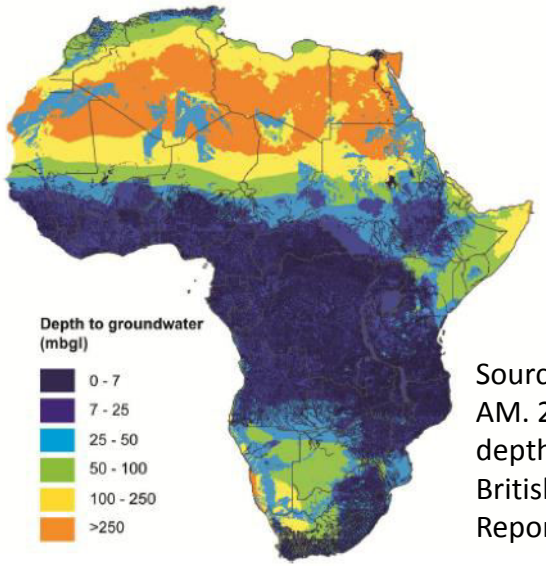
AMGRAF focus:

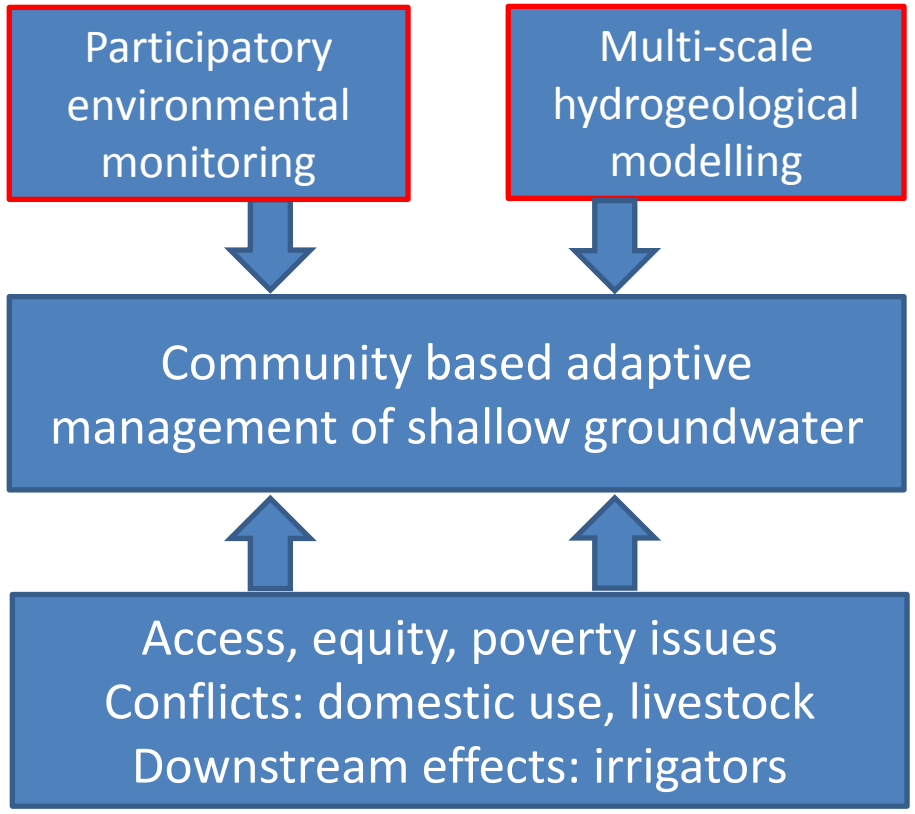
- productive use (small-scale irrigation)
- shallow groundwater (<25m)



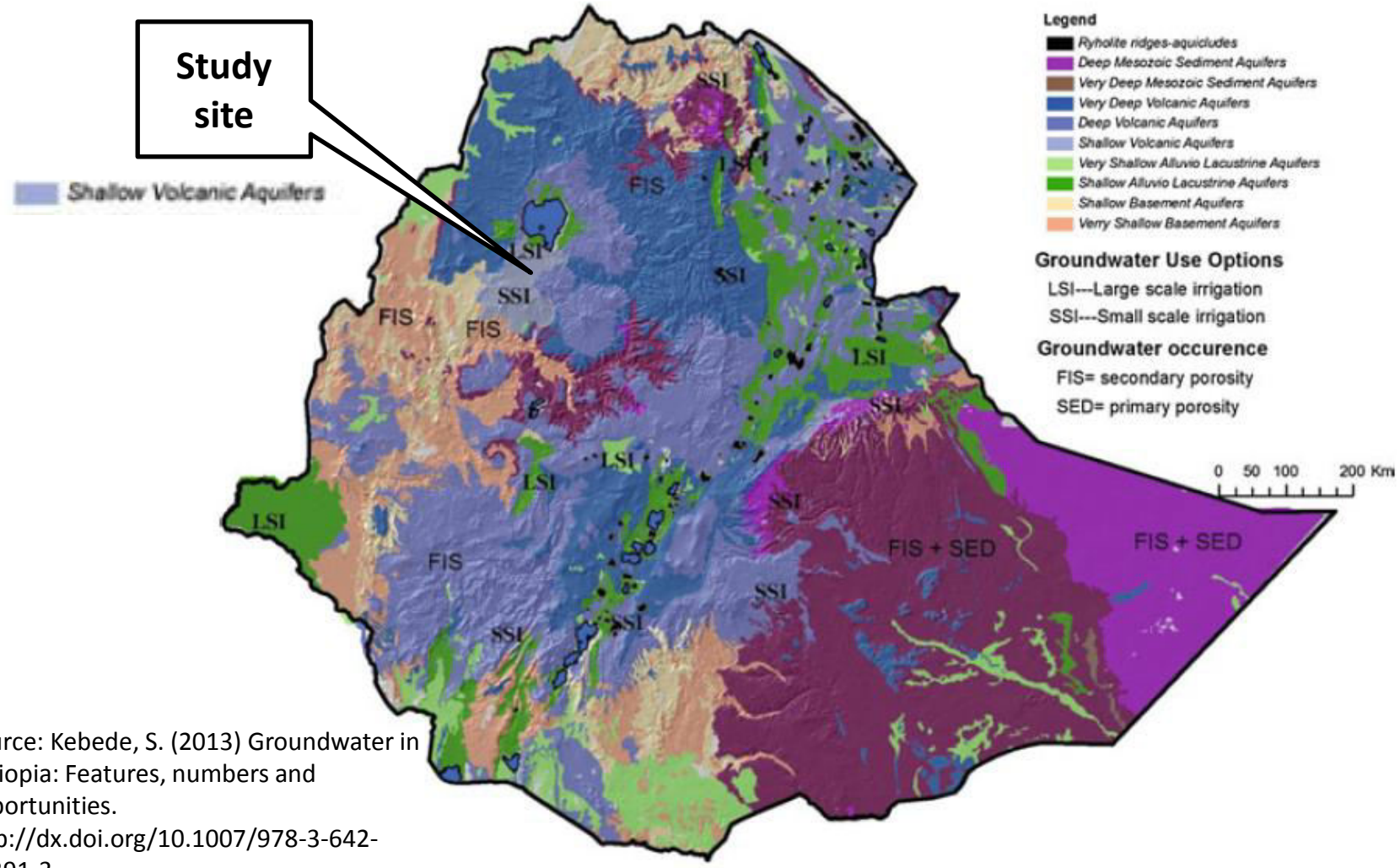
Source: Bonsor HC and MacDonald AM. 2011. An initial estimate of depth to groundwater across Africa. British Geological Survey Open Report, OR/11/067. 26pp.

Widespread potential, but very limited information available

AMGRAF aim: to demonstrate feasibility of community management of shallow groundwater, and provide enabling tools

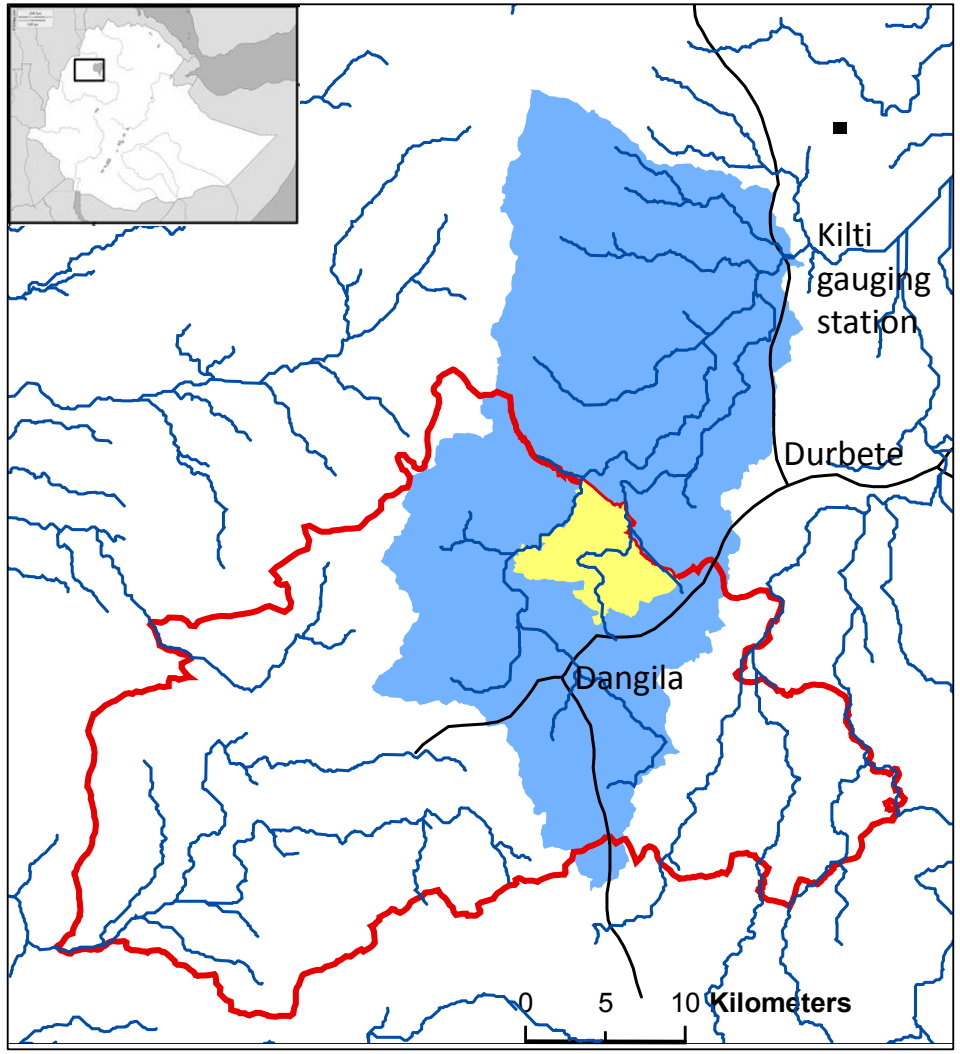


Aquifer type distribution in Ethiopia



Source: Kebede, S. (2013) Groundwater in Ethiopia: Features, numbers and opportunities. http://dx.doi.org/10.1007/978-3-642-30391-3

Assessment and management scales



Large scale (resource unit):

Kilti catchment

(tributary of Gilgel Abay, headwater of the Blue Nile)
660 km^2, long-term gauged data

Administrative and local community scales:

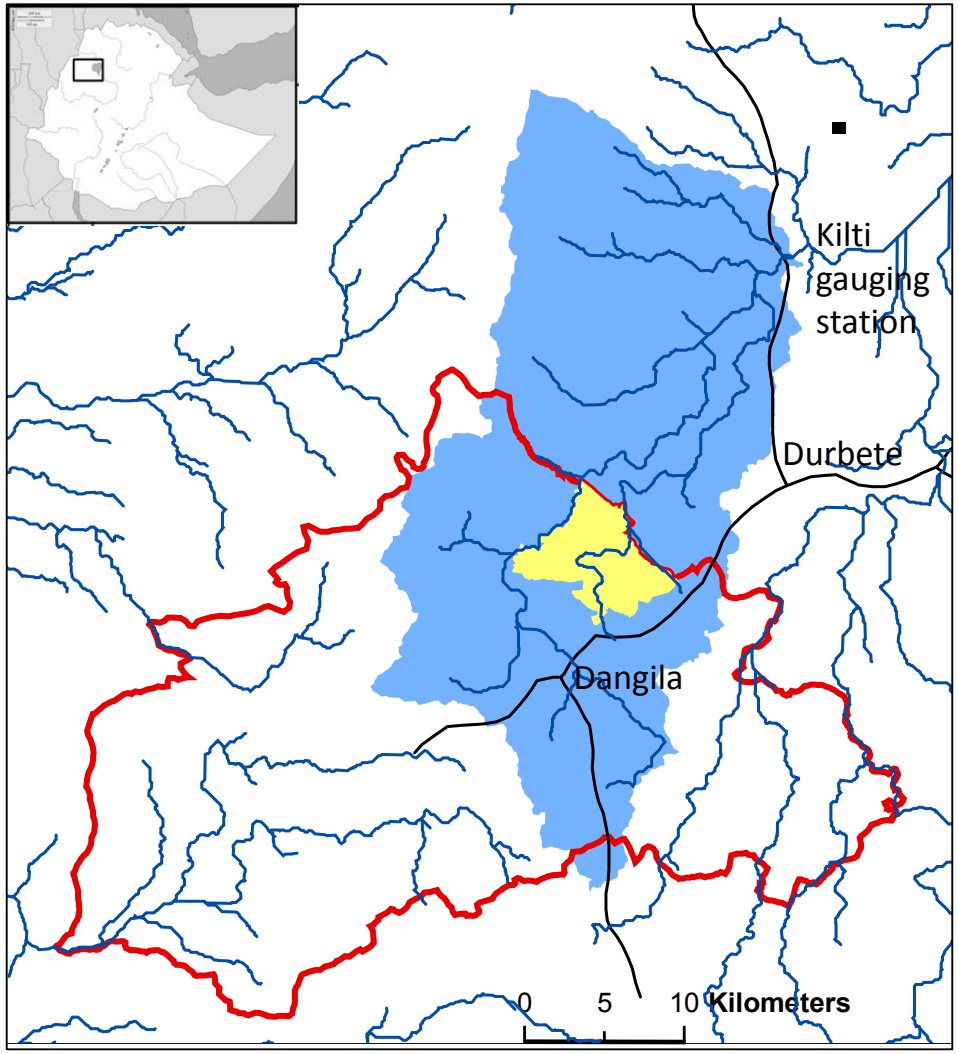
Dangila woreda

Amhara region

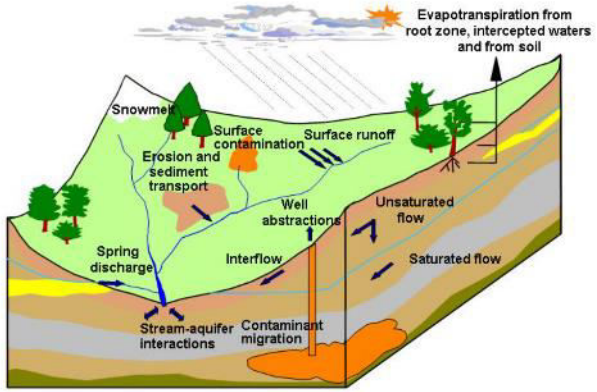
Dangeshta kebele

Focus study area ~ 5-10 km^2, community-based monitoring

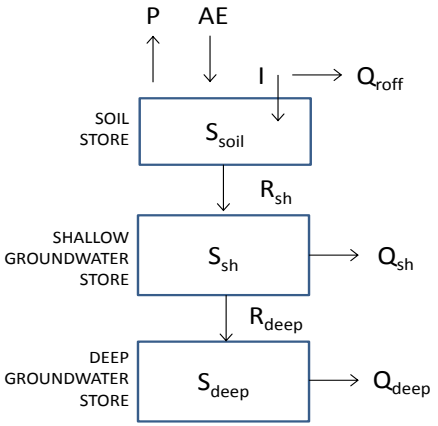
Multiscale modelling



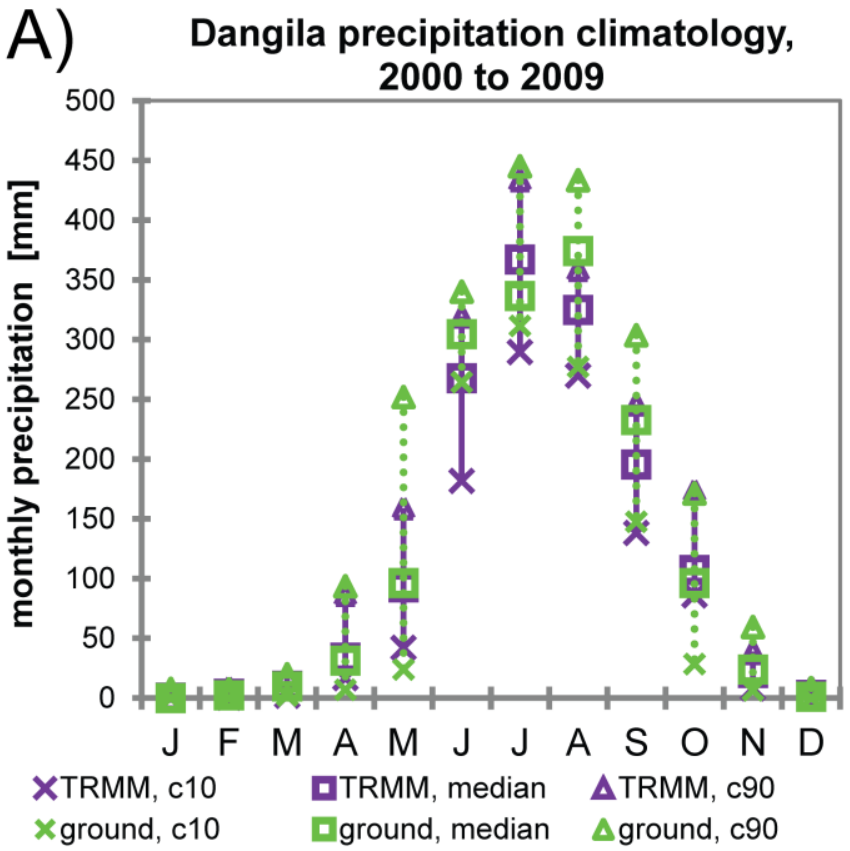
Shetran integrated physically-based catchment model (research.ncl.ac.uk/shetran)

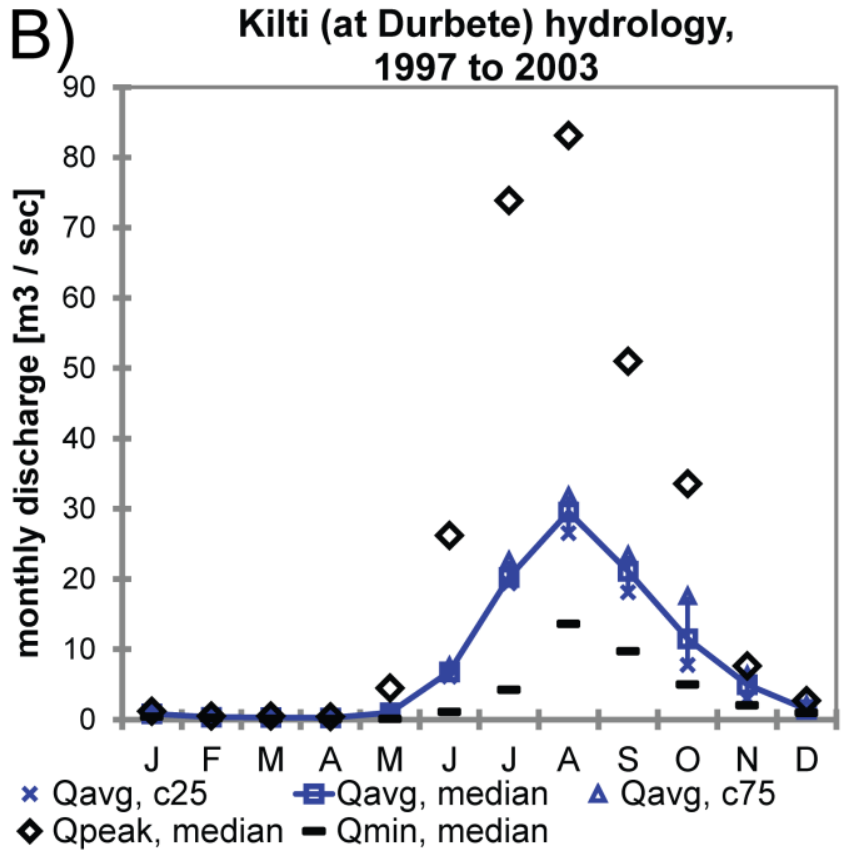


Simple water balance models



Catchment-scale climate and streamflow variability

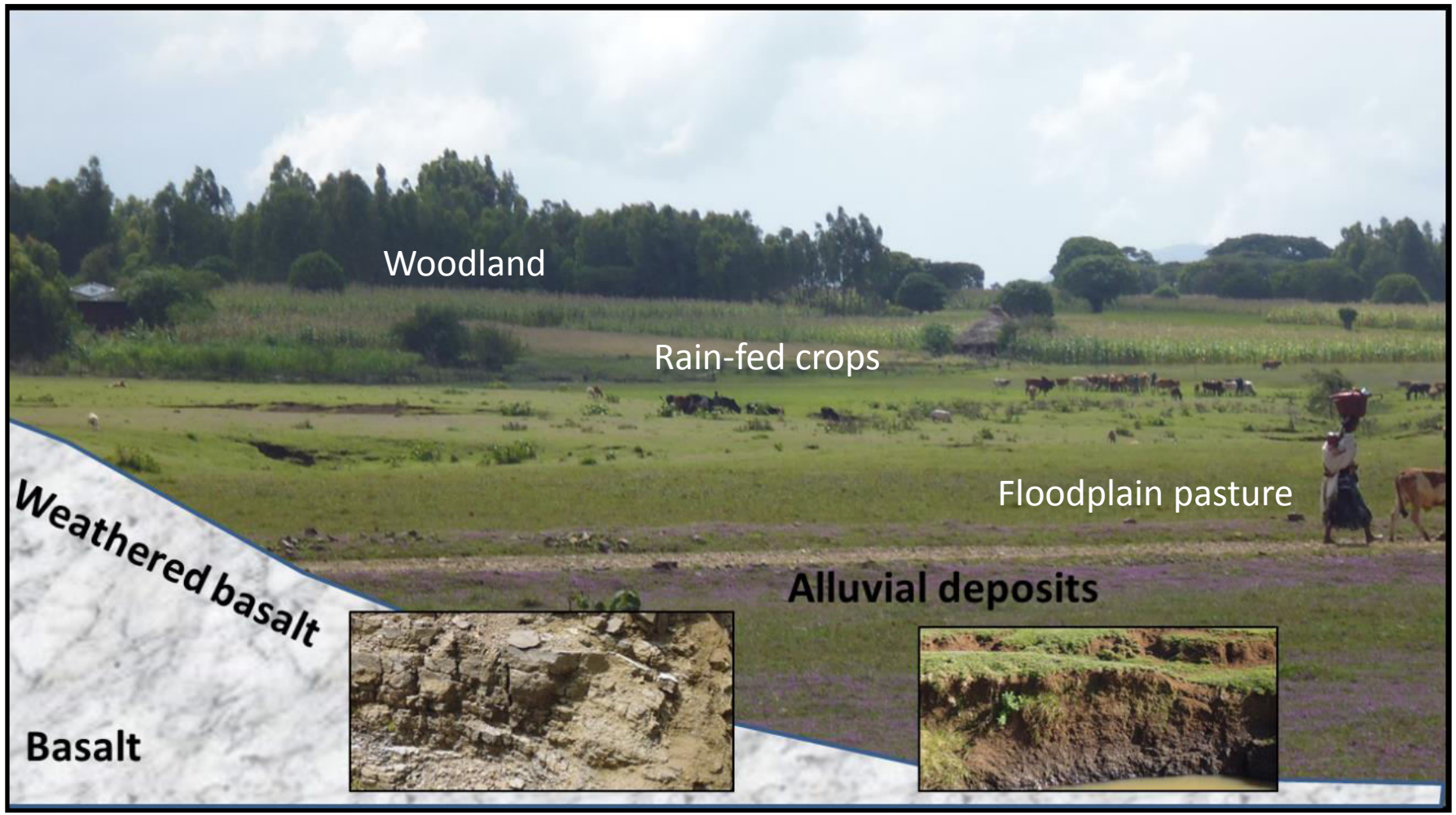




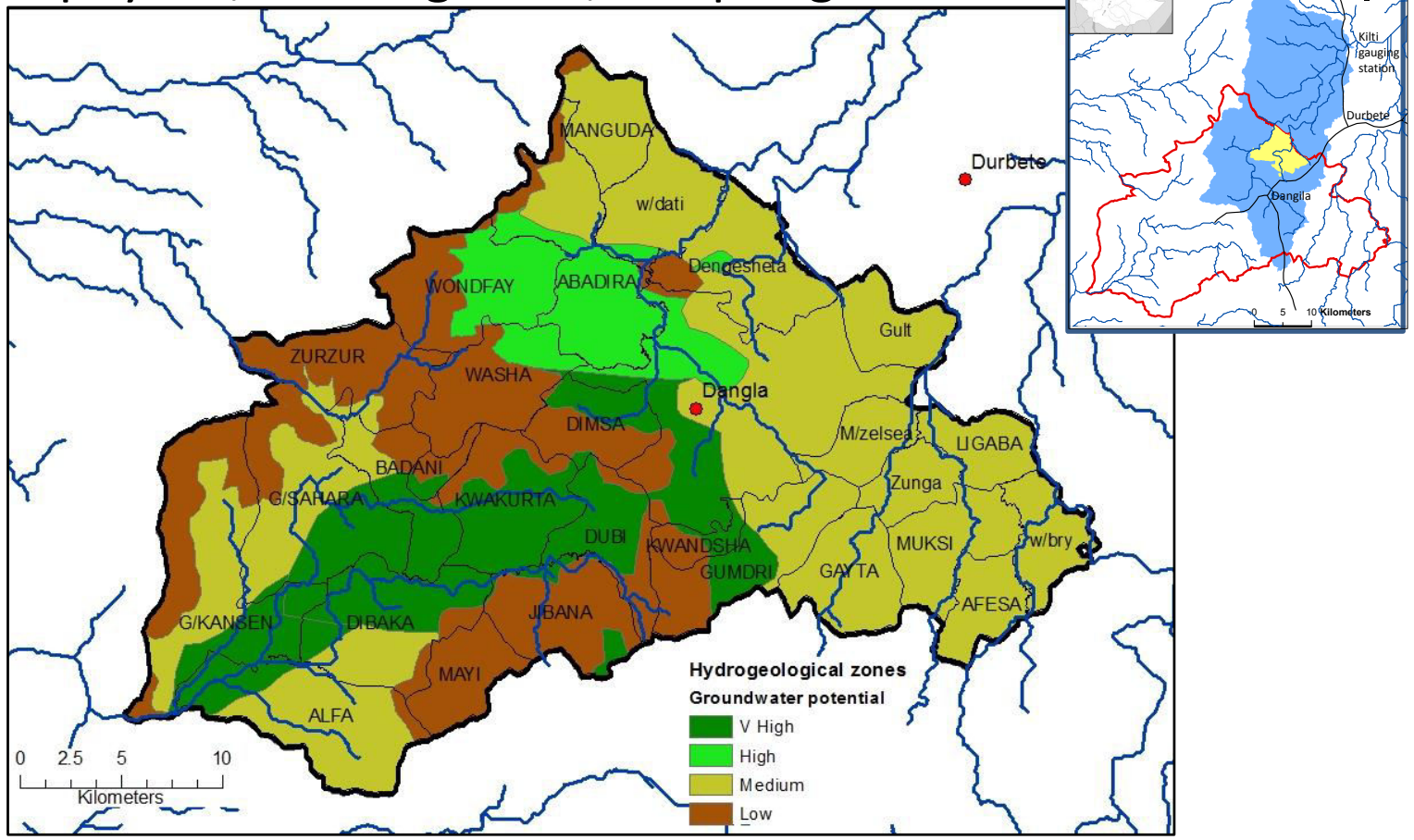
Ground observations have greater variability than global climate products

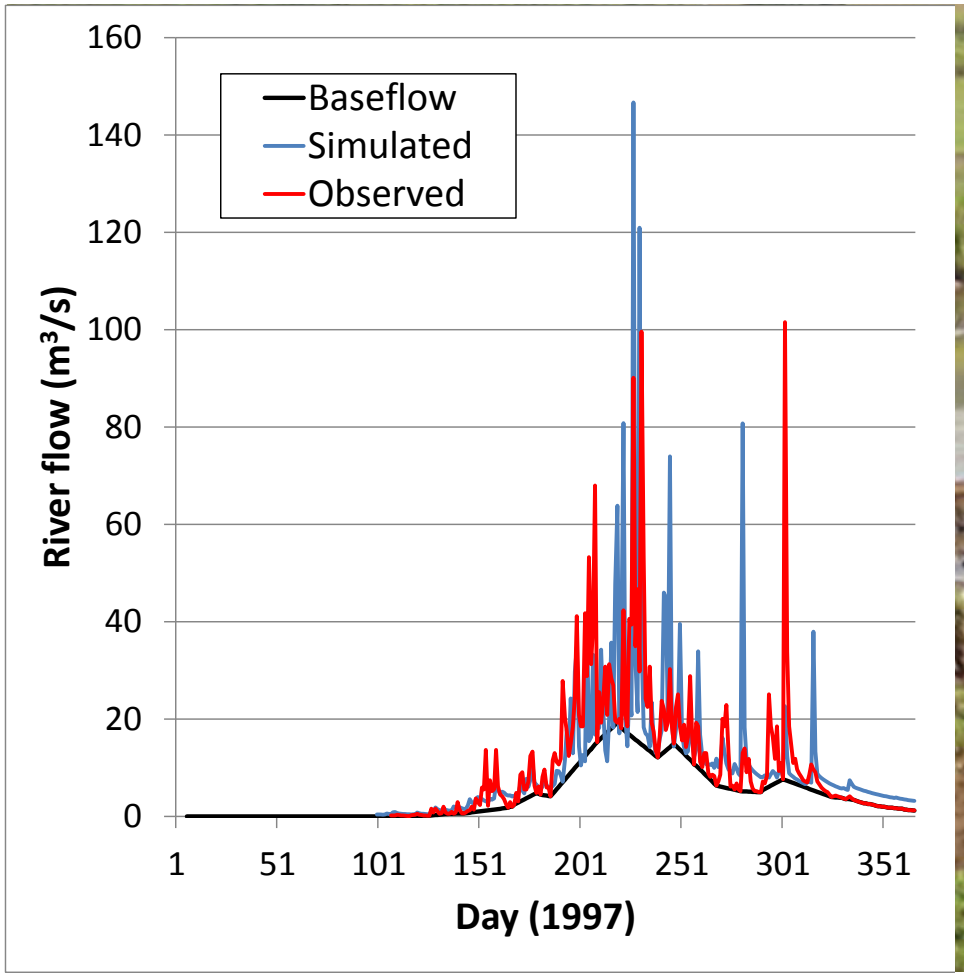
High variability of extreme streamflow response years

Geology and land-use

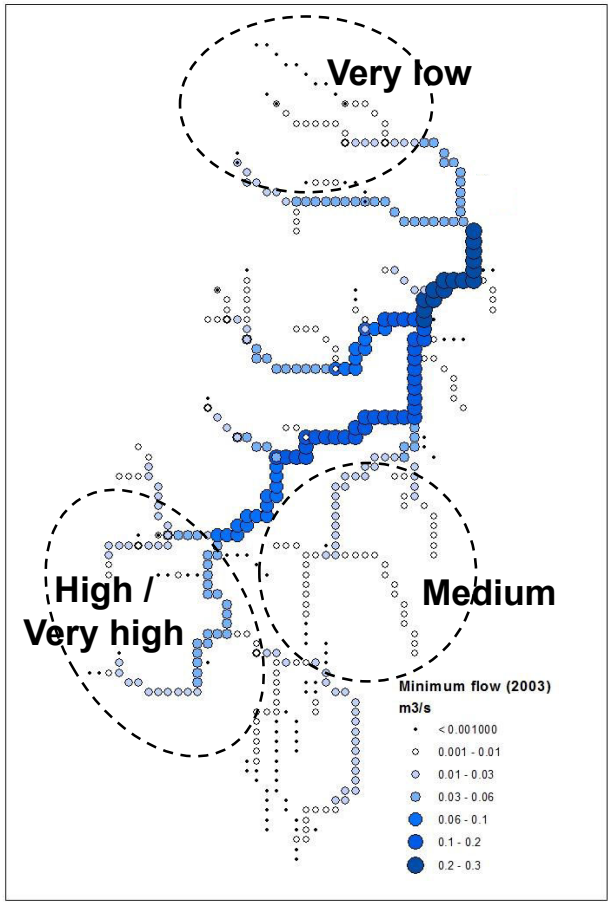


Interpreted hydrogeological zones (groundwater potential), based on reclassification of large-scale geological maps, geological walk-over surveys, geophysics, 173 dug wells, 61 springs



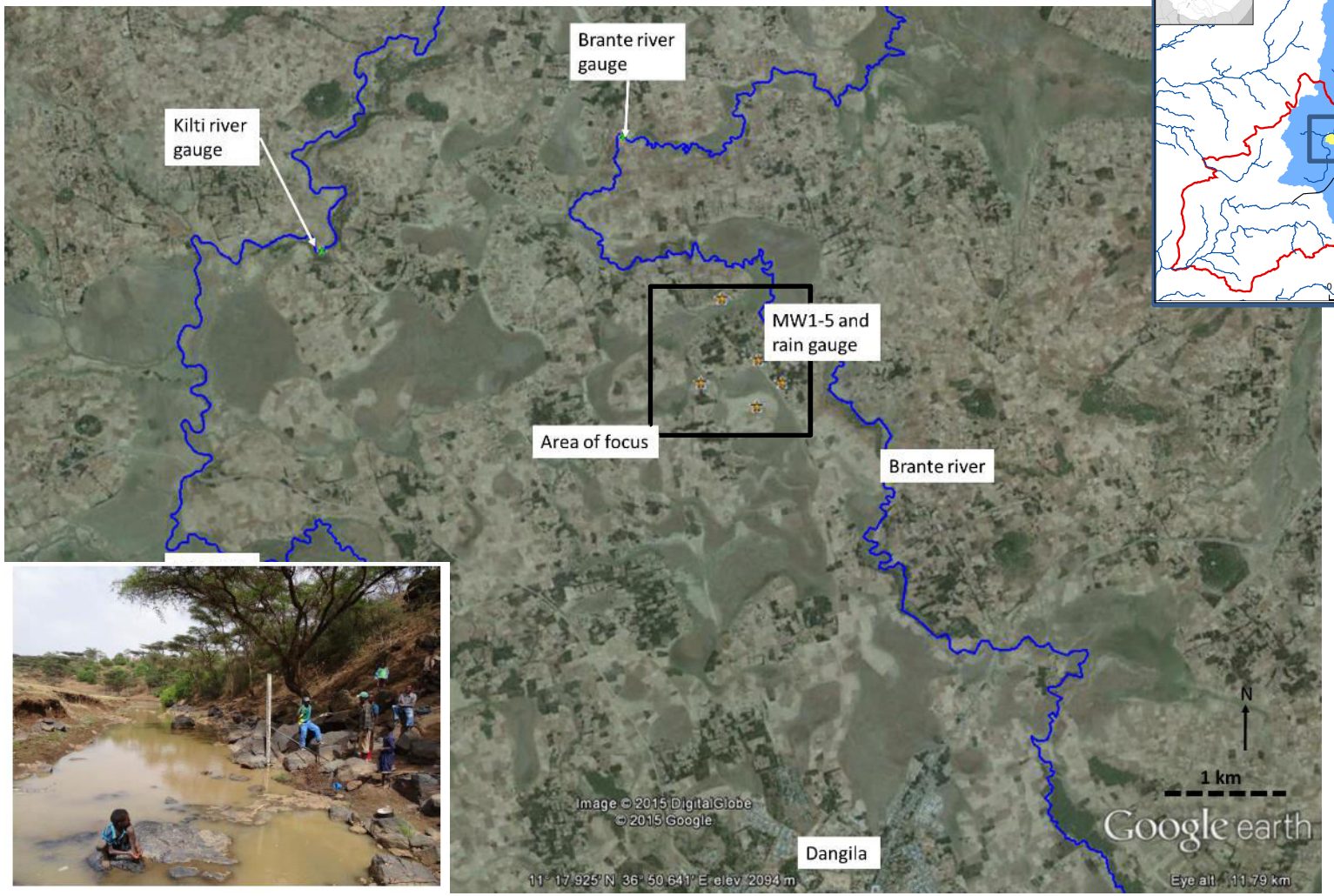


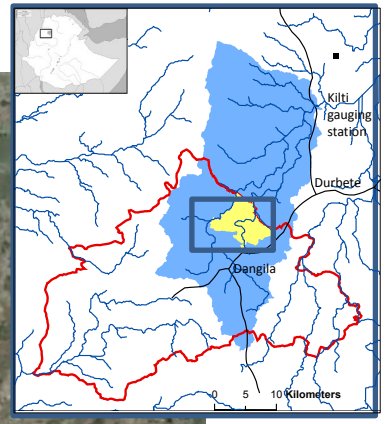
Catchment-scale dynamics generally represented for wet season, evidence of localised responses, simulated baseflow recession high during transition to dry season



Simulated streamflow represents general spatial behaviour of a connected river network at the catchment scale, consistent with hydrogeological zones

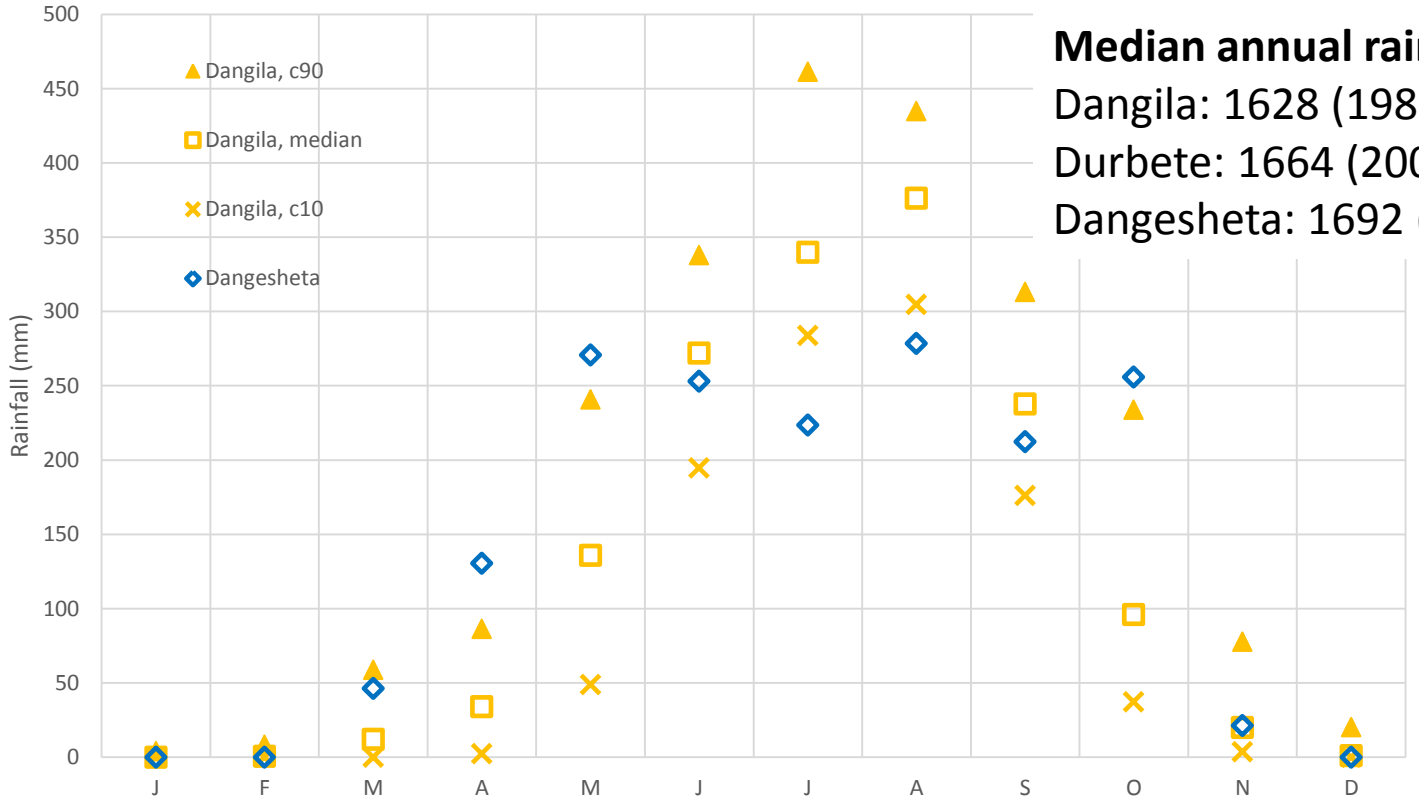
Local community hydrological monitoring





Local community monitored boreholes and raingauge

Dangila Monthly Rainfall (1987 to 2013) and first complete 12-months of Dangesheta community monitored data (Mar 2014 – Feb 2015)



Median annual rainfall (mm)
Dangila: 1628 (1987-2013)
Durbete: 1664 (2007-2013)
Dangesheta: 1692 (2014-15)

Wet season start/end (2007-2011)

2014 community monitored annual totals consistent with long-term data
2014 had unusually long wet season (to be corroborated with other data sources)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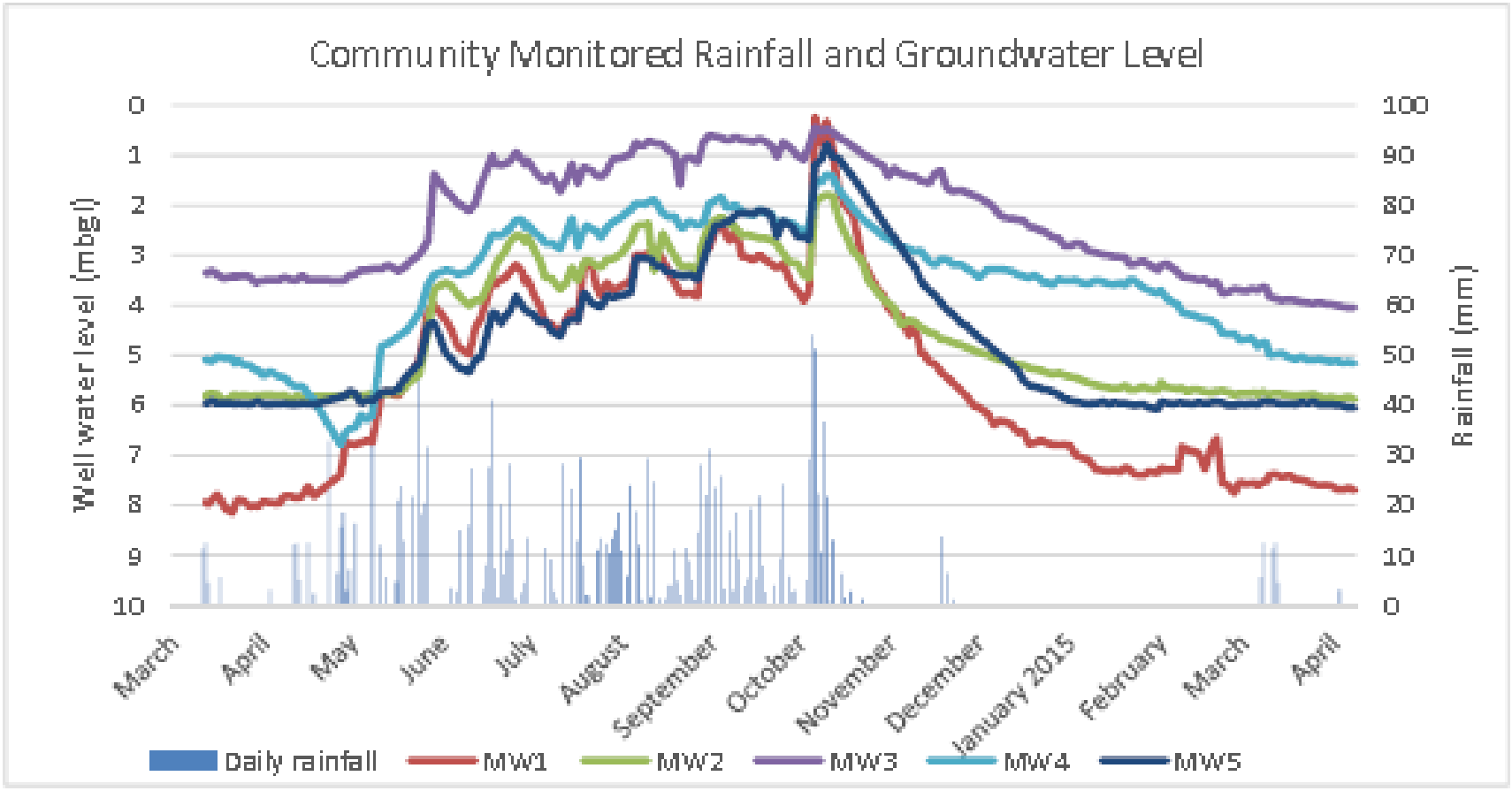
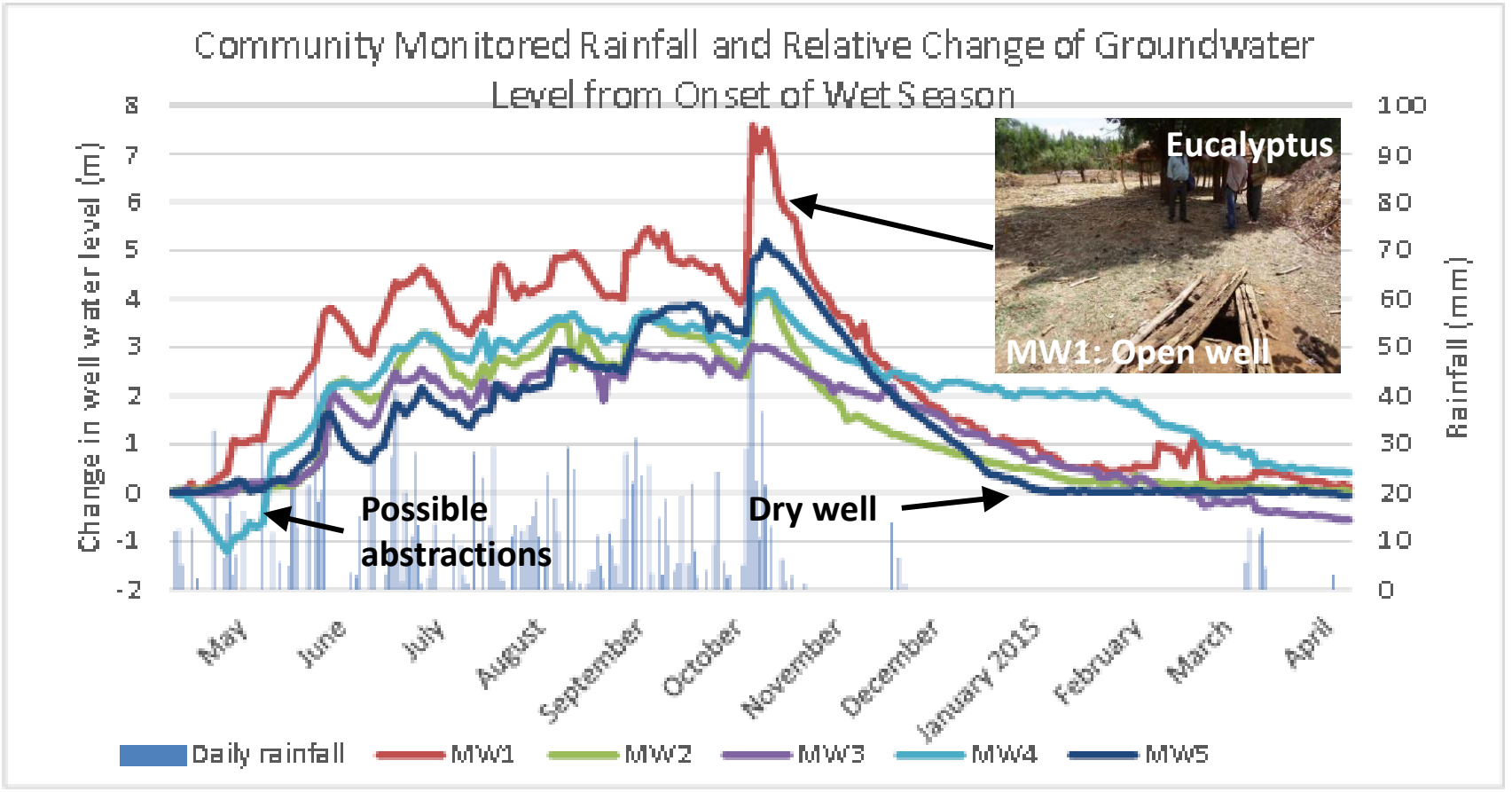
adaptive management of groundwater in Africa


Community Monitored Rainfall and Groundwater Level
Well water level (mbgl)
0
1
2
3
4
5
6
7
8
9
10
Rainfall (mm)
100
90
80
70
60
50
40
30
20
10
0
March
April
May
June
July
August
September
October
November
December
January 2015
February
March
April
Daily rainfall
MW1
MW2
MW3
MW4
MW5



Generally good quality data collected by the community

Data provide information on local spatial groundwater responses

Preliminary interpretations

Largely endorheic floodplain basins

MW4

MW5

MW3

MW1 and rain gauge

MW2

Symbols indicate surveyed wells and springs

N

500 m

Brante river

"Hanging" floodplains with restricted outlets

Google earth

11° 18.425' N 36° 50.843' E elev 2078 m

Eye alt 6.15 km

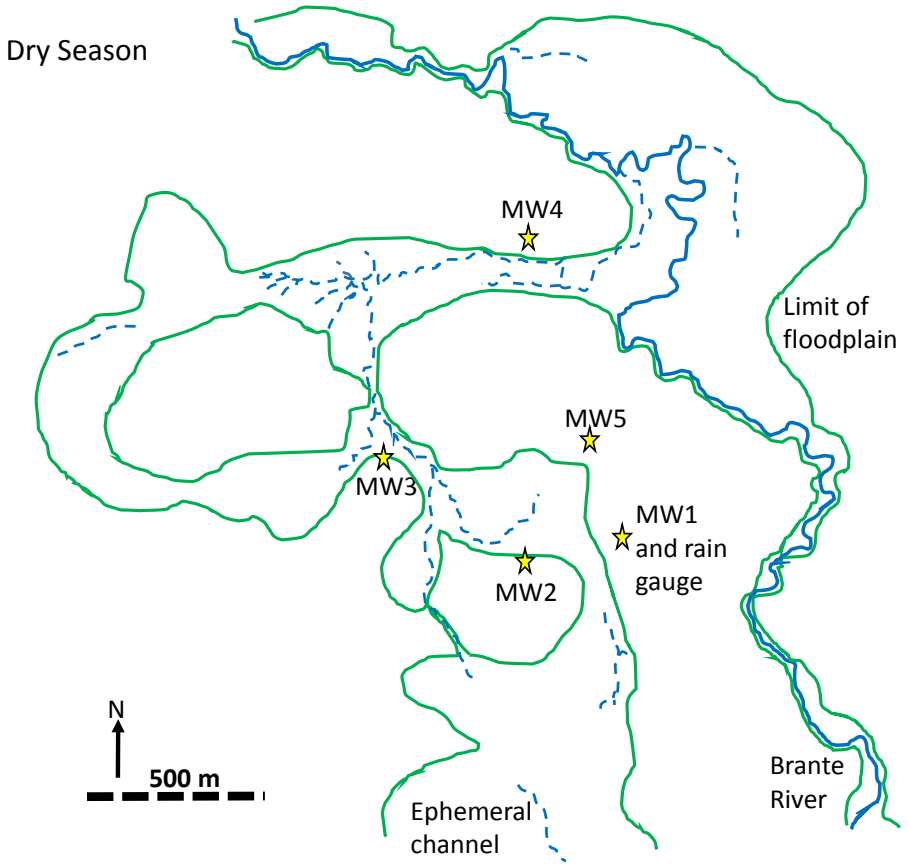
Preliminary interpretations – dry season

Fragmented shallow groundwater bodies

Non-contiguous flowing river reaches

Geological controls (basalt outcrops) on topography and connected areas

Existing wells generally located on or above floodplain perimeter

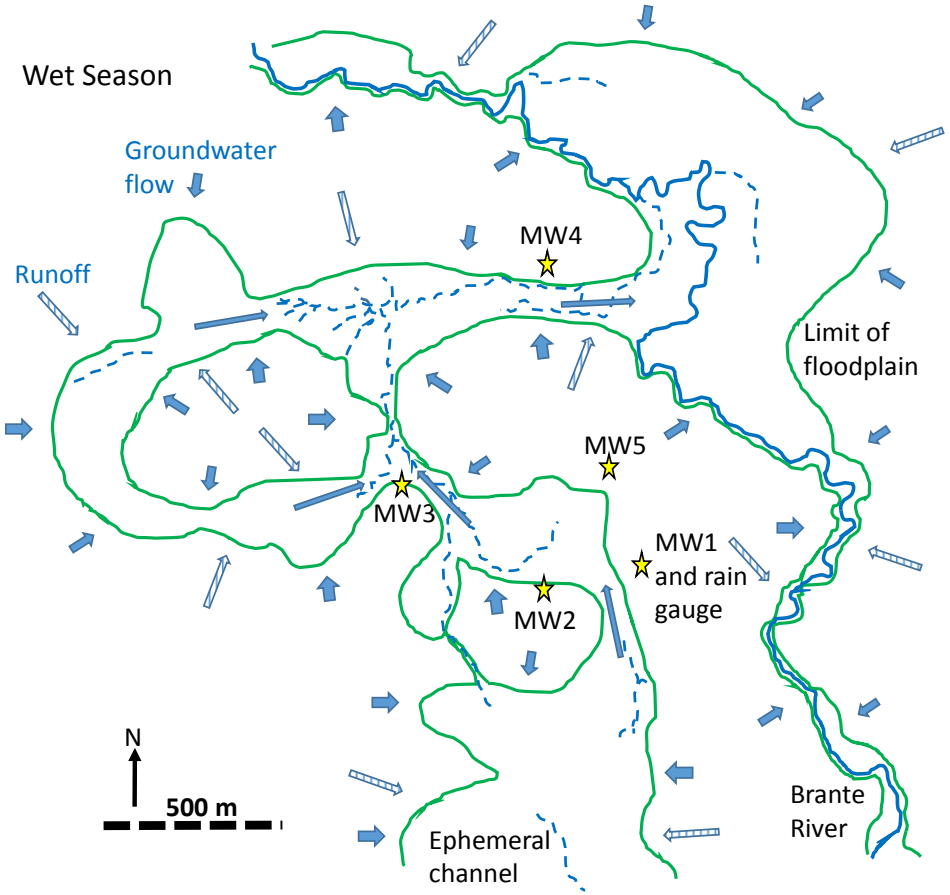


Preliminary interpretations – wet season

River reaches become inter-connected

Shallow groundwater bodies recharged by river water as well as direct rainfall

Shallow groundwater storage and discharge controlled by narrow outlet sections



Conclusions

- Two resource unit scales have been identified:
  - **catchment scale** (connected river network, long-term monitoring data)
  - **local scale** (disconnected shallow groundwater bodies, community-based monitoring)

- This assessment methodology provides the potential for community-based adaptive management of shallow groundwater resources to develop small-scale irrigation

- Further work in progress:
  - Hydrochemical analysis, including isotope studies, to better characterise groundwater ages and recharge sources
  - Use of collected data and understanding to construct local scale resource water balance models
  - Assessment of resource vulnerability to climate and land-use patterns

Co-authors:

- David Walker, Demis Alamirew, Alemseged Haile, Nathan Forsythe, John Gowing

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Council for Scientific & Industrial Research

Geological Survey of Ethiopia

International Water Management Institute

Thank you for listening
Any questions?

www.research.ncl.ac.uk/amgraf

A related talk based on our research in Ethiopia will be given by John Gowing on Friday 29 May