Applications of Remote Sensing Hydrology in Data-poor regions: Case study Nile Basin, Africa.

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Nile Basin (FACTS)

- Lifeline for more than 300 million people, belonging to 11 African nations.
- Covers an area of about 1.3 million Square miles.
- The Basin receives the majority of the water from rainfalls.
- Main hydrologic systems: White Nile and the Blue Nile that Connecting to form the River Nile.
- Has a large Latitudinal extent.
Nile Basin (Latitudinal extent)
Nile Basin (Latitudinal extent)
Nile Basin (Latitudinal extent)
(Challenges)

- Insufficient real time ground-based hydrologic datasets.
- Issues in the quality of the available ground based datasets.
- The institutional bureaucracies.

- Meanwhile the available data from remote sensing and model reanalysis have uncertainties and errors.
Challenge Question?

- So, Under the current changing climate conditions and insufficient ground information:

- TO WHAT extent the available Remote Sensing, and Model reanalysis datasets can substitute the lake of ground information, and help to understand the state of water resources along the Nile Basin?

- In otherward, how reliable we can use Remote sensing data in water resources applications?
Datasets

- Remote Sensing Data (recorded by on board sensors).
- Model Reanalysis Data (produced by hydrologic models).
- In situ Data (by meteorological and gauging stations).

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HyDrometeorology and RemOte Sensing Laboratory (hydro.ou.edu)
Optimum goal

**Graphical Flowchart:**

- **GRACE Level3:** TWS
- **GLDAS:** SM/SWE, PAR
- **Monthly-ET**
- **GPCC Rainfall**
- **GHNC-M Temp**
- **MODIS-VI/LSWI/LST/GPP**
- **DEM/GWL**

**Nodes:**
- ΔTWS
- ΔSM/ΔSWE
- ΔGW
- Historical Trend Analysis
- MV/LULC changes
- Drainage Net
- SR
- MRA/ΔWS
- DHMS + SDM
- Basin Vulnerability

**Abbreviations:**
- ΔTWS: Δ Total Water Storage.
- ΔSM: Δ Soil Moisture.
- ΔSWE: Δ Snow water Equivalent
- ΔGWL: Δ Ground Water Level
- ΔWS: Δ Water Storage
- MRA: Multiple Regression Analysis.
- ET: Evapotranspiration data.
- GPCC: Global Precipitation Climatology Centre data.
- GHNC-M: Global Historical Climatology Network.
- VI: Vegetation Indices.
- MV/LULC: Meteorological Variability/Land Use Land Cover.
- LSWI: Land Soil Water Index.
- GPP: Growth Primary Production
- DEM: Digital Elevation Model
- SR: Surface Runoff.
- DHMS: Distributed Hydrologic Modeling System
- SDM: Spatial Data Modeler

**Website:** [HyDrometeorology and RemOte Sensing Laboratory (hydro.ou.edu)](http://hydro.ou.edu)
The two satellites measure the spatial and temporal variations in the Earth’s gravity field according to the changes in their traveling distance (Wahr, 2004).
Objectives

ΔTWS: Δ Total Water Storage.
WET: Water Equivalent Thickness.
LC: Land Cover.
LST: Land surface Temperature.
VI: Vegetation Indices.
PRE: Precipitation.
ET: Evapotranspiration.
ST: Surface Temp
GHNC-M: Global Historical Climatology Network Monthly.
GPCC: Global Precipitation Climatology Centre data.
GRDC: Global Runoff Data Centre.
Objectives

• We understand all these datasets can produce nicely estimates, but how reliable these estimates are?
Methodology

• Instead of using the two-D regular linear regression model between two variables.
• What if we can model these multiple variables in multi dimensional space?
• Generalized Additive Model for Location, Scale and Shape (GAMLSS) model
Methodology

- GAMLESS Model

\[ f(R_{\text{ref}} | \mu, \sigma) = \frac{1}{R_{\text{ref}} \sqrt{2\pi}\sigma} e^{-\frac{(\ln R_{\text{ref}} - \mu)^2}{2\sigma^2}} \]

\[ R^2 = 0.82 \]
Methodology

- Model 8 using the input from all sources even we included the energy balance variables as well.
Results

![Graph showing TWS metrics over time](image-url)
Results
Conclusion

• The Nile Basin is one of largest basins that contains the longest river.
• We deployed RS and model reanalysis data to understand the variability in the water resources in the Nile Basin region.
• Using SRA to detect the inter-annual variability of the water resources.
• The GAMLSS approach was used to test the correlation between the TWS and the other climatic variables
• RS and model reanalysis data for water trend detection in the region can be utilized to understand the water resources variability in the region.
Thank You!

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