EGU21-9340
https://doi.org/10.5194/egusphere-egu21-9340
EGU General Assembly 2021

Investigation of present-day ground displacement in Taiyuan basin by InSAR in the context of interbasin water transfer project

Wei Tang[1], Xiangjun Zhao[1], Gang Bi[2], Jing Li[1], Mahdi Motagh[3,4], Mingjie Chen[1], and Hua Chen[5]
[1]China University of Mining & Technology,Beijing, College of Geoscience and Surveying Engineering, Surveying, China (weitang@cumtb.edu.cn)
[2]Shanxi Institute of Surveying, Mapping and Geoinformation, Taiyuan, China
[3]GFZ German Research Centre for Geosciences, Geodesy, Potsdam, Germany
[4]Institute of Photogrammetry and GeoInformation, Leibniz University Hannover, Hannover, Germany
[5]School of Geodesy and Geomatics, Wuhan University, Wuhan, China

Located in the middle of Shanxi Province, northern China, Taiyuan basin is a dry and water-short region. This region is reaching alarming levels of aquifer depletion due to decades of groundwater overexploitation, which has caused severe land subsidence in the basin. The Wanjiazhai Water Diversion Project (WWDP) was designed to ease water scarcity by transporting water from the Yellow River to the Taiyuan basin through 452.4 km-long canals. By the end of 2018, the WWDP had supplied 2.87 billion m^3 of water to Shanxi Province, which replenish the basin's surface water body as well as the underground aquifer. The groundwater levels have continued to rise since 2003, with rising levels of more than 70 meters by 2018 in comparison with its low stand in 2000.

In this study, we use 2007-2010 ENVISAT, ALOS-1 data, and 2017-2020 Sentinel-1 data to study the response of the basin's aquifer to the groundwater rebound against the background of the water transfer project. We addressed the issue of tropospheric delay and its impact on the seasonal deformation by combing GACOS (Generic Atmospheric Correction Online Service) and a common-point stacking method. The accuracy improvement of deformation by this correction method was validated with measurements from seven continuous GPS stations in the basin. Groundwater rebound triggers ground uplift, which was identified in five areas by InSAR with a rate up to 25 mm/yr. The uplifting displacement time series are well correlated with groundwater level recovery. The land subsidence in the south of the basin continues but the rates decreased significantly in 2017-2020 detected from Sentinel-1 as compared to that in period 2007-2010 from ENVISAT and ALOS-1. All these uplifting signals and the decreasing rates of land subsidence found in Taiyuan city provide the indication that water management practices are successful in mitigating further subsidence.

We found a significant seasonal displacement concentrated within the central region of the basin corresponding to the main irrigated areas in the Taiyuan basin. The maximum peak-to-peak amplitude is 43 mm observed from ENVISAT and decreases to 20 mm observed from Sentinel-1. The seasonal amplitudes change rapidly across faults, indicating that the fault is an effective barrier to across-fault fluid flow. To further quantify the causal relationships between water level

and ground displacement, groundwater levels and ground displacement at three wells located near the area affected by significant seasonal land subsidence are analyzed by Cross Wavelet Transform (XWT) method. We found the time lags of about one month between land subsidence and the forcing groundwater level declines. Such a cross wavelet analysis with high spatial-temporal resolution therefore enables tracking the health of the aquifer system and highlights the system's sustainability in aiding water resources allocation against the background of the water diversion project.