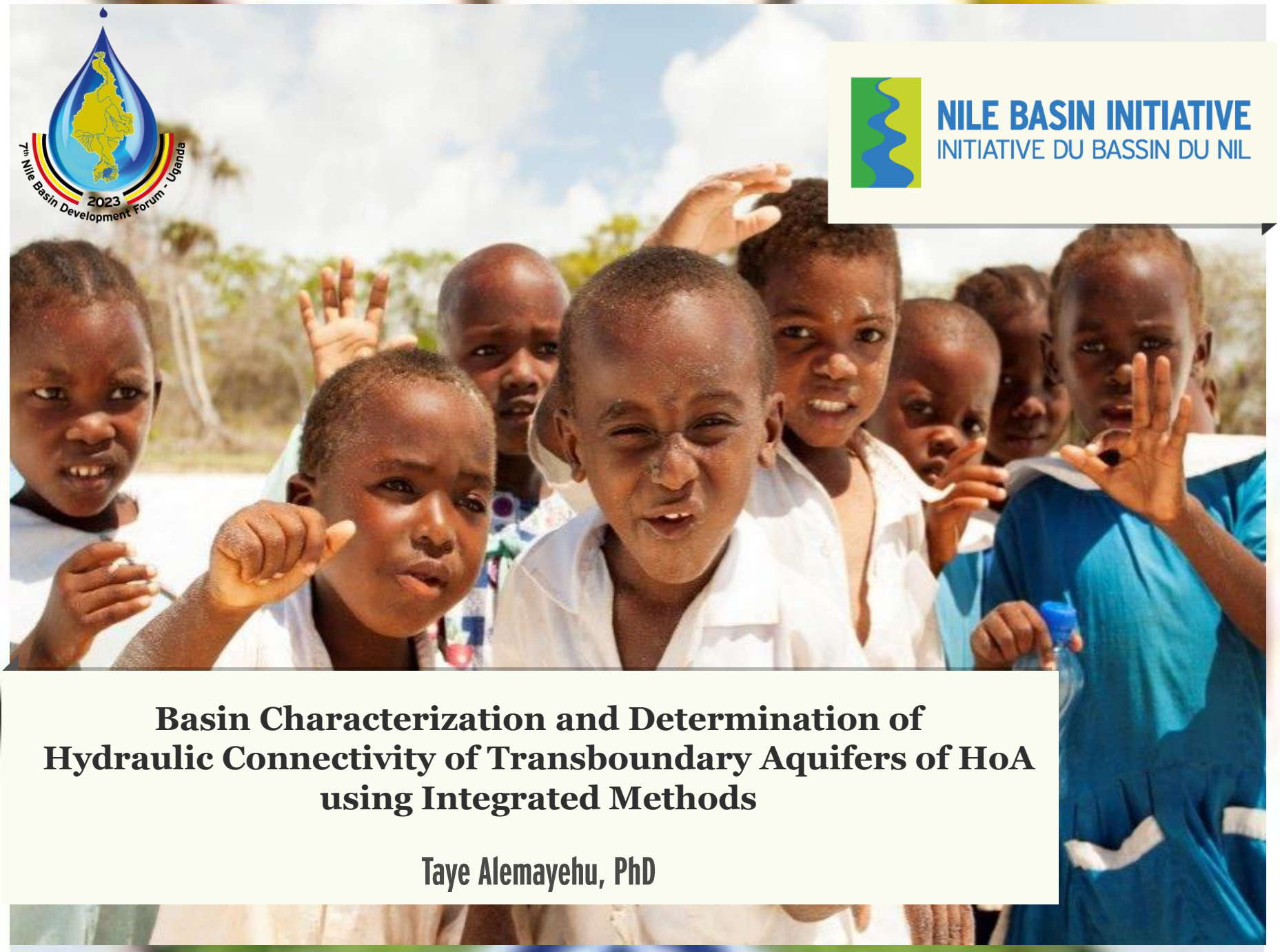

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7th Nile Basin Development Forum - Uganda 2023

Basin Characterization and Determination of Hydraulic Connectivity of Transboundary Aquifers of HoA using Integrated Methods

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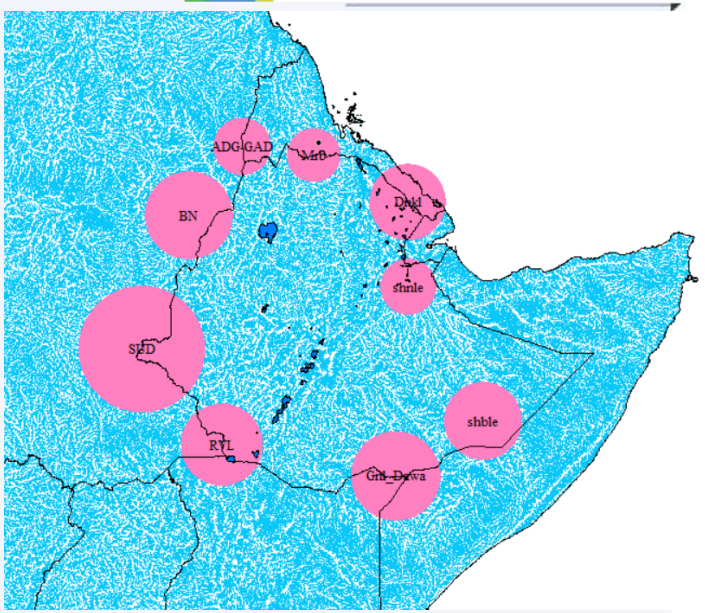
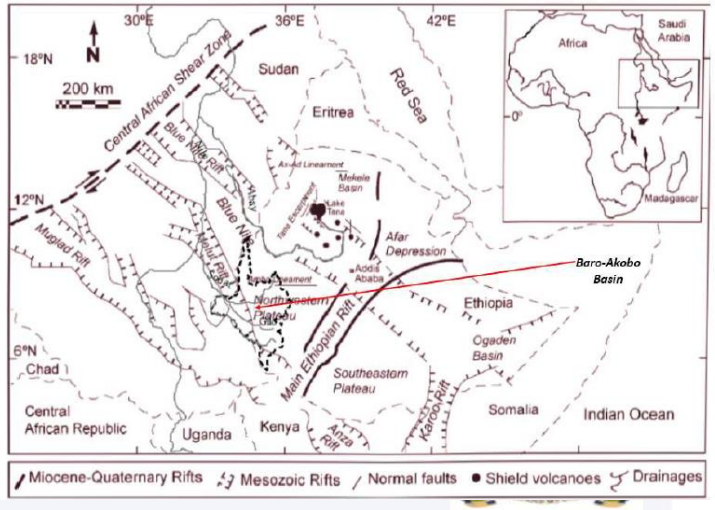
Characteristics of Shared Aquifers in the Horn of African (HoA)

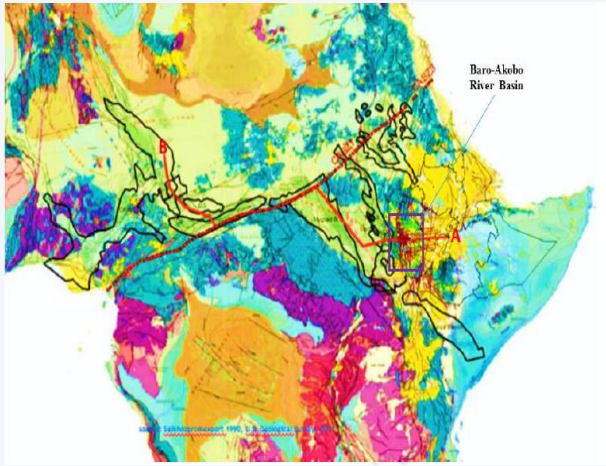
- The Horn of Africa countries almost have a common water resources.
- Similar to the surface water resources, where about 97% is outflowing, the groundwater also flow out radially to the neighboring countries from Ethiopia.
- Sharp drop and complete disappearance of perennial flows are observed along rivers flows as they pass through the various geo-structural and hydrogeological regimes.
- This work is aimed to characterize the Baro - Akobo sub-basin of Nile River and determine trans-basin flow as part of the whole system.

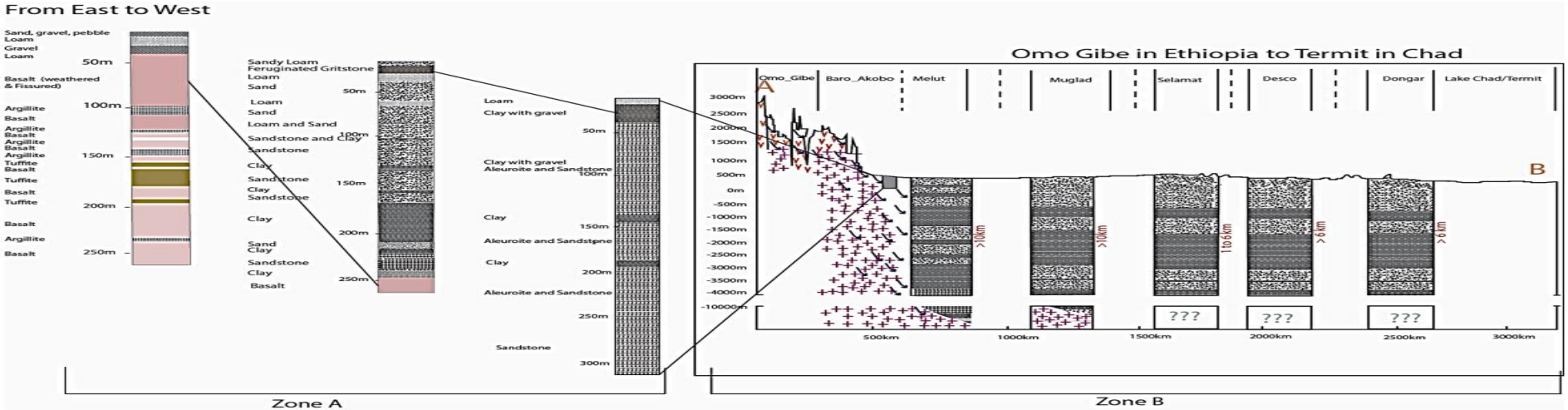




Characteristics of Shared Aquifers in the HoA

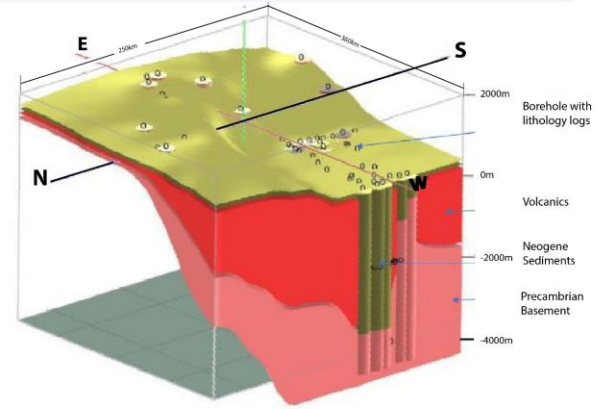
- Groundwater investigations and research works are mostly localized and bounded by boundaries
  - This made the knowledge we have on regional connectives limited
  - Influence of the regional structures such as CASZ, Anza, Melut, Muglad, Karoo, Blue Nile Rifts and the African Mesozoic Rift, the red sea and Aden Fault systems on the flow system and nature of the water are barely known.
  - The configuration of regional aquifers and the general gradient of the lower floor (The basement) are not yet well understood & constructed
  - This may lead to the development of inadequate GWRM strategy and action plan
- This work is aimed to touch around this issues taking the Baro - Akobo sub-basin of Nile River as a case.





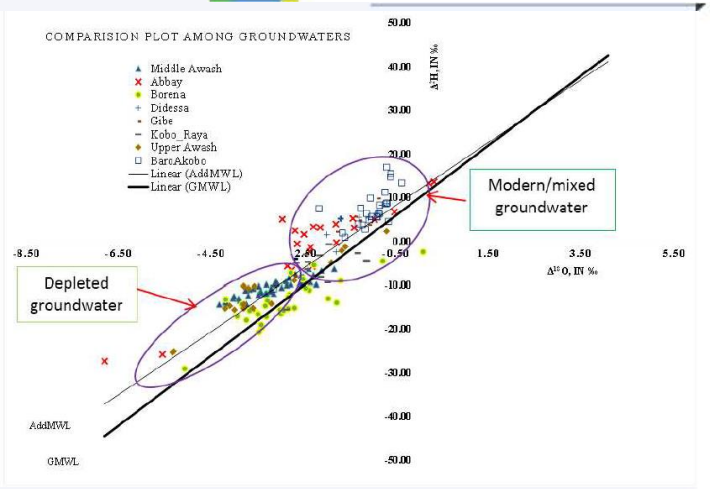
Methods

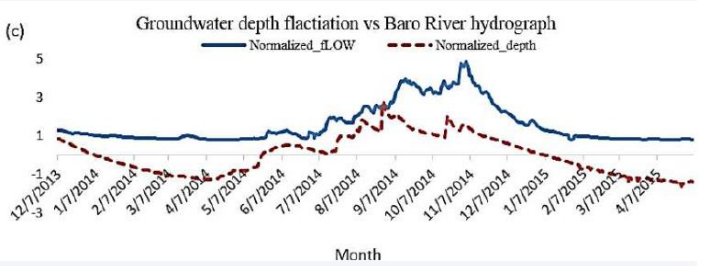
- Review of existing regional studies, geological and structural, and remote sensing methods including optical, thermal, and microwave RS were used to study the regional connectivity.
- Hydrogeochemical and isotope (stable and radioactive) methods were employed to determine regional and local hydrogeology and characteristics of the basin.
- Well monitoring - stream flow measurement and water balance and water budget methods were used to characterize surface flow pattern
- A total of 363 samples from wells, springs, rivers, lakes, swamps, and rain were collected for this study and an additional 270 water quality data sets were added from previous studies.
- These data were analyzed for their hydrogeochemical characteristics and isotope signatures.

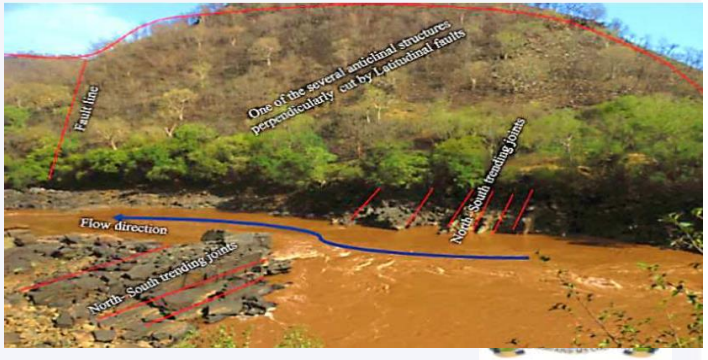


Results

- Among all basins in Ethiopia, the Baro-Akobo basin shows the highest enrichment. This indicate the proximity of the rainfall sources, which presumably are the Sud and other wetlands in South Sudan.
- The hydrochemical properties of the waters show evapotranspiration is the dominant hydrologic process in the basin and explains the large amount of water that is lost in the lowland plain.
- Analysis of Radon-222 shows no significant groundwater flux over the wetlands; which are part of Machar Marshes. This shows evaporation to be dominant hydrological process in this zone.
- Results from all analyses help explain that the wetland has poor groundwater potential and recharge rate due to the extensive clay cover and the loss of the bulk of the groundwaters through the regional geological structures to the deep seated continental sediments, presumably reaching the hydraulically connected African Mesozoic Rifts; mainly Melut and Muglad.
- The deep underground northward flow, along Nile River, is retarded by Central African Shear Zone in the Sudan.
- Findings also explain the reason for the deep Neogene sediments to be commonly dry and the limited retention capacity of the aquifers of the West Ethiopian Plateau.
- Analysis of the oxygen, deuterium and tritium isotopes show the groundwater of the basin to be modern water.

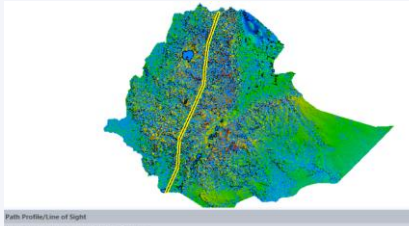


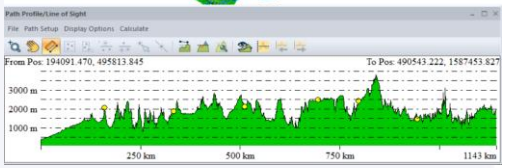


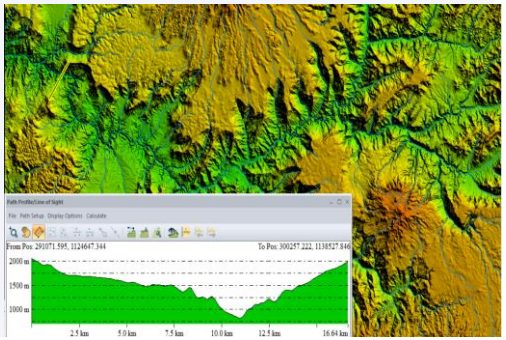


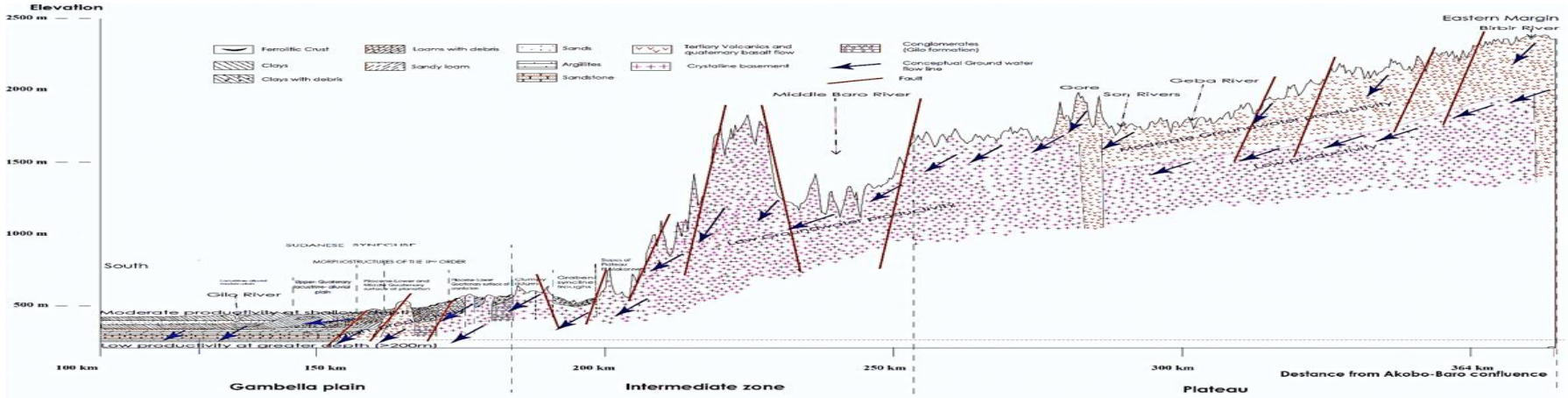
Conclusions & Recommendations

- Folds, faults, joints and lateral and vertical lithologic variations play major role in shaping the hydrologic nature of the basin and the hydrogeology of the aquifers of HoA. The strong structural and litho-stratigraphic controls are observed on the drainage and flow patterns; while the varying hydrographic signatures of each sub-basin shows the prevailing eco-hydrological conditions and the varying stress level on them.
- The HoA is a hydrologically, hydrogeologically and agroecologically connected system:
  - Huge reservoir development capacity in upstream countries, to help catch the waters disappearing into the greater depths,
  - Extensive arable/irrigable land in the water stressed downstream countries,
  - Common challenges of drought and other natural calamities
- Joint management and planning are required to make use of the disappearing huge amount of the groundwater resource.









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THANK YOU!