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Impacts of water resources management on the North China Plain revealed in multi-mission earth observation datasets

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The natural conditions of surface water bodies and groundwater aquifers in many densely populated river basins have been altered in order to satisfy various human water demands, such as drinking water supply, irrigation, power generation and navigation. The North China Plain (NCP) accounts for about 24% of the country's population, and the huge water demand makes it one of the regions with the strongest artificial intervention in the water cycle. China has promoted the South-to-North Water Diversion (SNWD), which diverts surplus water from the Yangtze River Basin to the water-deficient North. Since the central line project of SNWD has become fully operational in 2014, more than 16 km^3 of water have been supplied to the NCP, which has had a significant impact on water resources in the regions along the route. Monitoring the recent dynamics of surface and sub-surface water storage is essential for water resources management and sustainable use of ongoing and forthcoming SNWD water transfers. Multi-mission satellite earth observation methods provide timely and spatially resolved datasets for monitoring inland water bodies, which have been validated over the last two decades. In this study, first, we evaluate the influence of SNWD on the Terrestrial Water Storage (TWS) monitored by the Gravity Recovery and Climate Experiment (GRACE) and its follow-on mission (GRACE-FO) over the NCP. The results indicate that the significant downward trend during 2002 – 2014 period, has stopped in the past 5 years, since the implementation of the central line project of SNWD. Second, Sentinel-3 radar altimetry and Sentinel-1 SAR missions were used to monitor the water surface extent and water surface elevation of surface water bodies. Sentinel-1 with its newly available Synthetic Aperture Radar (SAR), high spatial resolution and short temporal baselines shows potential for monitoring surface water area variations. Sentinel-3 benefits from the new Sentinel Ku/C Radar Altimeter (SRAL) and a modified on-board tracking system and shows great potential for monitoring inland water surface elevation (WSE) variations for several large and medium reservoirs and canals in this region. We show that, along with other policy measures, the SNWD transfers have had a significant impact on the water balance of the NCP region as evident from multiple satellite earth observation missions.