Leveraging Earth Observations and Machine Learning for Sustainable Groundwater Management

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West Africa Project Objectives

Assist stakeholders and water managers in West Africa to assess, characterize, and sustainably manage groundwater resources for economic development and drought resilience.

Focus areas/deliverables:

1) GRACE regional subsetting tool
2) Groundwater Data Mapping application
3) Regional groundwater model development
GRACE Water Storage Anomaly
Calculating Groundwater

**GRACE**
Total Water Storage Anom.

**GLDAS**
Total Surface Water Storage Anom.

**GLDAS**
Total Soil Moisture Storage Anom

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Total Groundwater Storage Anomaly
GRACE Data Visualization Application
Regional Subsetting Analysis
Groundwater Data Mapping App

- Water Level Measurements
- Time and Space Interpolation Algorithms
- Well Locations
- Earth Observations
Temporally Sporadic Data

- Well Time series often include large gaps in collected data.

- Some wells may only have data for one or two years.
Correlation with Earth Observations

Depth to Water Table [m]

GLDAS
Soil Moisture Storage Anomaly [cm]

Rapid Rise
Decline

Drought Period
Wet Year

Decline
Drought Period
Earth Observations

- Palmer Drought Severity Index (PDSI)
- Global Land Data Assimilation (GLDAS) Root Zone Soil Moisture
- Climate Prediction Center (CPC) Soil Moisture
- Gravity Recovery and Climate Experiment (GRACE) Total Water Storage
Extreme Learning Machine

\[ \bar{Y} = W_2 \sigma(W_1 X + \bar{b}) \]

\[ \sigma(x) = \max(0, x) \]
Extrapolation

Cedar Valley Aquifer
Utah, USA
Imputation

Cedar Valley Aquifer
Utah, USA
For selected aquifers, the app allows the users to create raster animations using machine learning algorithm. This illustrates how groundwater levels are changing over time.
By comparing rasters of groundwater elevations over time, we can compute a plot illustrating cumulative change in groundwater storage vs time.

This allows water managers to assess if groundwater resources are being used sustainably.
Geospatial Information Tools for Sustainable Groundwater Management in West Africa

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The project is funded by the NASA SERVIR program. The objective of the SERVIR program is to assist developing countries in using Earth Observations to assess, analyze, and sustainably manage natural resources and to improve lives. SERVIR works with a set of regional "hubs" serving more than 30 countries. These hubs are located in Amazonia, West Africa, East and Southern Africa, Hindu Kush Himalaya, and Mekong. Every three years NASA forms an Applied Science Team that works with the regional hub to deliver science, data, training. Our project was funded in October, 2019 and will continue through October, 2022. We are working in Ghana, and Senegal. The hub is headquartered in an organization called AGRHYMET, located in Senegal and funded by USAID.

The objective is this website is to provide a repository of information, links, training materials and other resources related to this project.

http://hydroinf.groups.et.byu.net/servir-wa/
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