Global Hydrology in the Anthropocene

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Abstract :

The real hydrological cycles on the Earth are not natural anymore. Global hydrological model simulations of the water cycle and available water resources should have an ability to consider the effects of human interventions on hydrological cycles. Anthropogenic activity modules, such as reservoir operation, crop growth and water demand in croplands, and environmental flows, were incorporated into a land surface model to form a new model, MAT-HI. Total terrestrial water storages (TWS) in large river basins were estimated using the new model by off-line simulation, and compared with the TWS observed by GRACE for 2002-2007.

MAT-HI was further coupled with a module representing the ground water level fluctuations, and consists a new land surface scheme HiGW-MAT (Human Intervention and Ground Water coupled MATSIRO). HiGW-MAT is also associated with a scheme tracing the origin and flow path with the consideration on the sources of water withdrawal from stream flow, medium-size reservoirs and nonrenewable groundwater in addition to precipitation to croplands which enabled the assessment of the origin of water producing major crops. Areas highly dependent on nonrenewable groundwater are detected in the Pakistan, Bangladesh, Western part of India, north and western parts of China, some regions in the Arabian Peninsula, and the western part of the United States through Mexico. Cumulative nonrenewable groundwater withdrawals estimated by the model are corresponding fairly well with the country statistics of total groundwater withdrawals. Ground water table depletions in large aquifers in US estimated by HiGW-MAT were compared with in-situ observational data, and the correspondences are very good. Mean global exploitation of ground water for 2000 estimated by HiGW-MAT is 360 km3/y as an excess of ground water withdrawal over natural recharge into aquifer.

This unsustainable groundwater use, together with artificial reservoir water impoundment, climate-driven changes in terrestrial water storage and the loss of water from closed basins, could have contributed a sea-level rise of about 0.77mm/y between 1961 and 2003, about 42% of the observed sea-level rise.