The potential of GRACE gravimetry to detect fast impoundment of a small reservoir in the upper Yellow River

*Shuang Yi[1], Chunqiao Song[2], Qiuyu Wang[4], Linsong Wang[3], Kosuke Heki[1], Wenke Sun[4]

1. Dept. Natural History Sciences, Faculty of Science, Hokkaido University, 2. Department of Geography, University of California, Los Angeles, Los Angeles, CA90095, United States, 3. Institute of Geophysics and Geomatics, China University of Geosciences, Wuhan, Hubei, China, 4. Key Laboratory of Computational Geodynamics, University of Chinese Academy of Sciences, Beijing 100049, China;

Artificial reservoirs are important indicators of anthropogenic impacts on environments, but their gravity effects have been seldom studied. Here, satellite gravimetry Gravity Recovery and Climate Experiment (GRACE) is utilized to detect the gravity effect of the Longyangxia Reservoir (LR) situated in the upper stream of the Yellow River. Heavy precipitation in the summer of 2005 caused the LR water storage to increase 37.9 m in height or 13.0 Gt in mass. Three different GRACE solutions from CSR, GFZ and JPL and three different filters (an anisotropic decorrelation filter DDK4, Gaussian filter and a decorrelation filter) are compared here. In this case, CSR solutions have the highest signal-noise-ratio and DDK4 shows the best ability to reveal the expected gravity signals. We obtained 109 combinations of inundation area measurements from satellite imagery and water level changes from laser altimetry and in situ observations to derive the area-height ratios in the LR, which agrees well with an alternative method based on the digital elevation model. After removing simulated gravity signals caused by mass changes in the LR, the root mean square of GRACE series in the LR is reduced by 31.1%. If the residuals are totally attributed to GRACE errors, the standard deviation of GRACE observation in this study spot is estimated to be 3.1 cm. With an area of 383 km^2, the Longyangxia Reservoir is the smallest signal source reported to be detected by GRACE.

Keywords: GRACE, space gravimetry, gravity of reservoirs, time-varying gravity, reservoir impoundment

