Abstract

Groundwater plays a significant role in human adaptation and ecological sustainability by providing global water and food security. Despite numerous studies in recent times, there has been no agreement on the primary drivers on groundwater quantity changes over South Asia. Thus, predicting future groundwater trends seems remote. Using various data sources (in-situ well observations with screen depth information, satellite-derived groundwater storage and vegetation, global hydrology model-based groundwater recharge (GWR) and groundwater withdrawal (GWW), meteorological variables and few others; between 1985-2018) and methods (Artificial intelligence (AI), statistical, and numerical) this thesis aims to evaluate the relative importance of natural and human-induced drivers influencing groundwater quantity, develop the most suitable AI-based prediction models and finally estimate the future groundwater quantity in parts of South Asia. The findings highlight the variable response between groundwater levels (GWL) and climate depending on the aquifer depth and influence of climatic and anthropogenic drivers in different parts of the Indus-Ganges-Brahmaputra-Meghna (IGBM) basin aquifer of South Asia. Furthermore, the findings also show the dominance of GWW in most of the study area, particularly at the greater depth of the aquifer. Moreover, in the most exploited areas, the hydrological processes governing the groundwater recharge are overwhelmed by unsustainable GWW, thus decoupling the hydro-climatic continuum. The spatio-temporal and depth-wise variability of AI-based model performances suggests good prediction of GWLs across most of the study area. Furthermore, it is found that satellite derived GWS and vegetation data can be used as a potential predictor for GWLs. The results also suggest that long short-term memory network (LSTM) and support vector machine (SVM) performs better than feed-forward neural network (FNN), recurrent neural network (RNN) in predicting GWLs. Finally, the deep learning-based future estimates (2019-2023) suggests higher future declining five-year trends in parts of north-central and south India, besides the prevailing long-term statistically significant ($p<0.1$) declining GWL trends in northwest India and Ganges basin. The application and analysis proposed in this study can be employed as an operational tool for efficient and intelligent management and monitoring of groundwater resources.

Keywords: *South Asia; Indus-Ganges-Brahmaputra-Meghna (IGBM) basin aquifer; Artificial Intelligence, Groundwater quantity prediction, Climate variability; Anthropogenic influences; Hydrogeology*

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