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Groundwater for Resilience in the IGAD Region: Facts and Figures and Future Prospects

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2nd IGAD Water Forum
25-27, January 2022
Entebbe, Uganda

Innovative water solutions for sustainable development

Food·Climate·Growth

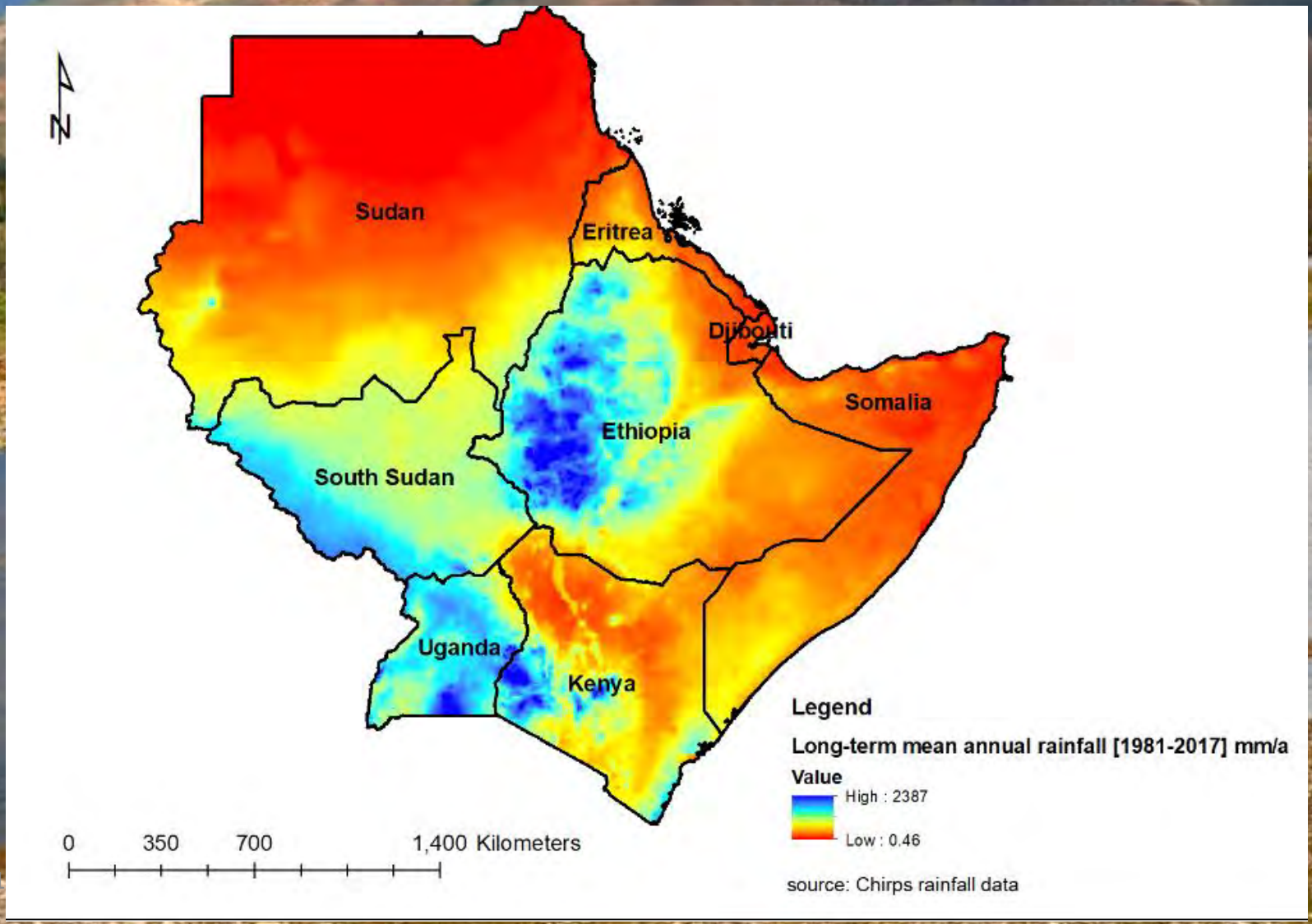
Outline

- The IGAD region – and its water resources
- Hydrogeology
- Groundwater: a critical resource for development
- The state of groundwater resources in the IGAD region
- Groundwater management for sustainability and resilience
- Conclusions

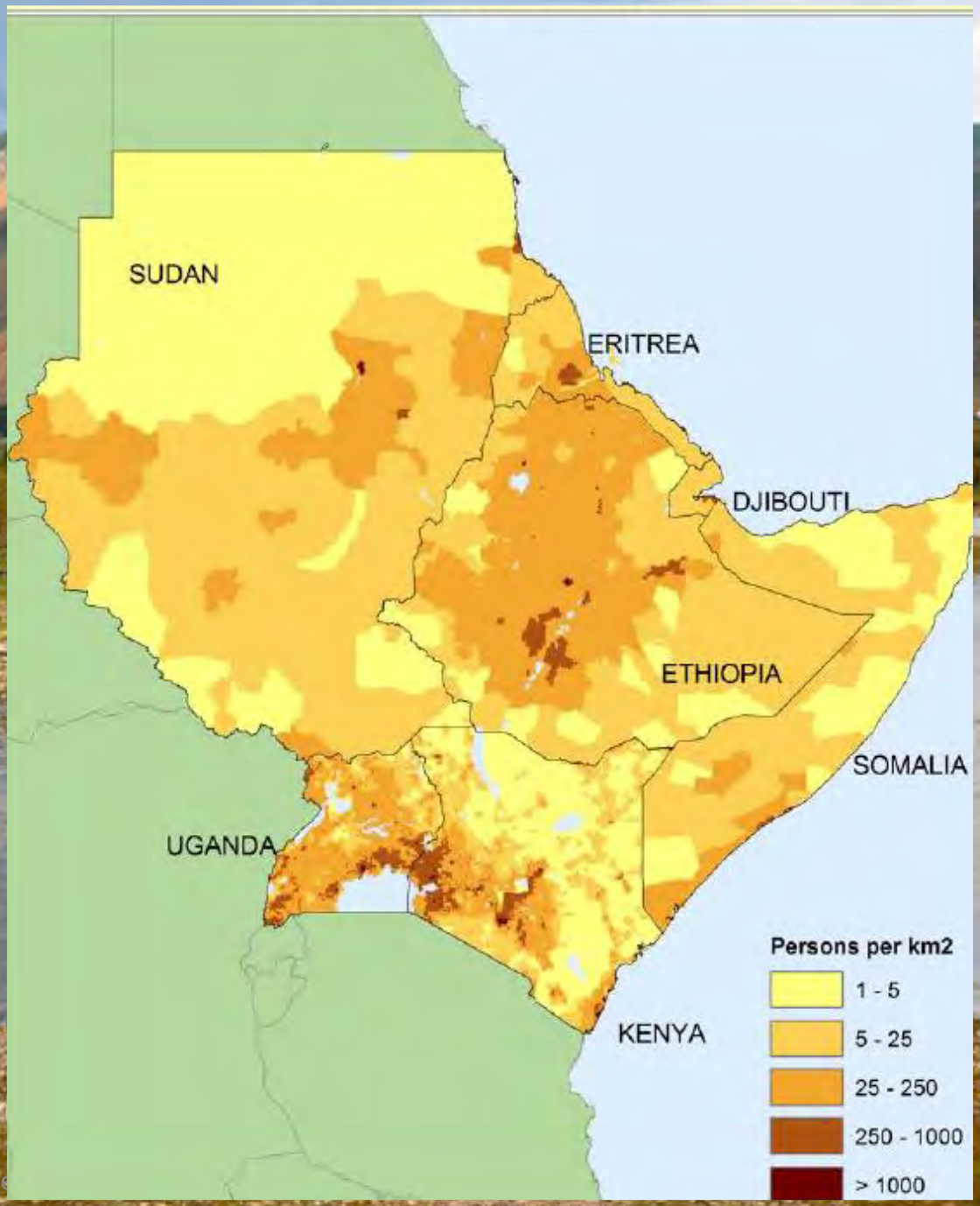
The IGAD Region – and its Water Resources

- Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda
- 5.2 million km^2
- 251 million people
- 60% arid or semi-arid
- 80% of population dependent on agriculture
- Vulnerable region compounded by climate change

Rainfall


N
Sudan
Eritrea
Djibouti
Somalia
Ethiopia
South Sudan
Uganda
Kenya
0
350
700
1,400 Kilometers
Legend
Long-term mean annual rainfall [1981-2017] mm/a
Value
High : 2387
Low : 0.46
source: Chirps rainfall data

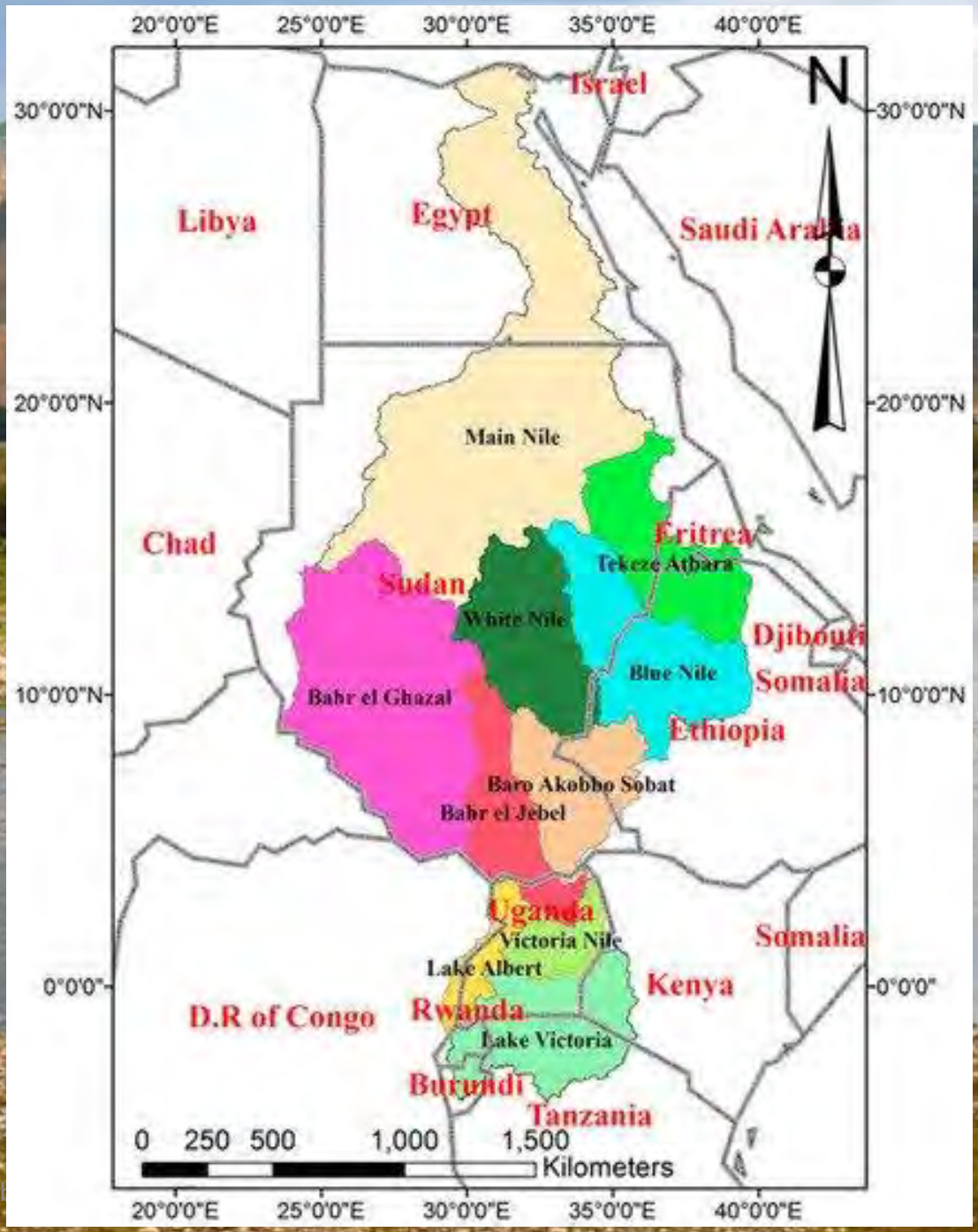
Population density



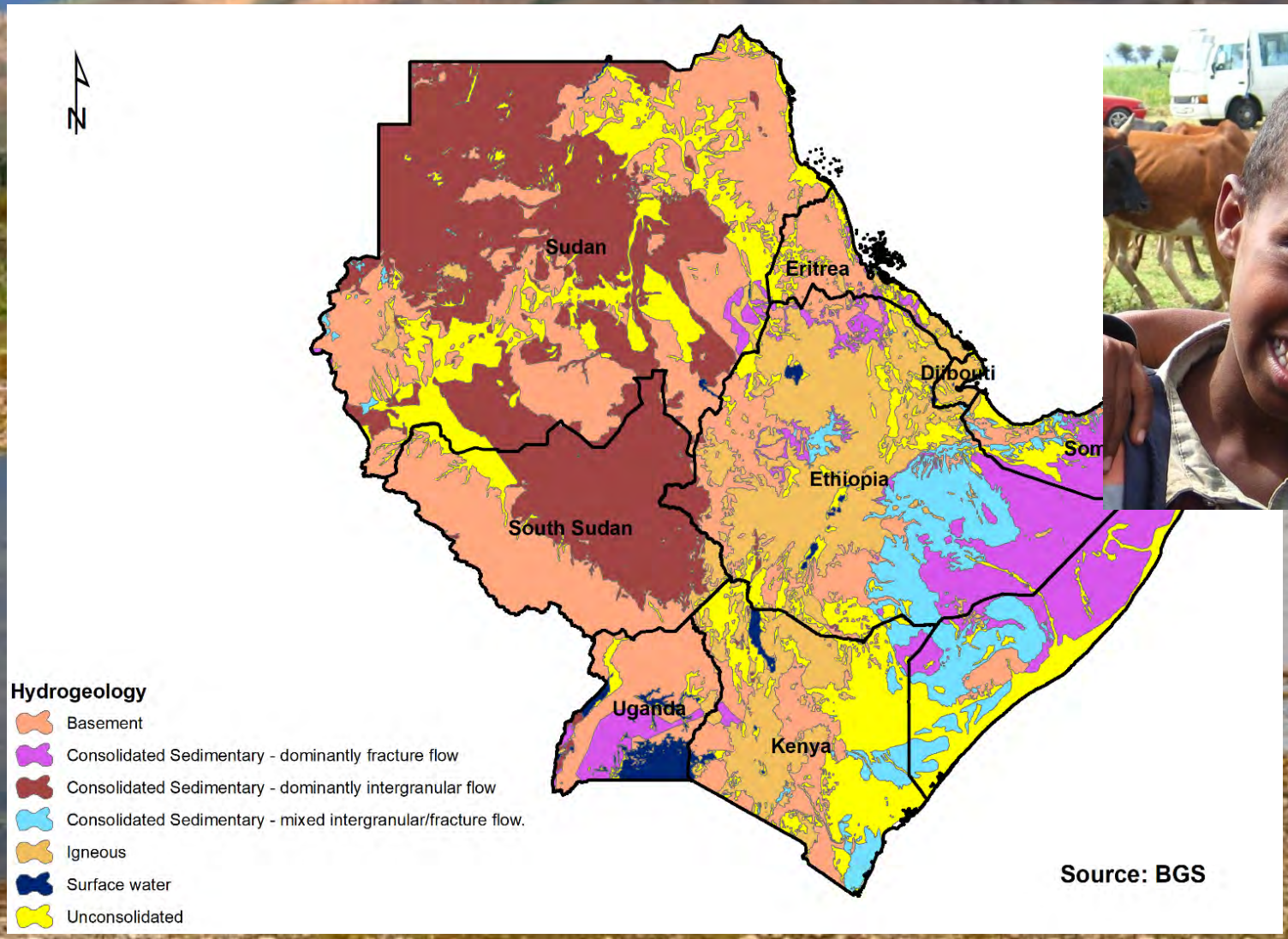
Surface water systems

Nile Basin

- Nile Basin is 86% within IGAD region

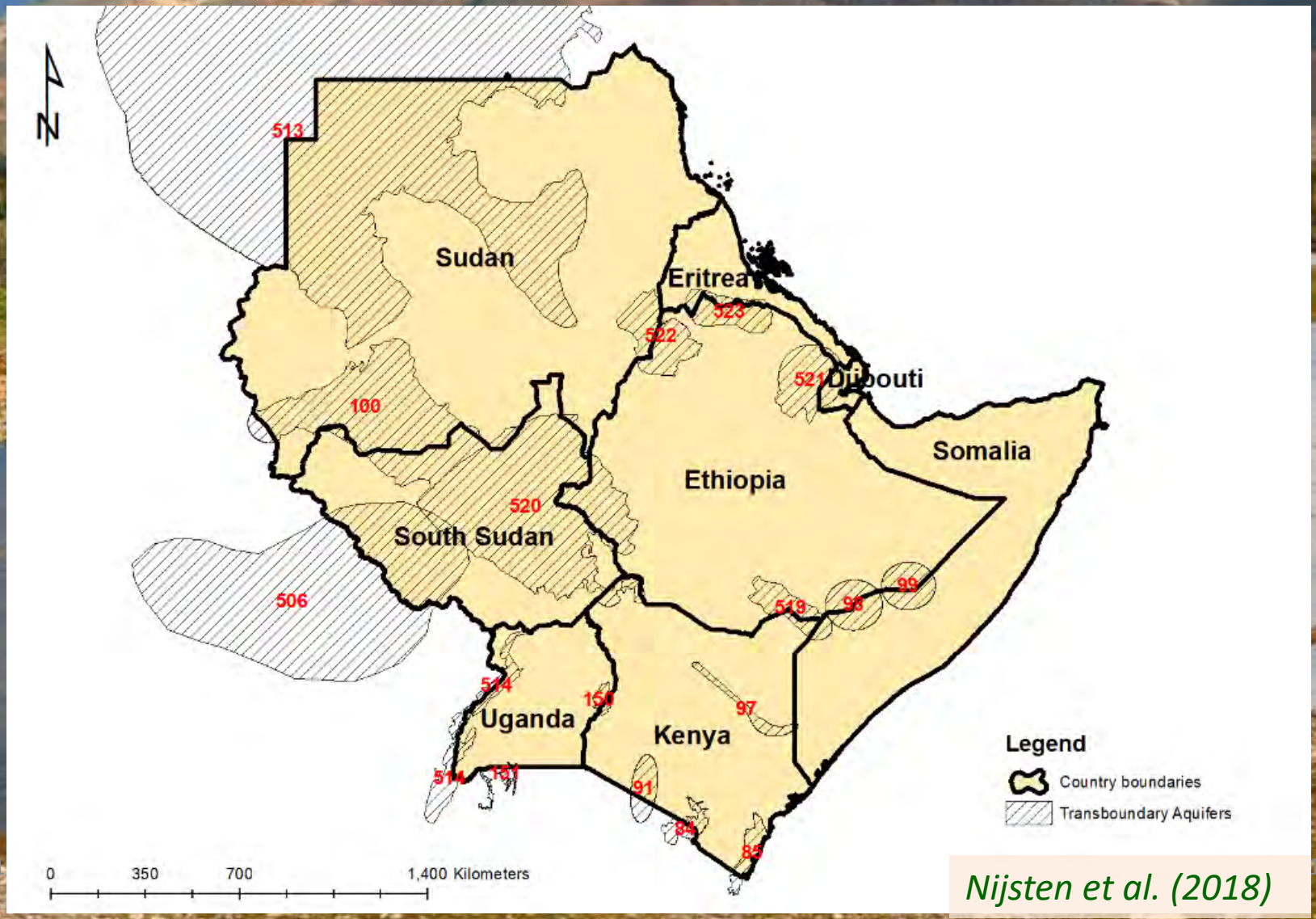


Hydrogeology



The East African Rift System

Transboundary aquifers



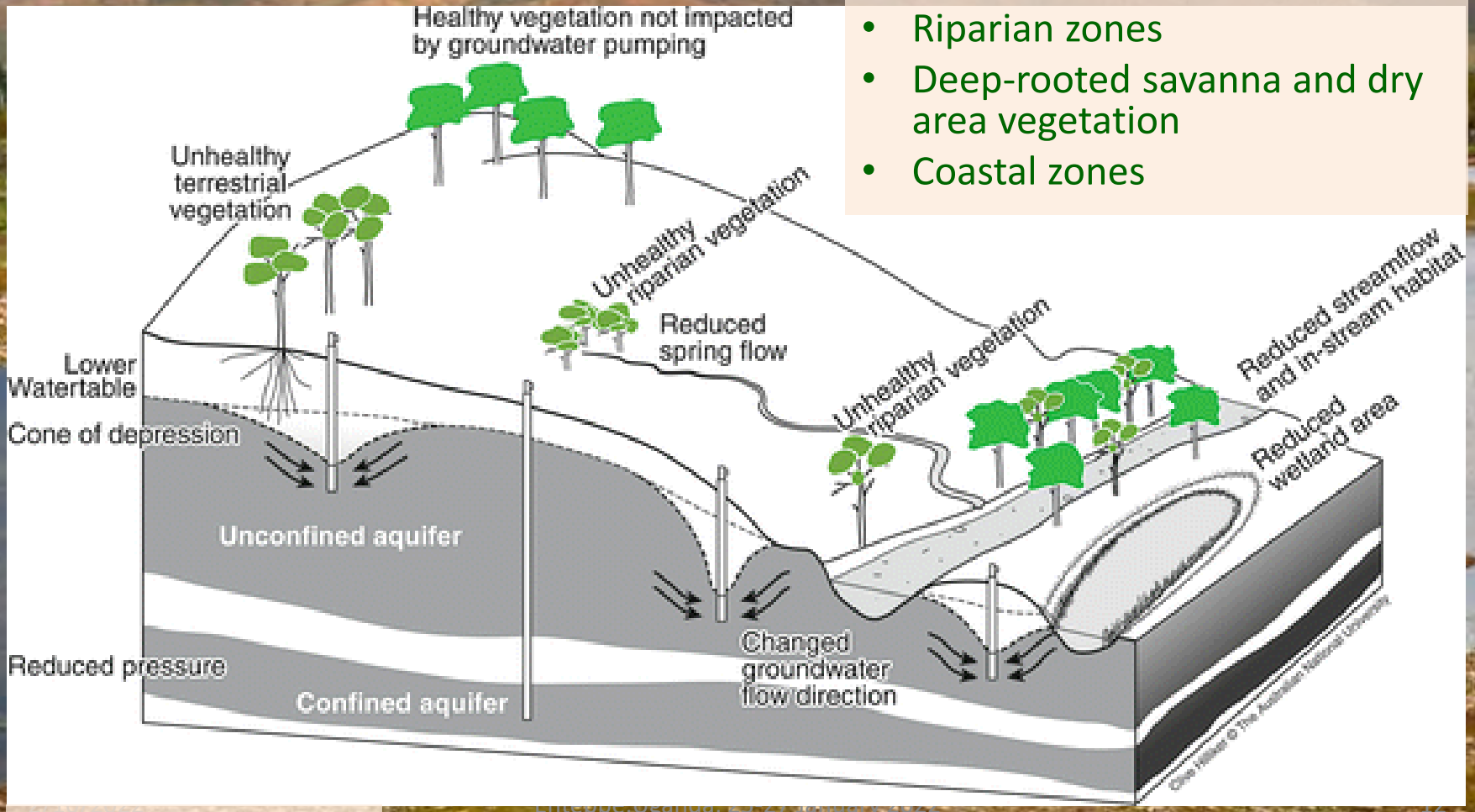
Nijsten et al. (2018)

Transboundary aquifers

ID	Aquifer Name	Sharing countries
97	Merti Aquifer	Kenya, Somalia
98	Jubba	Ethiopia, Somalia
99	Shabelle	Ethiopia, Somalia
150	Mount Elgon Aquifer	Uganda, Kenya
519	Dawa	Ethiopia, Kenya, Somalia
521	Afar Rift valley / Afar Triangle Aquifer	Djibouti, Ethiopia
522	Gedaref	Ethiopia, Sudan
523	Mereb	Ethiopia, Eritrea
84	Kilimanjaro Aquifer	Kenya, Tanzania
85	Coastal Sedimentary Basin I / Karoo Sedimentary Aquifer	Kenya, Tanzania
91	Rift Aquifer	Kenya, Tanzania
151	Kagera Aquifer	Tanzania, Rwanda, Uganda
100	Baggara Basin	Central African Republic, South Sudan, Sudan
506	Karoo-Carbonate	Central African Republic, Congo, South Sudan
513	Nubian Sandstone Aquifer System (NSAS)	Chad, Egypt, Libya, Sudan
514	Aquifere du Rift	Democratic Republic of the Congo, South Sudan, Uganda
520	Sudd Basin	Ethiopia, Kenya, South Sudan

Groundwater-dependent ecosystems

- Springs, oasis, rivers, lakes and wetlands
- Riparian zones
- Deep-rooted savanna and dry area vegetation
- Coastal zones



Eamus et al. (2016)

Groundwater: A Critical Resource for Development

- Smallholder donor-supported irrigation using deep groundwater

Villholth (2013)

- Smallholder informal farmer-led irrigation using shallow groundwater

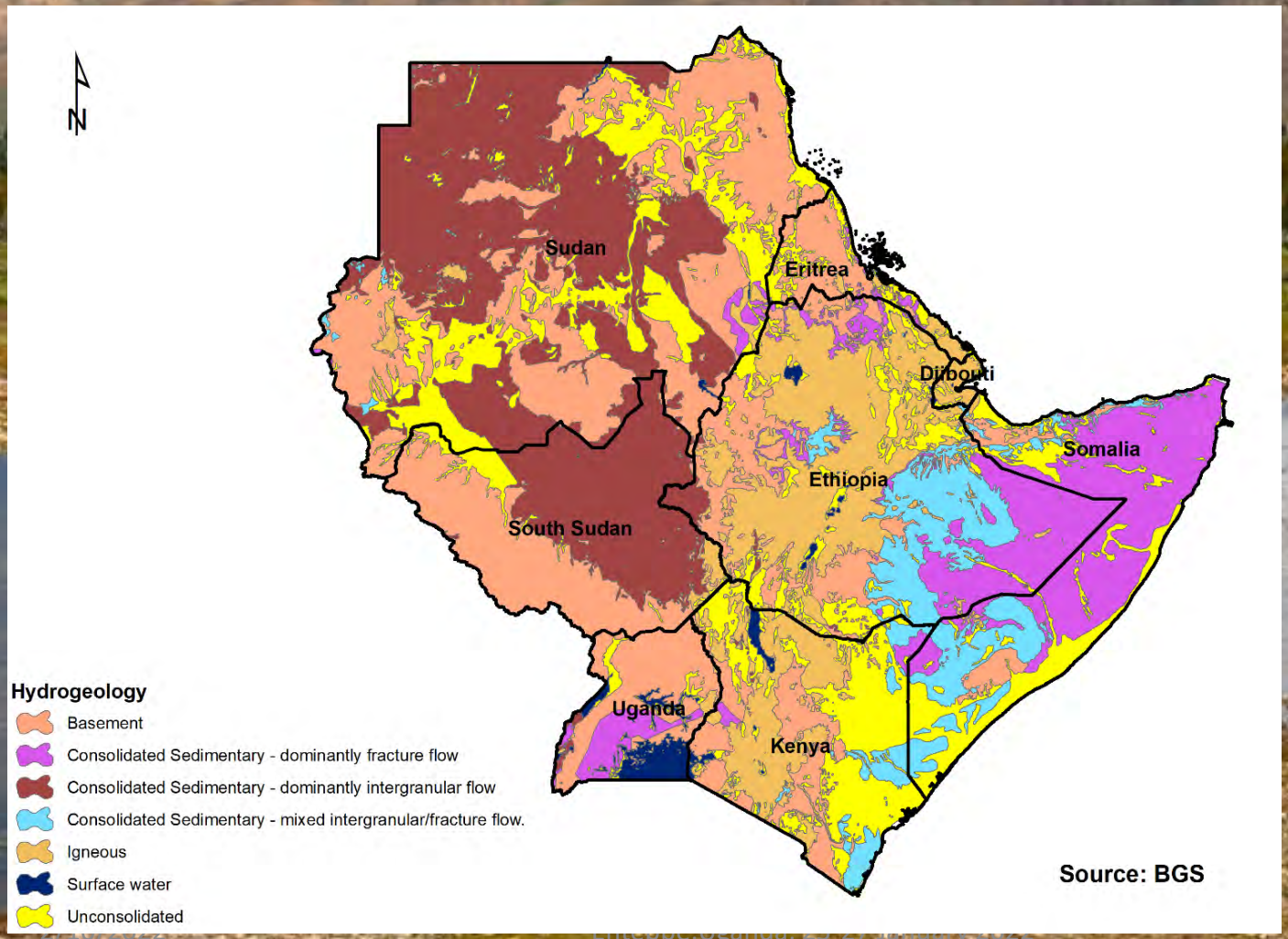
Villholth (2013)

- Commercial export-oriented horticulture agriculture

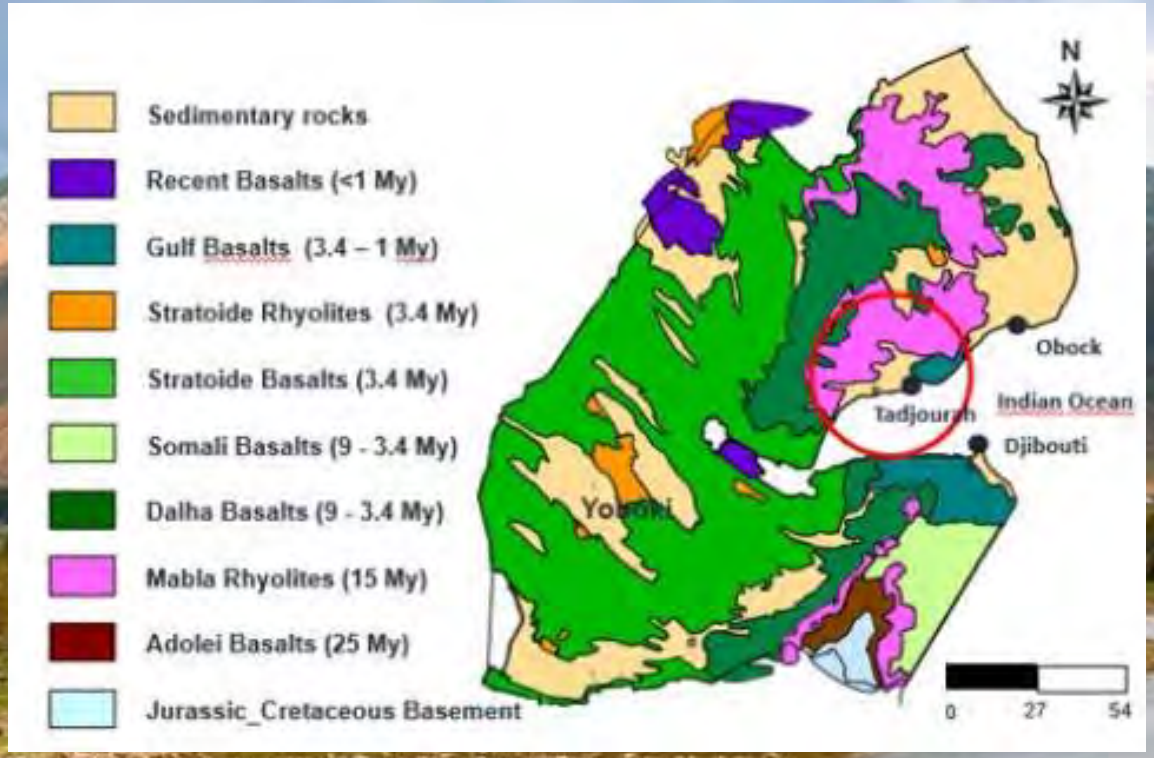
Villholth (2013)

- Pastoralism partially or fully dependent on groundwater

The State of Groundwater Resources - Snapshots



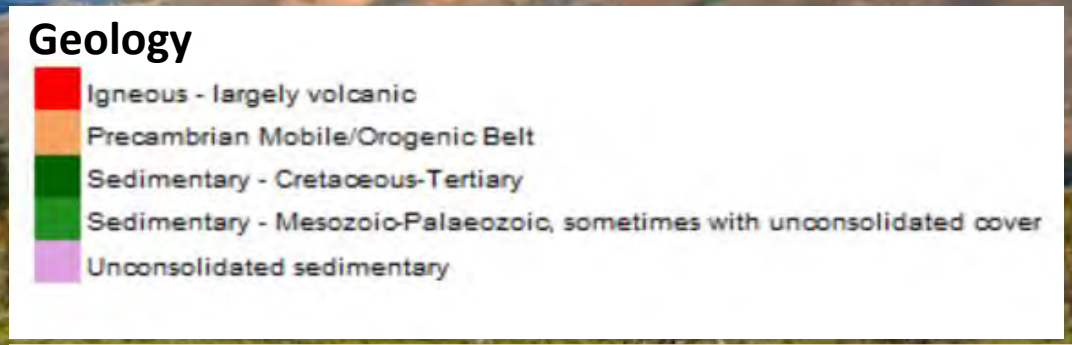
Djibouti

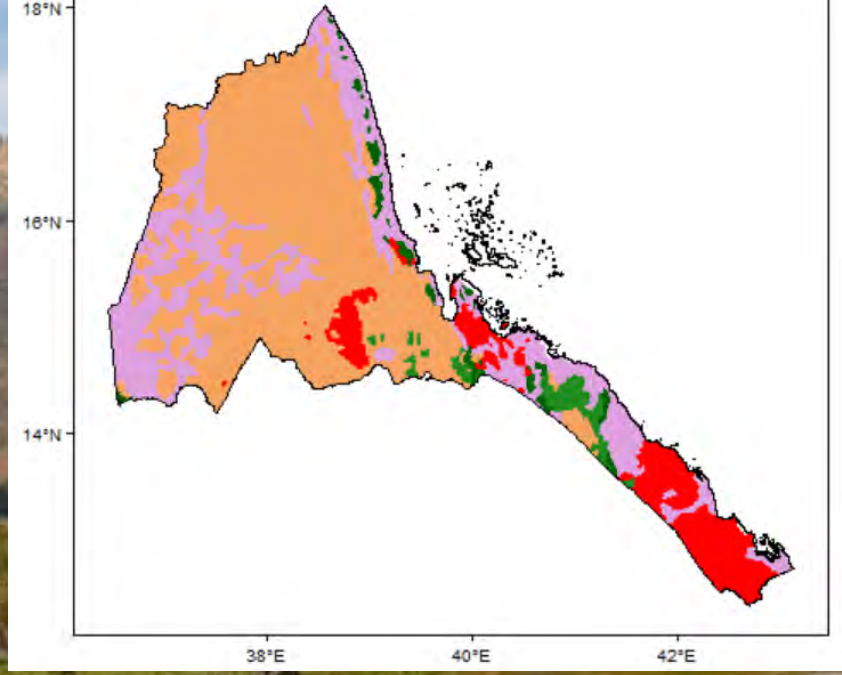


RAZACK et al. (2019)

- The aridity and absence of perennial surface water have led to intensive exploitation of groundwater to meet increasing water demands in all sectors (drinking water, agriculture and industries)
- Groundwater is at risk of depletion (15 mill. m^3/year, FAO AQUASTAT (2005))
- Groundwater recharge is estimated at 3-5% of the annual rainfall
- In coastal areas, seawater intrusion is a significant risk of groundwater degradation

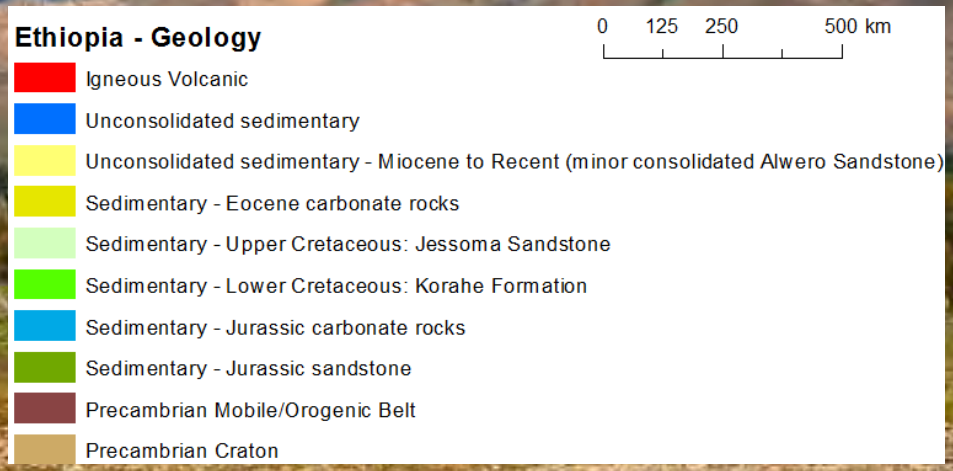
Eritrea

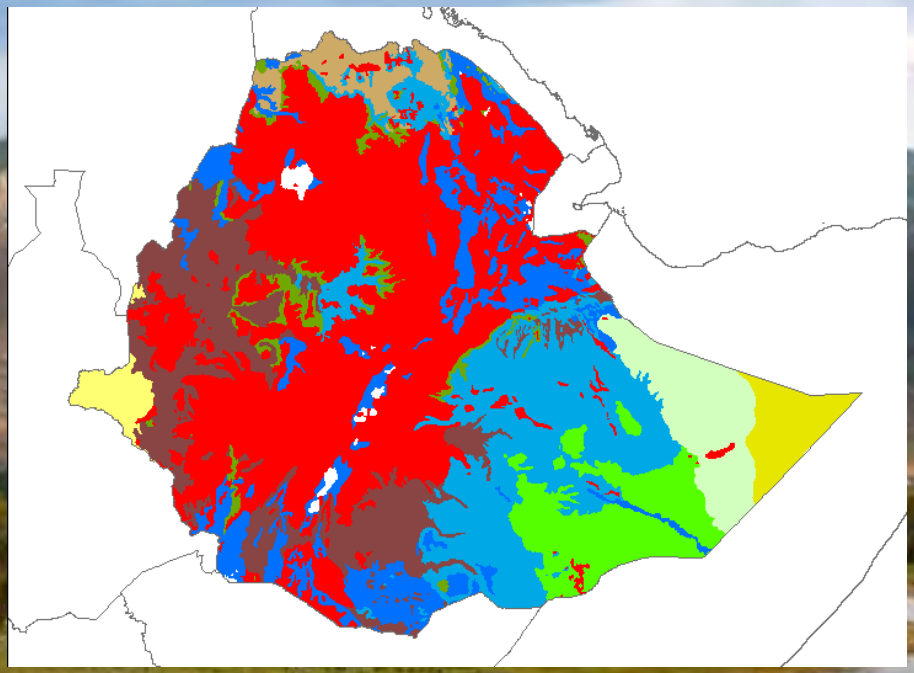




- The water supply of Eritrea is almost all dependent on groundwater resources (Vasudevu, 2009)
- The main aquifers are alluvial sediments and fractured granites
- There is only one perennial river, the Setit (Tekezze) River, which also forms part of the border with Ethiopia - all other rivers are seasonal
- Total water withdrawal was estimated at 582 Mm^3 in 2004, of which 550 Mm^3 was for agriculture (94.5%), 31 Mm^3 for municipal consumption (5.3%) and 1 Mm^3 for industry (0.2 per cent) (Water Action Hub, 2022)

Ethiopia



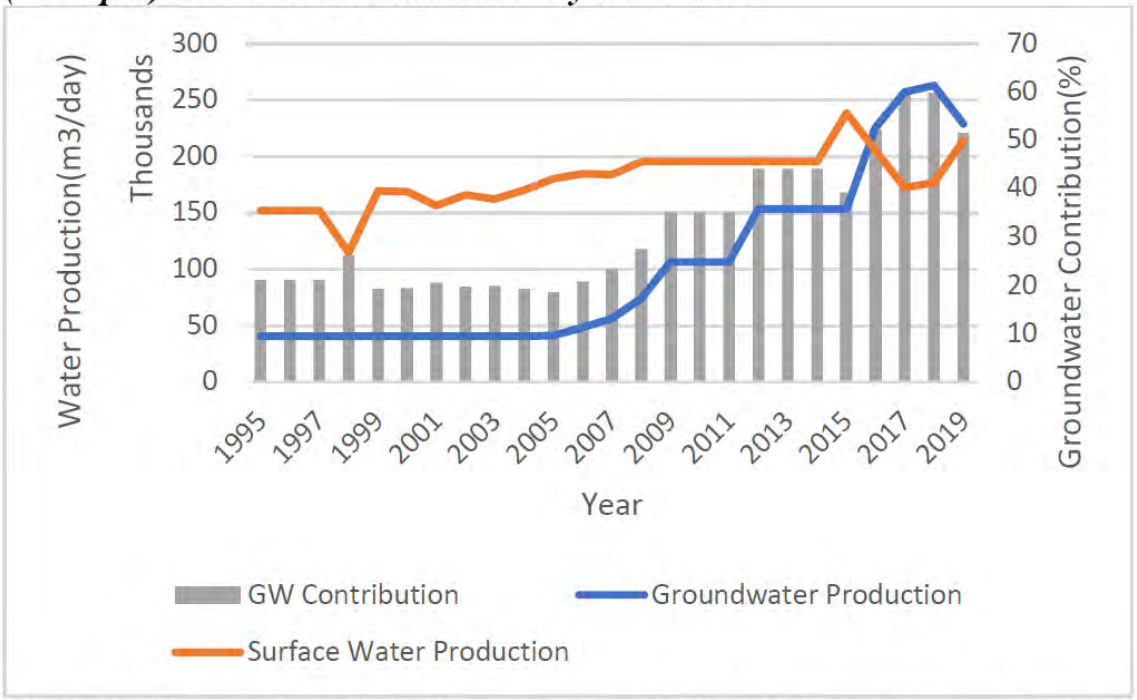


Pavelic et al. (2012) and BGS EARTHWISE™

- Groundwater provides >90% of water for domestic and industrial supply, and a small but growing fraction for irrigation
- Aquifers generally have low storage compared to large sedimentary basins elsewhere in Africa
- Recharge varies a lot, from 0 to 300 mm/yr
- Salinity and fluoride (e.g. Rift Valley) are major groundwater quality issues, making 30% of resources below standards for drinking

Ethiopia

The importance of groundwater for municipal water supplies in Addis Ababa (Ethiopia) has increased substantially since 2007.

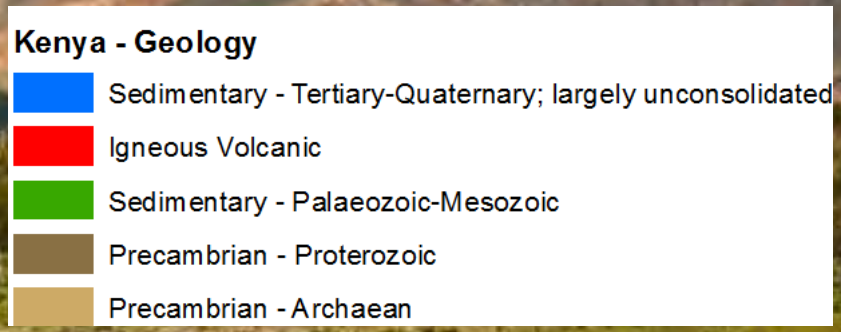


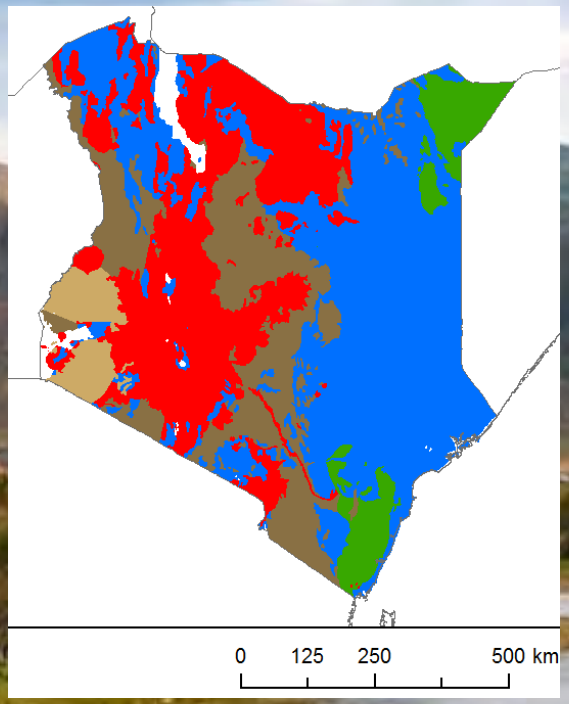
With thanks to Dr. Behailu Birhanu (Addis Ababa Science Technology University)

AMCOW (2022)

- Groundwater for Addis has increased by a factor of 5 since 2007.

Kenya

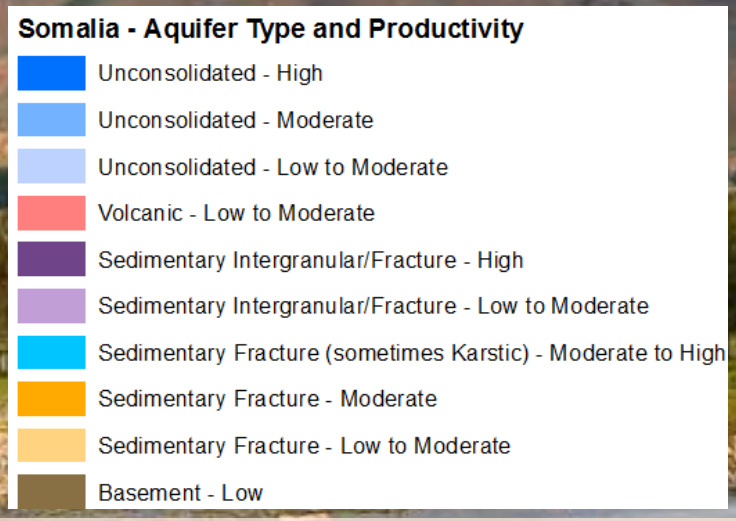


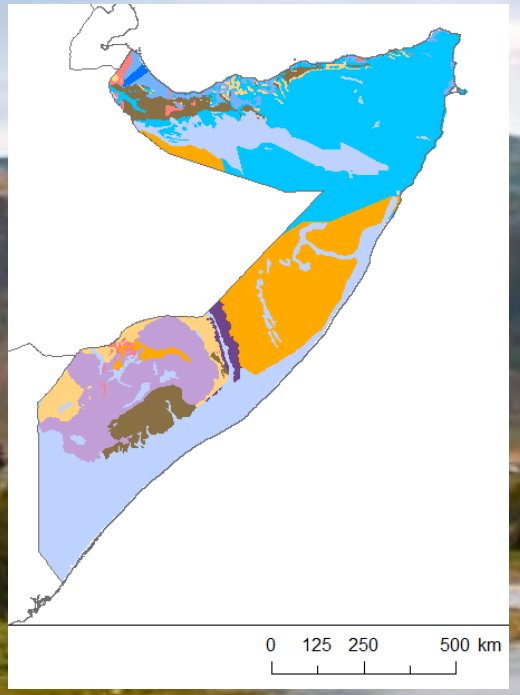


BGS EARTHWISE™

- Some aquifers are being over-abstracted with associated problems of water level decline and sometimes water quality deterioration, in particular the Nairobi volcanic aquifer
- In total, groundwater abstraction is 57.2 Mm^3/year, or 30% of recharge
- River pollution by industrial waste and sewage pose a great risk to groundwater quality

Somalia

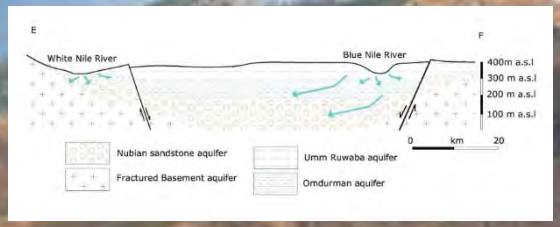


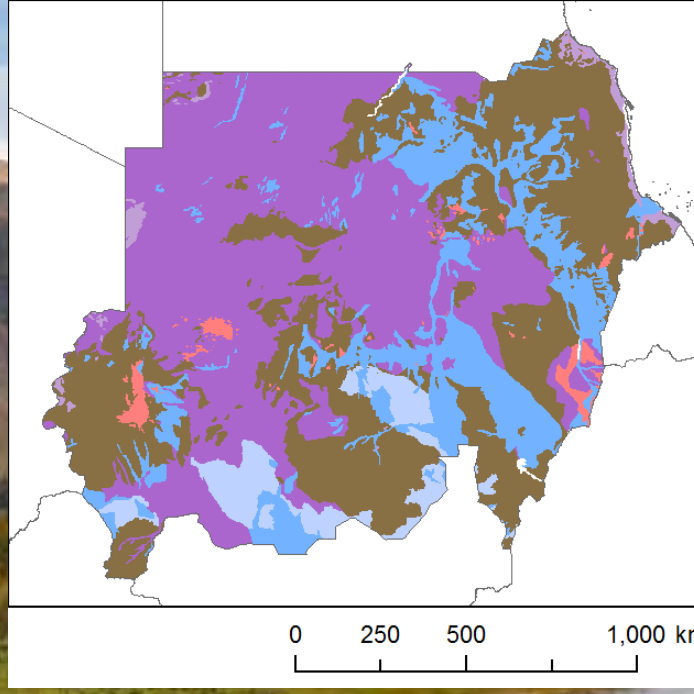


BGS EARTHWISE™

- Apart from areas along the Juba and Shabelle Rivers, all regions depend on groundwater for domestic water supply, livestock and small-scale irrigation
- There is very low effective rainfall
- Most groundwater sources have salinity levels above 2,000 µS/cm, and many shallow wells are unprotected and vulnerable to microbiological and other contamination

Sudan



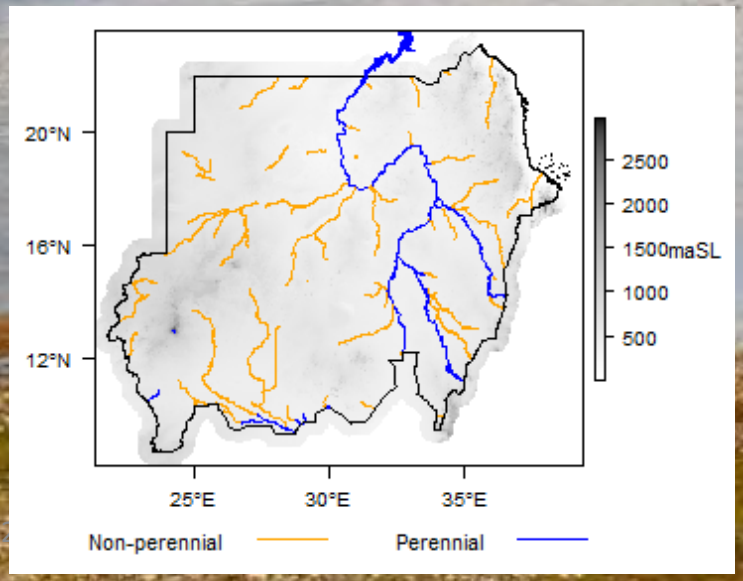


Sudan - Aquifer Type and Productivity

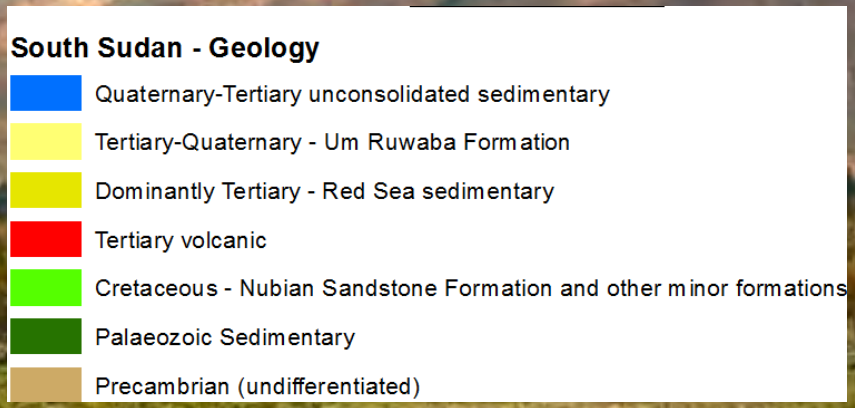
- Unconsolidated - Low to High
- Unconsolidated - Low to Moderate
- Sedimentary Intergranular/Fracture - Moderate to High
- Sedimentary Intergranular/Fracture - Low to Moderate
- Igneous Volcanic - Very Low to High
- Basement - Low

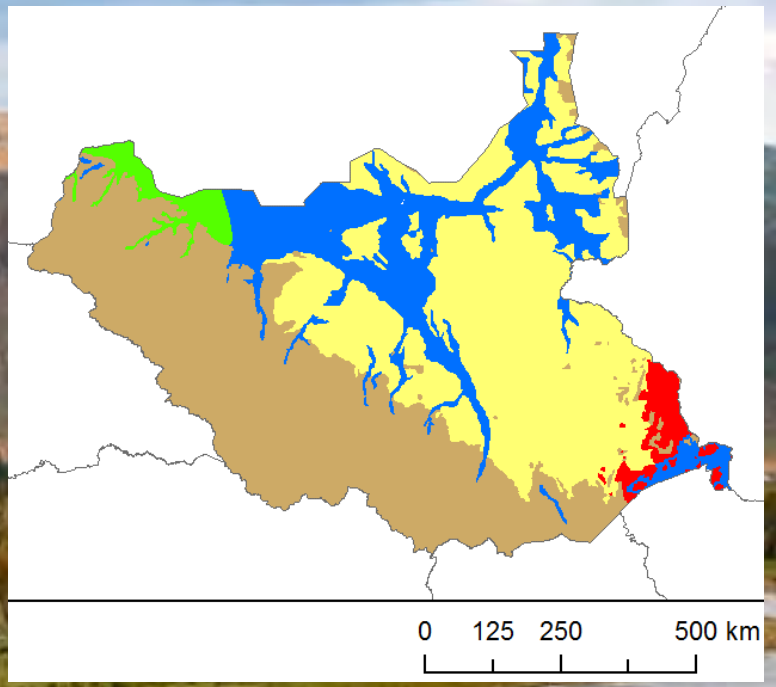
BGS EARTHWISE™

- Groundwater in Sudan is used largely for human and livestock needs, with relatively small amounts of abstraction for small-scale irrigation
- Due to the general aridity, most groundwater is replenished through perennial tributaries of the Nile River



South Sudan





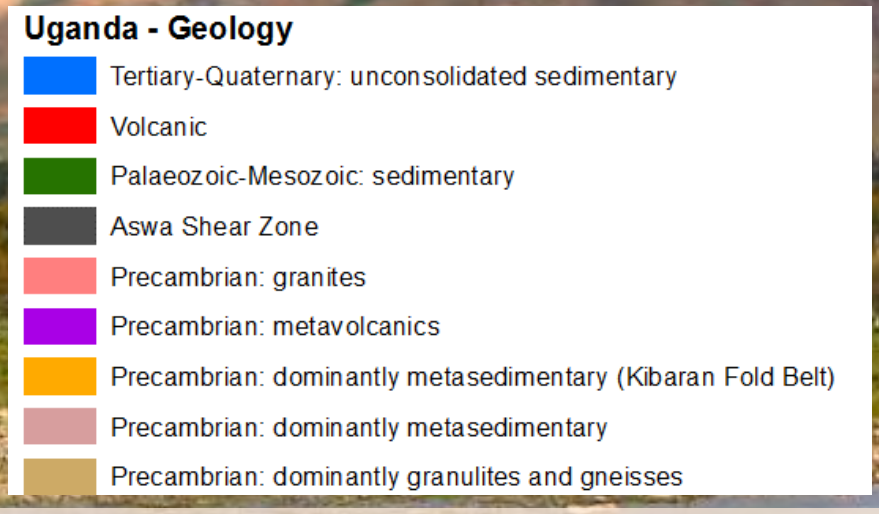
- Groundwater is an important source of water supply, especially during the dry season. Groundwater is typically brackish, yields and the success rate for well drilling low

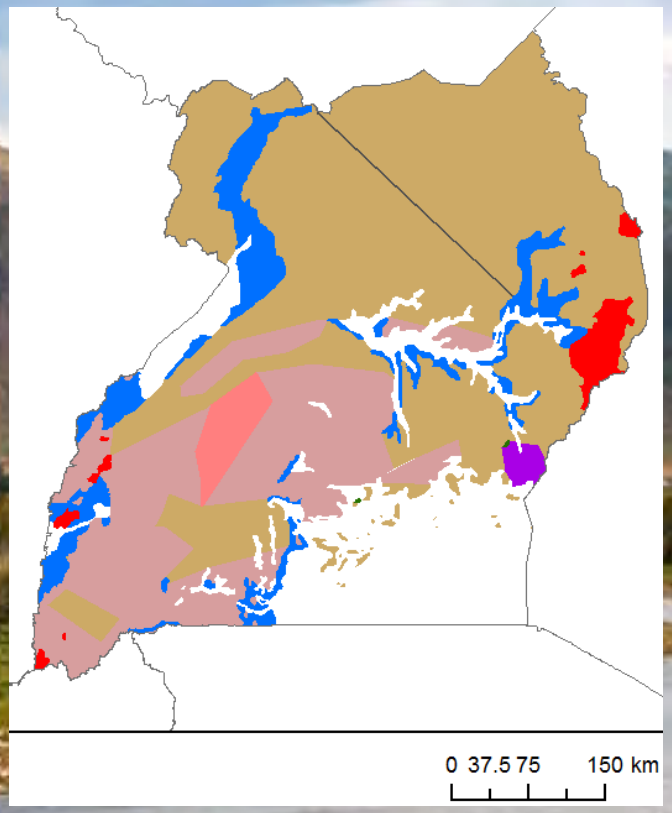
- Hydrology of South Sudan is governed by the Sudd Wetlands (Ramsar site) which may not be well connected to groundwater

BGS EARTHWISE™ and Wikipedia

Uganda

BGS EARTHWISE™





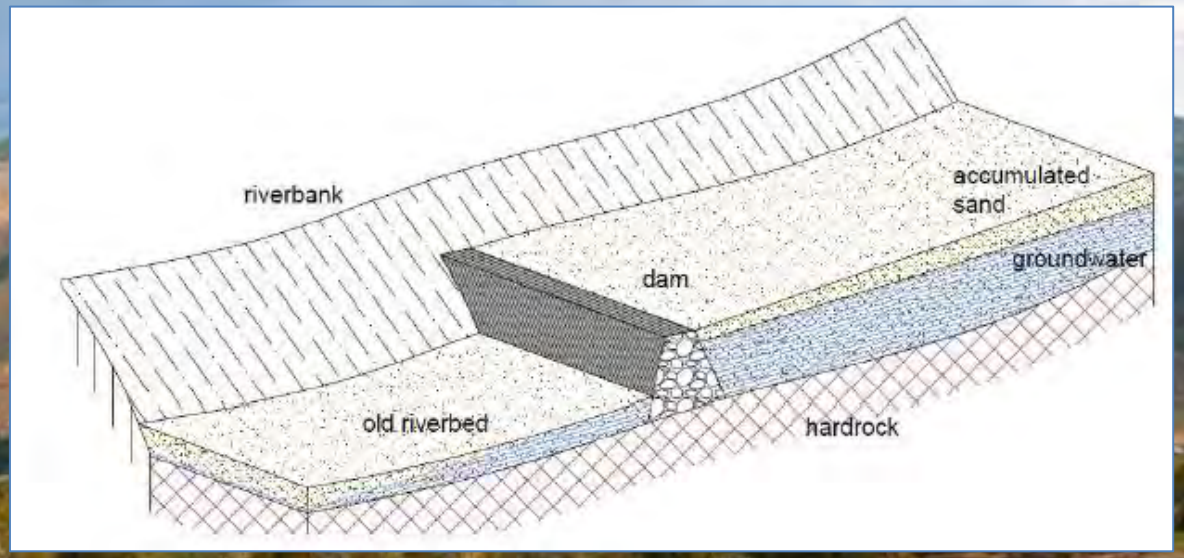
- Most groundwater use is for domestic demand in rural/urban areas
- There are no widespread groundwater quantity issues
- Groundwater quality is generally good, though high concentrations of iron and manganese and microbial contamination related to fecal waste is common. High fluoride is observed in igneous aquifers
- Groundwater maintains baseflow to rivers, lakes, and wetlands

Groundwater Management for Sustainability and Resilience

Groundwater and climate change adaptation

- Dependence of population on rainfed agriculture implies sensitivity to climate variability and change (Tegebu, 2020)
- Climate change-induced migration can have substantial development implications and is a great concern (Tegebu, 2020)
- Groundwater systems are favourably distributed to offer sustainable, decentralised, cost-effective solutions to improve drought-resilient water access (IAH, 2019)
- Climate change affects groundwater resources directly by affecting the recharge rate and indirectly by increasing groundwater demand in all sectors (Taylor et al., 2013)
- Climate change brings extreme events, which challenge groundwater management and protection, but which may also provide significant episodic recharge for the medium-term re-stocking of aquifers (Cuthbert et al., 2019)
- Managing recharge, land use, and waste disposal is paramount for sustainable groundwater under climate change (Villholth et al., 2018).

MAR in IGAD



- Sand dams in Kenya

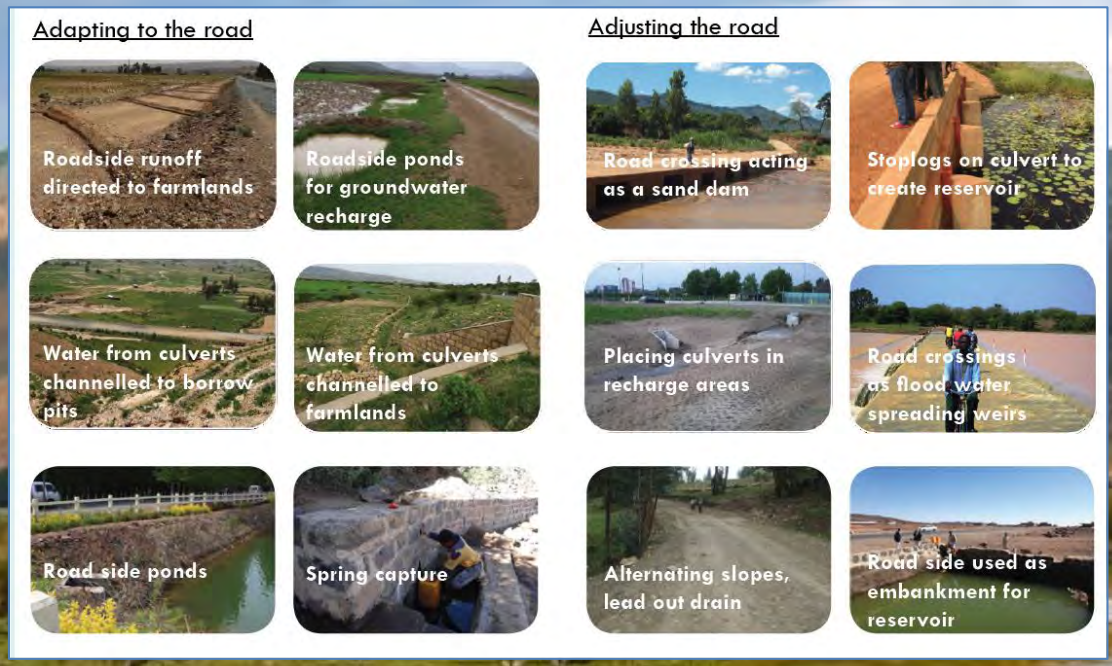
Ebrahim et al. (2020)

Groundwater-based Natural Infrastructure

GRIPP

GROUNDWATER SOLUTIONS INITIATIVE FOR POLICY AND PRACTICE

MAR in IGAD



- Road water harvesting in Ethiopia

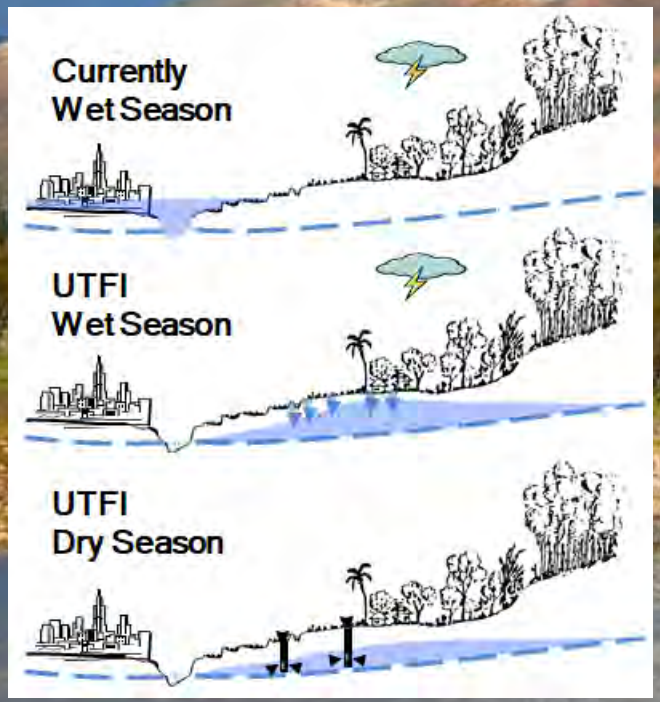
Ebrahim et al. (2020)

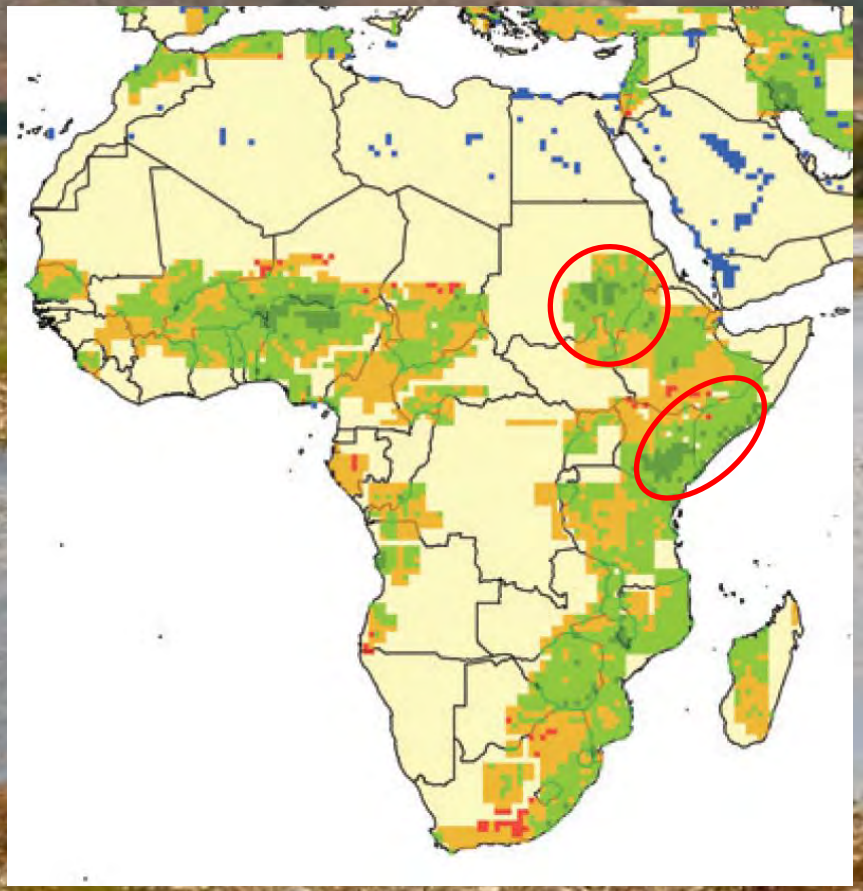
Groundwater-based Natural Infrastructure

GRIPP

GROUNDWATER SOLUTIONS INITIATIVE FOR POLICY AND PRACTICE

Underground Transfer of Floods





Low (0-25) Moderate (25-50) High (50-75) Very high (75-100) Groundwater depletion

Alam and Pavelic (2020)

Conclusions - Prospects for groundwater to underpin resilience and sustainability in IGAD

- Groundwater is a strategic resource in the IGAD region providing a critical foundation for sustainability and resilience to climate change and water insecurity
- Policy and institutional frameworks that enable groundwater to underpin reliable/sustainable/safe water access is a defining challenge for IGAD today
- Now is the time – as this Forum makes clear

Levers to support IGAD in terms of securing groundwater benefits

- AMCOW Pan-African Groundwater Program (APAGroP) and supporting partners
- Regional bodies with focus on groundwater /TBAs (SADC-GMI, ECOWAS)
- River/Lake Basin/Aquifer Organizations overlapping with IGAD (Nile Basin Initiative, Nubian Sandstone, EAC, Victoria Lake Basin Commission)
- Increasing donor support (GEF, WB/CIWA, SDC, USAID, BMZ, FCDO/UKRI/GCRF, Sida, etc.)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Thank you

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