The water impoundment in the Three-Gorge Reservoir (TGR) of China represents a huge mass redistribution from oceans onto a concentrated land area in a short period, and is captured by the Gravity Recovery and Climate Experiment (GRACE) unconstrained global solutions at a 400-km spatial resolution after removing correlated errors. The WaterGAP Global Hydrology Model (WGHM) is used to isolate the TGR contribution from regional water storage changes because of its ability to simulate interannual water storage changes like the 2006 drought. For the first time, this study compares the GRACE (minus WGHM)-estimated TGR volume changes with in situ measurements from April 2002 to May 2010 at a monthly time-scale. Overall, GRACE (minus WGHM) residues shows an increasing trend as in TGR in situ measurements during the past decade, and lead to similar estimates of impounded water volume. The GRACE (minus WGHM)-estimated TGR volume changes could explain 76% of in situ measurements with a Mean Absolute Difference (MAD) of 4.75 km$^3$ in the optimum comparison months from October to December, and have an uncertainty of 4.62 km$^3$ (MAD). All large (>10 km$^3$) differences (GRACE-WGHM-TGR) are positive, which are mainly caused by heavy rainfall in summer and snow fall in winter. In both cases, WGHM may underestimate soil moisture and surface snow, leading to overestimate the TGR volume change. Our results also suggest reservoir leakage and groundwater recharge due to TGR full filling and a non negligible contamination by neighboring lakes, the study of which being a worthwhile effort in the future.