

Long-term groundwater storage changes and land subsidence development in the North China Plain (1971-2015)

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The North China Plain (NCP) has been suffering from groundwater storage (GWS) depletion and land subsidence for a long period. This paper collects data of GWS changes and land subsidence from in situ groundwater-level measurements, literature, and satellite observations to provide an overview of the evolution of the aquifer system during 1971-2015 with a focus on the sub-regional variations. It is found that the GWS shows a prolonged declining rate of -17.8 ± 0.1 mm/yr during 1971-2015, with a negative (positive) correlation to groundwater abstraction before (after) 2000s. Statistical correlations between subsidence rate and GWS anomaly (GWSA), groundwater abstraction, and annual precipitation show that the land subsidence in three sub-regions (Beijing, Tianjin, and Hebei) represents different temporal variations due to varying driven factors. Continuous drought caused intensive GWS depletion (-76.1 ± 6.5 mm/yr) and land subsidence in Beijing during 1999-2012. Negative correlations between total groundwater abstraction and land subsidence exhibited after 1980s indicating that it may be questionable to infer subsidence from regional abstraction data. Instead, the GWSA generally provides a reliable correlation with subsidence. This study highlights the spatio-temporal variabilities of GWS depletion and land subsidence in the NCP under natural and anthropogenic impacts.

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