Abstract

The Indian Sub-Continent (ISC), which hosts the largest and densest global population, faces acute shortage of mostly drinking water and other usable waters as it is witnessing rapid rise in population, urbanization, and change in societal water use and lifestyle. The work of this thesis, aims to delineate the groundwater resources across the parts of the ISC, ranging from its quantification to its controlling factors. The study delves into the details of groundwater recharge, storage (GWS) change, it's possible estimation using other parameters (i.e. vegetation data), spatio-temporal variability of groundwater storage, and also the effect of water management strategies on groundwater storage in ISC using *in situ*, satellite-based and numerical model simulations. Groundwater recharge estimated from *in situ* groundwater levels exhibit comparatively higher values (>300 mm/yr) over the intensively irrigated alluvial plains of the Indus-Ganges-Brahmaputra (IGB) river system. High precipitation rates along with a combination of favorable hydrogeologic properties of the unconsolidated alluvial deposits and intensive irrigation in the IGB promote recharge. Most of the regions in the central and southern ISC experience comparatively lower recharge (<200 mm/yr) as a result of comparatively lower precipitation, less permeable surface geology, and less-intensive irrigation. *In situ* GWS anomaly data indicate renewal of GWS in western and southern ISC at a rate of 1.06±0.03, and 0.31±0.02 km^3/year in 1996-2014, on the other hand, the northern and eastern ISC have been subjected to rapid GWS depletion at a rate of -4.55±0.11 km^3/year and -3.59±0.14 km^3/year in 1996-2014, respectively. Satellite-based GWS anomaly shows GWS depletion in the northern and eastern ISC with rates of -14.02±1.37 km^3/year and -14.49±4.36 km^3/year, respectively, in 2003-2014. It is also found that, the spatial variability of groundwater storage anomalies are influenced by well spacing. A positive linear relationship does exist between the logarithm of spatial variability in GWS anomaly and the logarithm of spatial extent. Based on the outputs of robust statistical applications along with simulating the effects of water management policy changes, it is found that the GWS has been replenished due to application of proper water resource management practices in parts of the ISC.

Keywords: *Indian Sub-Continent; Groundwater recharge; Groundwater storage; Groundwater management policy; Hydrogeology*