EGU General Assembly 2024

EGU24-971, updated on 04 Oct 2024
https://doi.org/10.5194/egusphere-egu24-971
EGU General Assembly 2024

Terrestrial Water Storage Reconstruction: A Causal Inference Approach

Vivek Kumar Yadav[1] and Bramha Dutt Vishwakarma[1,2]
[1]Indian Institute of Science, Interdisciplinary Centre for Water Research, India (viveky@iisc.ac.in)
[2]Centre for Earth Sciences, Indian Institute of Science, Bengaluru, India (bramha@iisc.ac.in)

The water availability in a region is driven by the water cycle, which is changing quickly in response to climate change and direct human interventions. The water cycle is defined and controlled by the variation in water fluxes such as Precipitation (P), Evapotranspiration (Et), Runoff (R), and Storage change (ΔS). Out of these water fluxes, ΔS is a key variable for ecosystem habitability and surviving droughts. It is an important parameter in drafting water management policy, but due to lack of long and reliable data the impact of climate change on ΔS is yet to be understood. The only Global observations of Terrestrial water storage (TWS) are available from GRACE satellite mission since 2002 at monthly scale.

Although GRACE data has transformed hydrological science significantly, its short time series limits usage of GRACE for climate change analysis of hydrological fluxes (closing the multidecadal water budget and sea level budget, understanding the spatiotemporal evolution of water availability, and so on). To tackle this, several studies have attempted reconstructing ΔS prior to GRACE period. These studies employ either hydrological modelling of ΔS, statistical regression, or machine learning techniques. While machine learning methods have been assessed superior, they suffer from issues such as a lack of explainability, failure to identify causal drivers of TWS change, and use of short time series for feature extraction and training leading to poor or no representation of decadal natural variability.

Furthermore, in all the studies till now, representation of local human activities, such as ground water extraction or reservoir operation, was either absent or assumed to be a linear trend. Here we revisit a reconstruction method by Humphrey et al., 2017 and show that these approximations have a considerable impact on the quality of reconstruction. Then we propose a multivariate regression model that relates selected hydrometeorological variables with TWS. These variables are identified from causal analysis of JULES model outputs. We show that temperature has a very weak relation with TWS compared to precipitation. The causal inference based model is able to capture realistic variability in reconstructed TWS. Our TWS reconstruction for the Ganges basin outperforms the contemporary attempts and is able to identify the drivers for interannual changes in TWS . The results bring historical perspective to the current state of water resources in the basin and provide context for design of future water resources policy.