GAEC GSSTI

Monitoring Groundwater Using GRACE Data in Northern Ghana.

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Introduction

Groundwater storage depletion occurs when discharge exceeds recharge.

Although climate variability and climate change can play a role, most cases of long-term groundwater storage depletion result from intensive abstraction.

Groundwater potential is an essential marker of water security during the periods of drought

Main Uses of Groundwater




Background

Population growth and economic development have dramatically increased the demand for food and water

The r**esulting expansion of agriculture** into areas with limited precipitation and surface water has greatly increased the reliance on groundwater irrigation.

Urban groundwater use has risen exponentially to meet the ever-increasing population growth of mega-cities

Problem

- These trends have resulted in a **dramatic rise in groundwater pumping** and **associated high rates of aquifer depletion** around the globe.

- The **depletion of our world's aquifers** is **unsustainable** and will eventually impact the **food security** of future generations.

Question ?

Extractable volumes and depletion horizons by answering the obvious question that has been avoided thus far:

How much groundwater is there and how long will it last?

Approach

Groundwater Storage Depletion

- Gravity Recovery and Climate Experiment (GRACE)
- Numerical Modeling of aquifer storage using MODFLOW
- Groundwater Monitoring

Using the GRACE TWS along with model-based hydrologic components, groundwater can be estimated.

Monitoring Groundwater

- Traditionally, water wells are used for monitoring groundwater levels..
- There are no direct measurements of groundwater from remote sensing observations.
- Measurements from GRACE and GRACE-FO satellites have been used to estimate monthly, total surface, and groundwater depth since 2002 at a resolution of ~150,000 km^2.
- These measurements are used to derive global, large-scale groundwater distribution by using additional hydrological information.

Gravity Recovery and Climate Experiment (GRACE)

- ASA's GRACE mission provides the first opportunity to directly measure groundwater changes from space. By observing changes in the Earth's gravity field, scientists can estimate changes in the amount of water stored in a region, which cause changes in gravity.

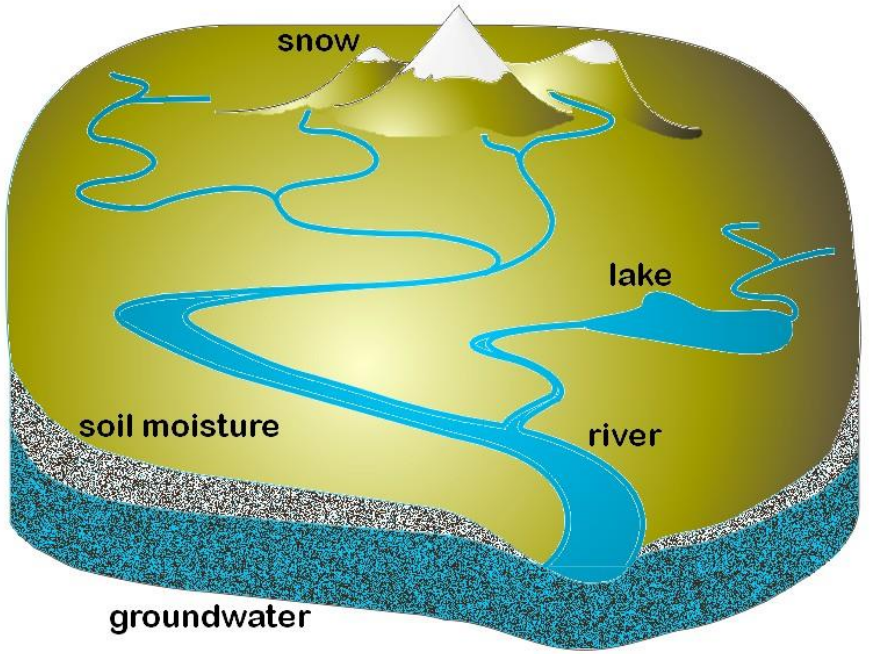
- GRACE provides a more than 10 year-long data record for scientific analysis. This makes a huge difference for scientists and water managers who want to understand trends in how our resources are being consumed over the long term.

Terrestrial Water to Groundwater

$P - ET - Q = \Delta TWS$ [terrestrial water balance]

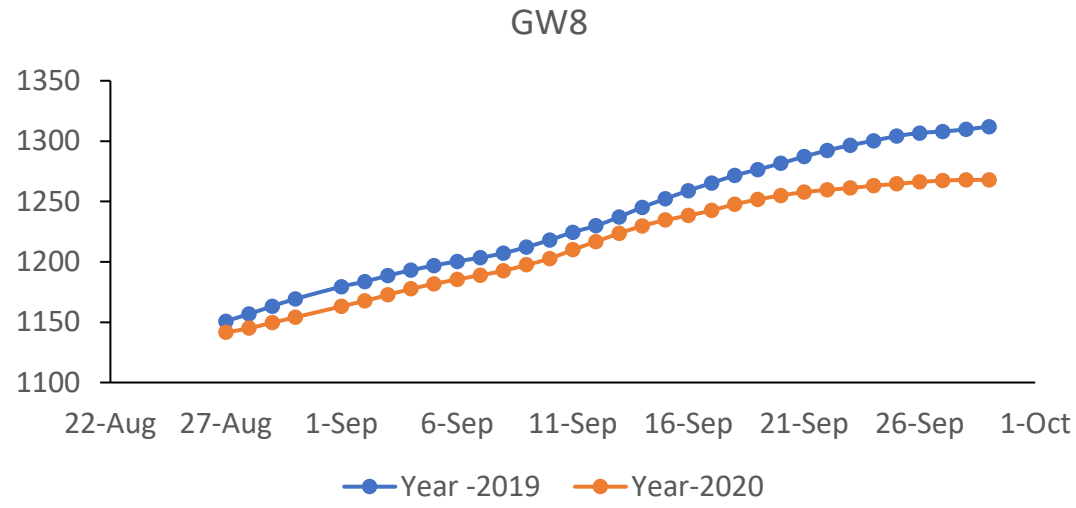
$\Delta TWS = \Delta GW + \Delta SM + \Delta SWE + \Delta SW$

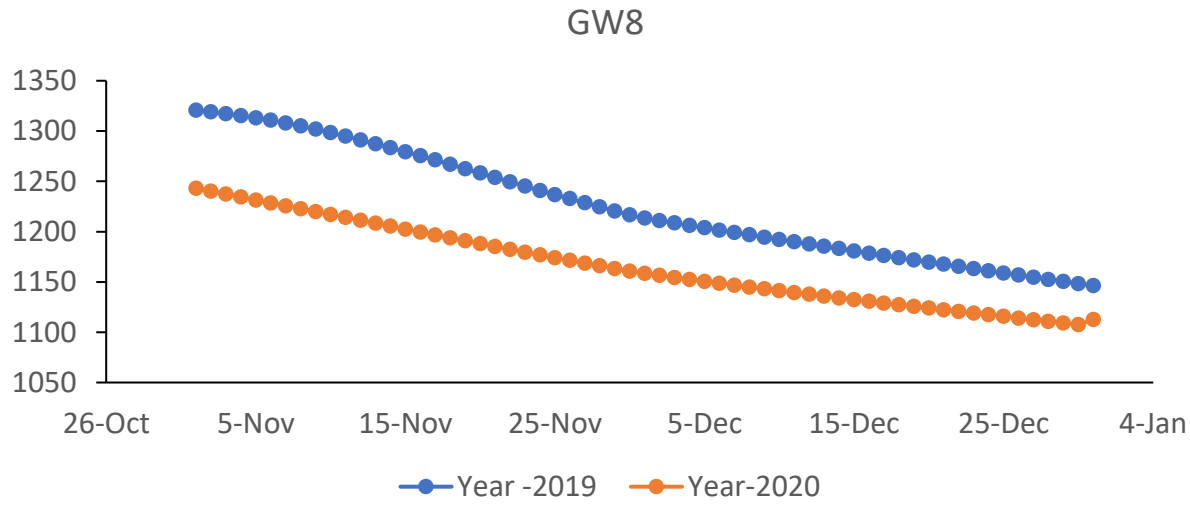
$\mathbf{\Delta GW = \Delta TWS - \Delta SM - \Delta SWE - \Delta SW}$

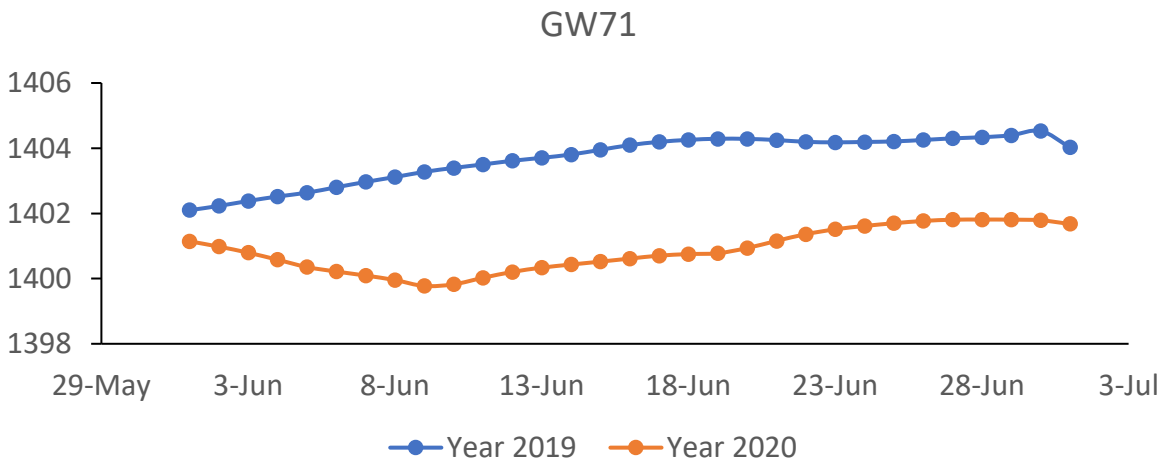


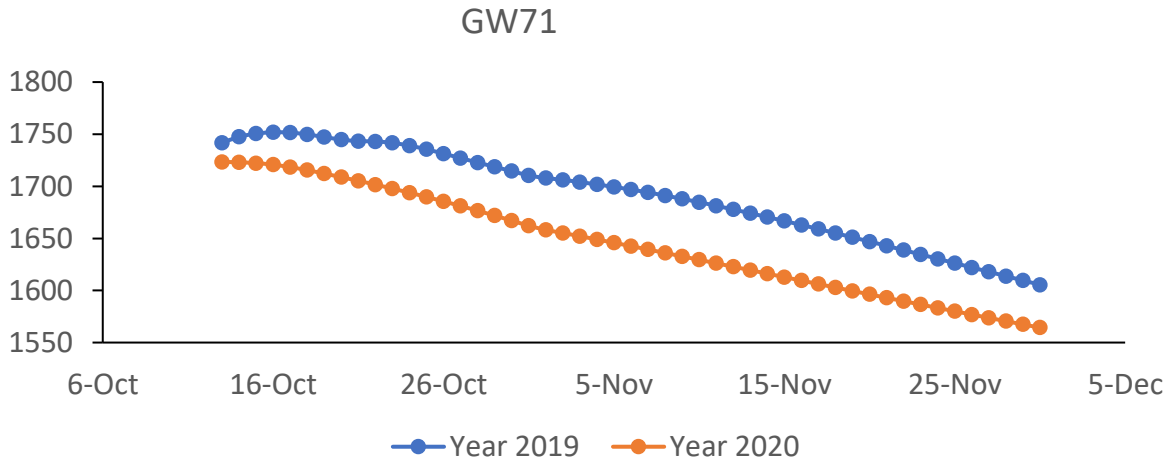
- P = precipitation
- ET = evapotranspiration
- Q = river discharge
- **ΔTWS** = **change in terrestrial water storage [from GRACE]**
- ΔGW = change in groundwater storage [unknown]
- ΔSM = change in soil moisture ΔSWE = change in snow water equivalent
- ΔSW = change in surface water storage
- [ΔGW, ΔSM, ΔSW from Global Land Data Assimilation System (GLDAS) models]

Grace Data Estimations at Monitoring Locations

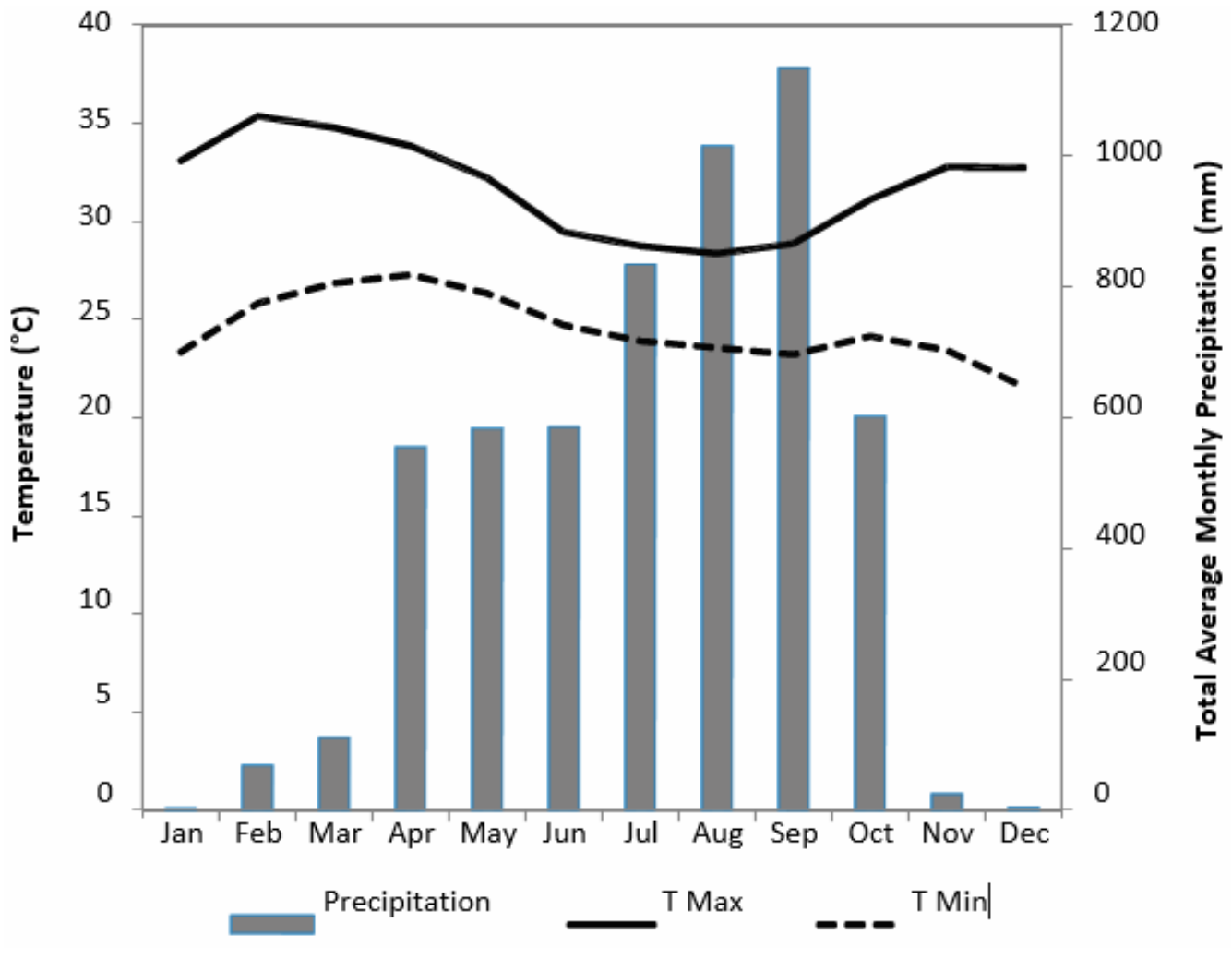




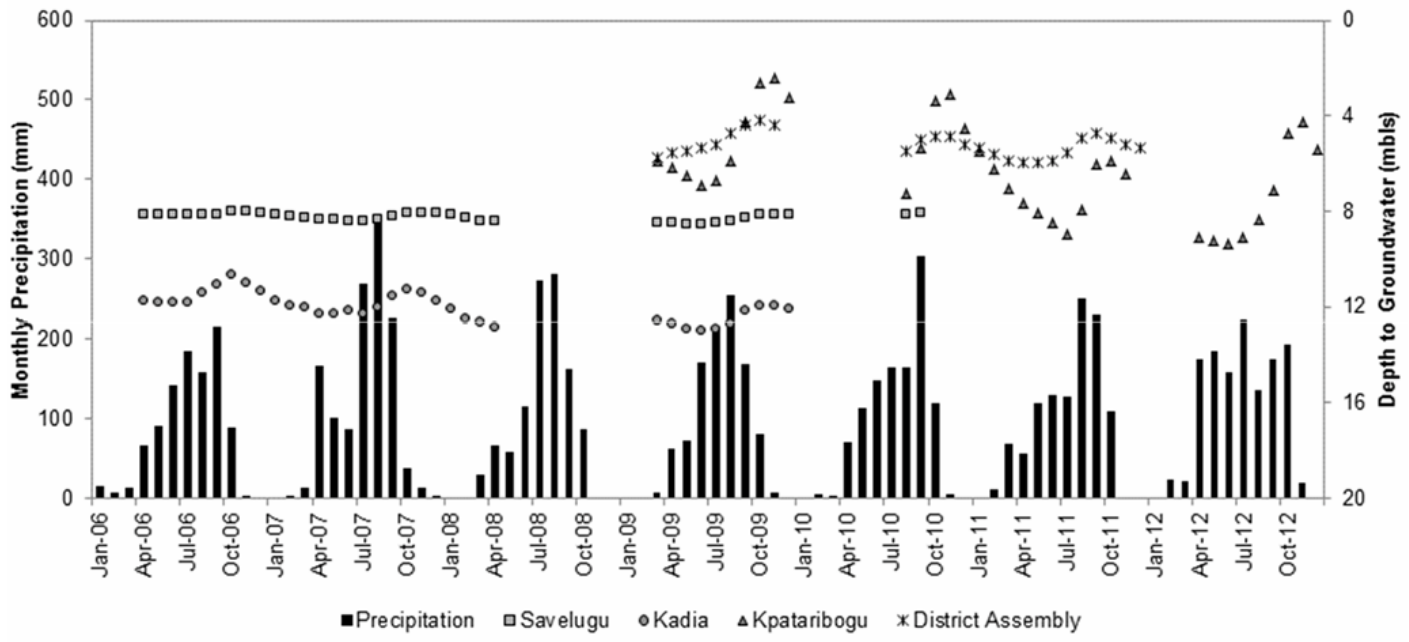




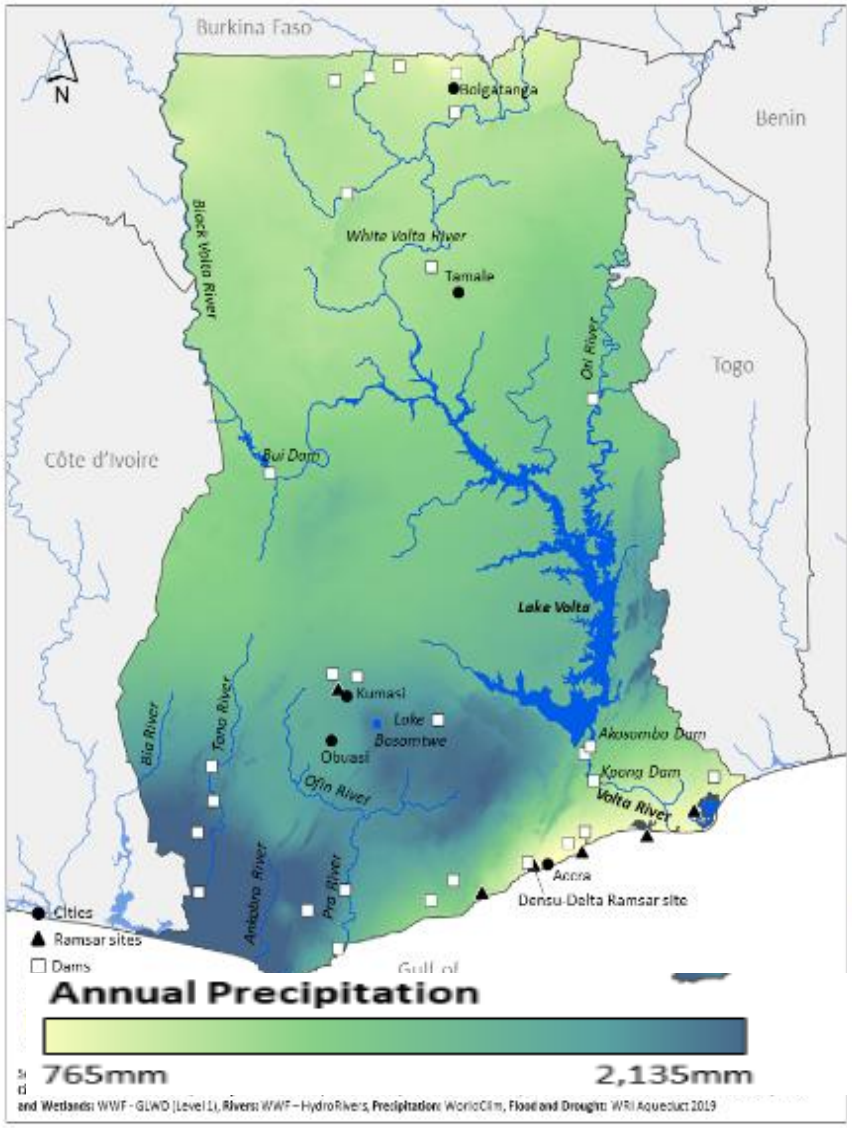
Average monthly precipitation, minimum temperature (T Min), and maximum temperature (T Max) for the study area

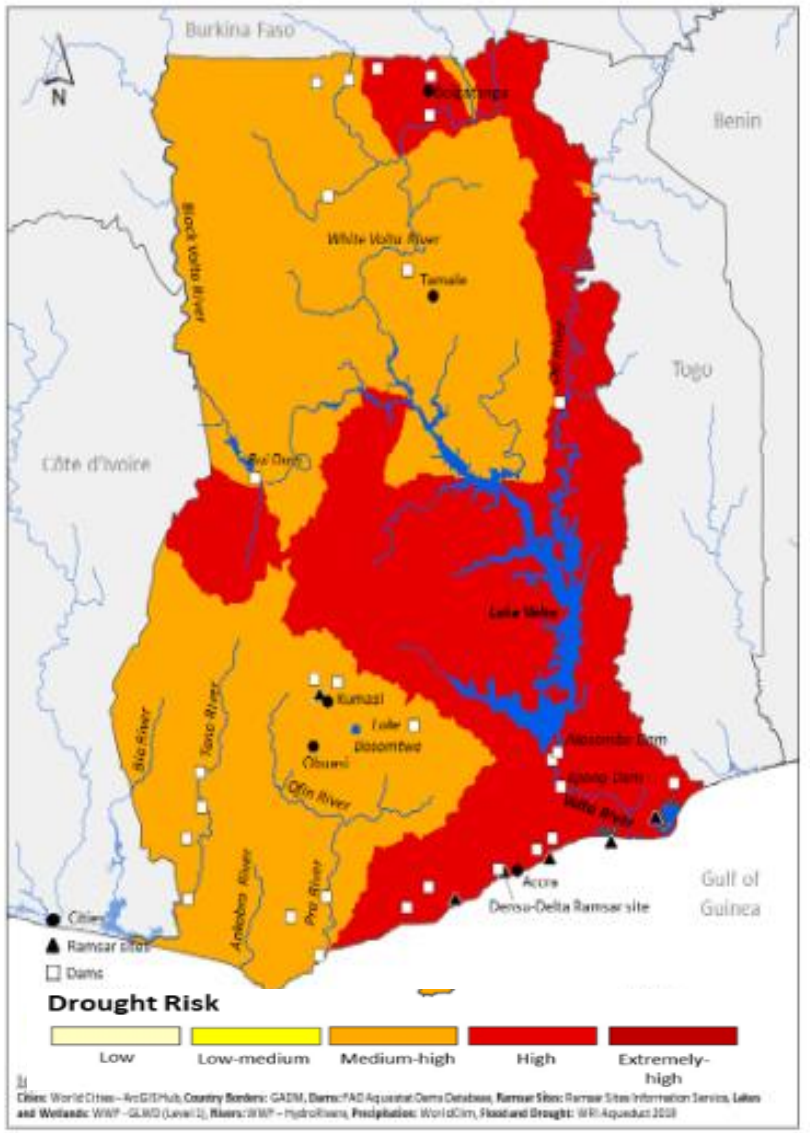


Average monthly precipitation (mm) and groundwater level response measured in meters below land surface (mbls) at the study sites.

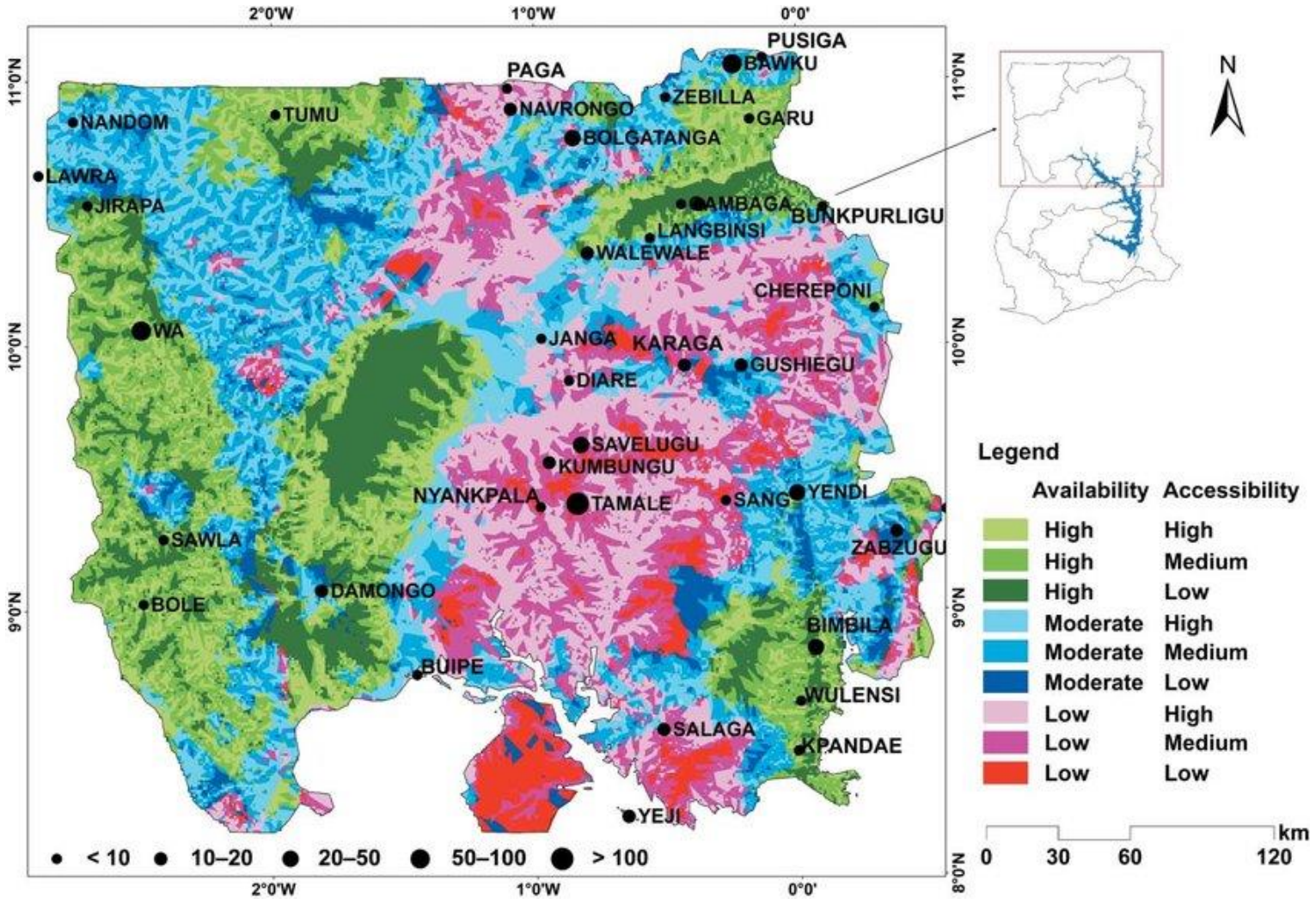


Annual Precipitation and Drought





Groundwater development potential map of Northern Ghana.



Conclusions

- Overall understanding of the general trends of groundwater depletion within the study region using GRACE
- Model Aquifer Storage using the finite-difference code, MODFLOW.
- Modified model was used for prediction simulation, and parameter scenario analysis.

Thank You

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