

Integration of hydrogeology and social sciences in practice, Two IWRM case studies with challenges and opportunities from semiarid Africa

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Floods-hit Sudan facing 'unprecedented challenges', UN warns

Over 800,000 have been affected and more than 120 people have died in the worst floods in Sudan in decades.

An aerial view shows buildings and roads submerged by floodwaters near the Nile river in South Khartoum, Sudan [El Tayeb Siddig/Reuters]

25 Sep 2020

Water problem or water management problem?

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East Africa

Key Message Update

Conflict-, drought-, and flood-affected areas face Crisis (IPC Phase 3) or worse outcomes

December 2021

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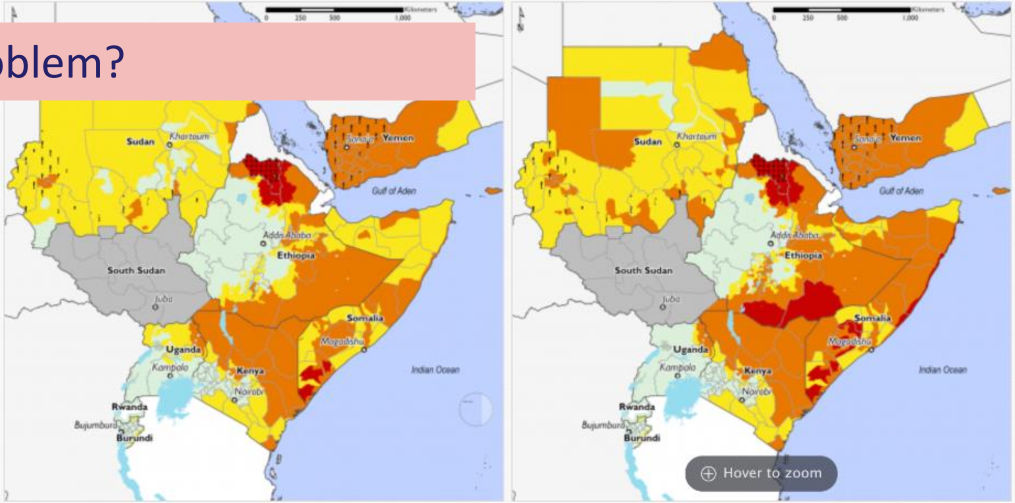
November 2021 - January 2022 **February - May 2022**



IPC v3.0 Acute Food Insecurity Phase

Presence countries: 1: Minimal 2: Stressed 3: Crisis 4: Emergency 5: Famine National Parks/Reserves

Remote monitoring countries: 1: Minimal 2: Stressed 3+: Crisis or higher

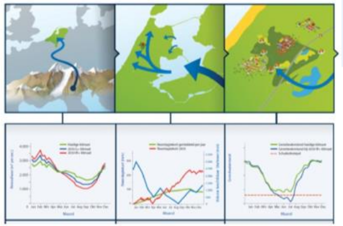
Outcomes may be worse than mapped, but available evidence is insufficient to confirm or deny Not mapped

Would likely be at least one phase worse without current or programmed humanitarian assistance

Does it look familiar?

Pictures of Anne van der Heijden
Sudan 2019 and Ethiopia 2020

IWRM process



Develop knowledge base

Establishment of catchment management organisations

IWRM process

1 Facts

2 Dialogue

3 Strategies

4 Implementation

Implementation of short and long term interventions

Development catchment management plan

Developing the knowlegde base

- **Challenges arise in collecting, processing, and mapping the facts**
  - In hydrogeology, a 3D situation is translated to 2D maps.
  - Socio-economic data are often stored based on administrative boundaries and need corrections for hydrological source-area delineation
  - Population density and water demand change over seasons, following crop cycles and livestock migration patterns.
  - Looking at local water availability, rainfall and surface water flows, and therefore groundwater recharge, are becoming more variable and less reliable.

- In practice, water availability (& water supply) assessments are often based on Water Infrastructure Assessments (WIA). These assessments are often lacking specifications for different seasons and user groups.

Lessons learned:

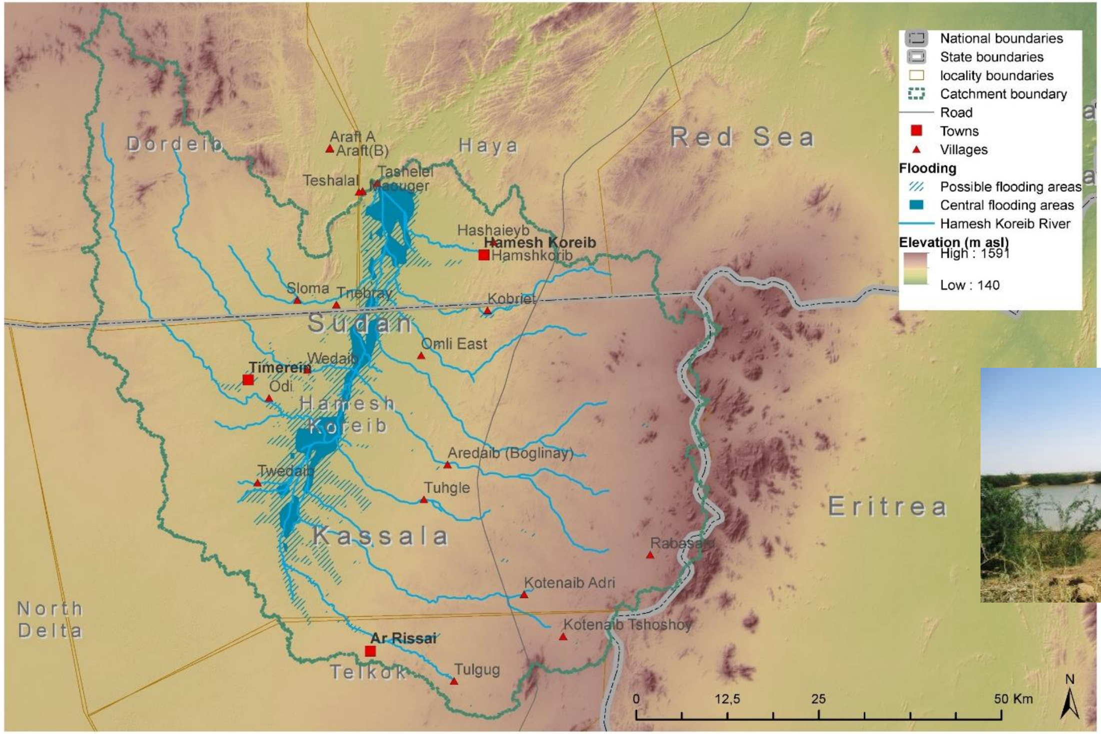
- For WIAs, **yields and supply are often averaged, thus disregarding seasonal changes.**
- Communication is key. Two-dimensional representation of a three-dimensional phenomenon. **Aim to visualize impacts of water use** for different stakeholder groups

Recommendations:

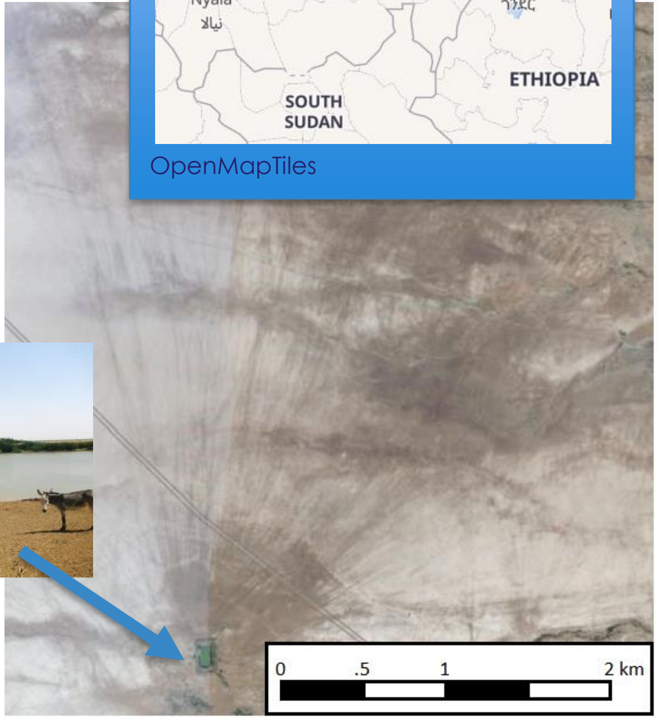
- Assessment of the rainfall regime and corresponding behaviour and movements of people and livestock is key for water gap assessments.

- Catchment characteristics have to be understood to be able to determine water resources potential and develop a watershed plan

Case 1 – Water gap assessment in Sudan



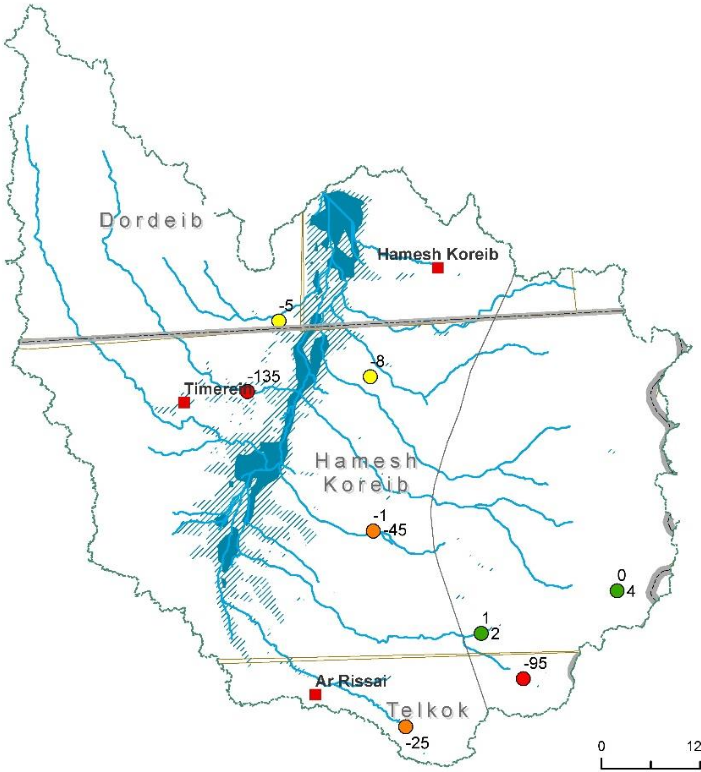
Hamesh Koreib catchment (Acacia Water, 2017)

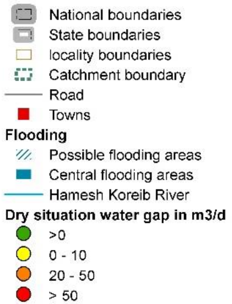


OpenMapTiles

Bing Imagery. Livestock migration lines towards water infrastructure

Water gap in dry and wet season





The map shows **the domestic water gap per water point** for the dry season in m³/d.

Recommendation:

Use different methods for validation of water demand and water supply

Annual total Precipitation for different return periods (arc2)

	Very dry (T15)	Dry (T5)	Average (T2)	Wet (T10)
Precipitation (mm/year)	31	127	176	324

Water demand vs supply (field data)

Average year	**m³/d**
Total domestic water demand in wet season	100
Total domestic water demand in dry season	409
Total domestic water availability	70

Water infrastructure assessment

Data collection approach: Step 1) WIA & Step 2) Water Need Tool

1) Simple field data collection sheet that is adaptable and can be applied in semi-arid environments in Africa and elsewhere, in which seasonality and socio-economic dynamics were taken into account.
2) Compare with resulting data from participatory workshop with the water need tool.

Main challenges:

- Lack of data and information availability;
- Reliability of estimates made by local communities
- Inaccessibility of the area for field investigation;
- Expectation management with the communities for project outcomes

General								
ID	Site name	State	Locality	Latitude (N) in UTM	Longitude (E) in UTM	Type of water infrastructure (e.g. borehole, hand dug well traditional/improved, hand pump, water yard)	Purpose of water supply Target groups: domestic, livestock, agriculture	Year of construction

2 Water use													
Domestic use													
Months of year in use for domestic purposes												Nr of people served daily	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	In wet season	In dry season

Livestock																			
Months of year in use for livestock purposes												Nr of livestock served - wet season				Nr of livestock served - dry season			
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Goats/sheep	Cattle	Camels	Donkeys	Goats/sheep	Cattle	Camels	Donkeys

2) Sustainable pathways

- To support strategic planning, an assessment of pathways towards sustainable groundwater use in African drylands was developed.
- Both hydrogeologic and socio-economic conditions tend to be quite location-specific. This makes developing a simple blueprint for integrated groundwater management impossible. However, by translating local conditions into regional advice, strategic pathways were developed for the drylands of Africa
- A sustainability pathway was developed for each of the representative landscape types. These sustainability pathways consist of three main categories of sustainability strategies:
  - measures that increase (ground)water availability,
  - measures that reduce water demand, and
  - institutional arrangements that affect (ground)water use.

Reference: Gevaert et al. 2020, Towards sustainable groundwater use in the African drylands
Download link

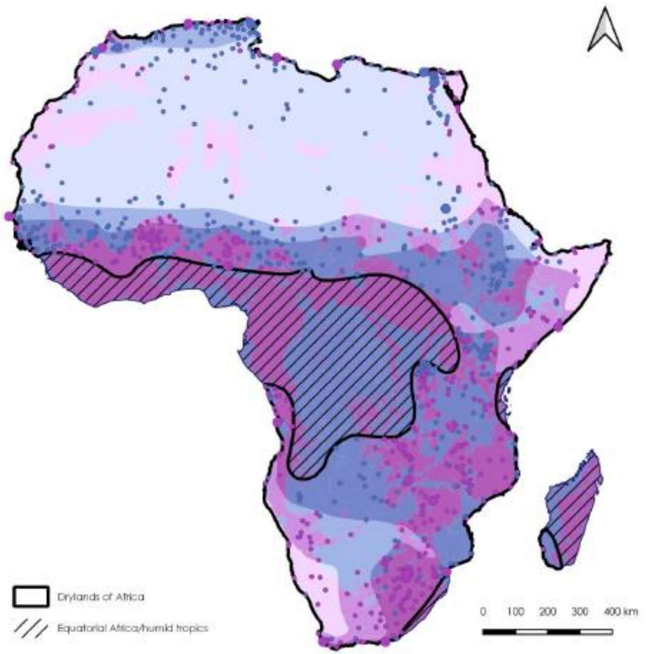
Lesson learned:

- The zonal hydrogeological and socio-economic setting determined the main groundwater issues and the potential sustainability strategies.

Recommendations:
- Small-scale projects are more effective in rural areas.

The following landscape types are considered to have the highest potential in terms of making steps towards sustainable groundwater use and are therefore considered to be priority areas:
• rural areas with medium recharge rates,
• rural areas with very low recharge and high aquifer productivity and storage, and
• smaller urban centers.

Sustainability pathways: urban/rural areas



Hydrogeol. Envir.	Urban/rural	Recharge/population	Legend	Strategies
Basement rocks Well productivity < 1 l/s Small stored volume	Rural	Recharge < 5 mm/y		• No strategies
		Recharge 5–25 mm/y		• Solar powered wells and surface reservoirs • Small-scale MAR
		Recharge 25–100 mm/y		• Well (fields) just outside village • Small-scale MAR • Agricultural water-saving and crop selection
	Urban	Population >5,000		• Bank infiltration in wadis and reservoirs • Non-conventional water sources
		Population >1,000,000		• Non-conventional water sources • Reduction of non-revenue water
Sedimentary and volcanic rocks Well productivity > 1 l/s Large stored volume	Rural	Recharge < 5 mm/y		• Prioritize water allocation • Agricultural water-saving and crop selection • Regulation of abstractions and exit strategy
		Recharge 5–25 mm/y		• Solar powered wells • Small-scale MAR
		Recharge 25–100 mm/y		• Multi-village, high-capacity wells • Small-scale MAR • Agricultural water-saving and crop selection
	Urban	Population >5,000		• Large-scale MAR • Non-conventional water sources
		Population >1,000,000		• Large-scale MAR • Non-conventional water sources • Reduction of non-revenue water

Reference: Gevaert et al. 2020 (Acacia Water)

The sustainability pathways presented here provide insight at the regional scale, but do not necessarily reflect the local situation.

Conclusions

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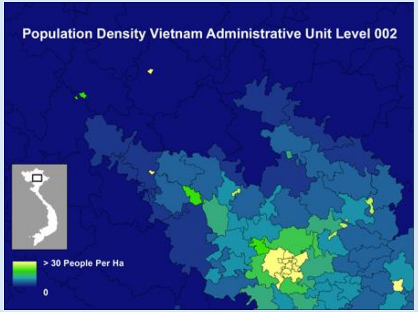
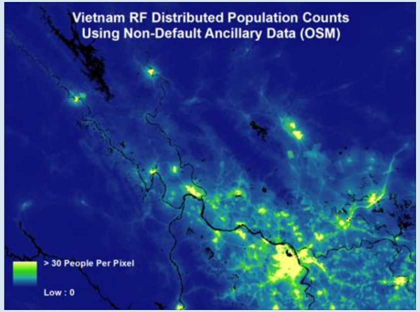
- Tailor-made approaches are necessary. In these assessments, remote sensing provides opportunities.
- Evidence-based inputs needed for discussion on water availability and equitable allocation
- Aim to visualise water use impacts on groundwater resources. Focus on tools that take spatial and temporal variability into account.
- For all implementation: regular **monitoring** is needed

Example tools

Gridded datasets of population density
WorldPop (https://www.worldpop.org/)





Source Image: Worldbank Blogs

Keep in mind seasonal changes in population data in Sub Saharan Africa

Participatory stakeholder processes
Development of community calendars with group interviews provide useful information on the occurrence and frequency of natural hazards and community water demand

Hazards		Months												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Frequency
Hazard	Drought			X	X						X			Every year
	Flood					X						X		Every three year
	Livestock diseases			X							X			During drought season
	Crop diseases					X						X		Sometimes affect the crops
	Human diseases (Malaria, Measles, Diarrhea etc.)				X	X					X	X		Every season during drought and flood out break
Problematic months	Economic/ price shock				X							X		Every year
	Shortage of pasture				X						X			Every year
	Shortage of water				X						X			It depends on the severe drought

Example: hazard calendar based on 2 focus group discussion, Dolo Ado woreda, Ethiopia (Acacia Water, 2020)

Thank you for your attention!

Interested to know more? Do not hesitate to reach out

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