Impacts of Global Groundwater Depletion to Regional Hydroclimatology in 37 Major Aquifers

*Pat J.-F. Yeh[1], Chong Zhang[2], MinHui Lo[3], Yoshihide Wada[4], James S. Famiglietti[5]

1. School of Engineering, Monash University, Malaysia, 2. Beijing Normal University, China, 3. Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan, 4. International Institute for Applied Systems Analysis, Laxenburg, Austria, 5. School of Environment and Sustainability and Global Institute for Water Security, University of Saskatchewan, Saskatoon, Canada

Global groundwater pumping (GWP) introduces dormant fossil waters into the active land-atmosphere-ocean water cycle and alters the combined land and atmosphere water budgets. Despite its adverse environmental impacts on regional water resources management and global seas level rises have been well recognized, the underlying physical mechanisms and paths are poorly understood due to the lack of large-scale GWP and long-term global hydrometeorological data to estimate these impacts. In this study, two sets of global-scale model simulations conducted for the 1900-1999 period by a fully-coupled climate-hydrologic model, one with GWP and one without, are used to investigate the effects of GWP in affecting the land and atmospheric water budgets over 37 major aquifers worldwide. The internally-consistent simulated water budget components, includ precipitation, evaporation, runoff, atmospheric vapor convergence, and water storage changes in land, ocean and atmosphere, are analyzed and their differences between two simulations are considered as the effects in changing regional hydroclimates due to long-term GW depletion. The analyses ranging from monthly to decadal timescales are focused on estimating the pumping sensitivity on various hydrologic stores and fluxes over these 37 aquifers. Lastly, the contribution of GWP to global sea level rise (GSLR) as a result of the changes in the land and atmospheric water budgets is also estimated via (1) the direct R contribution from land to ocean and (2) the indirect C contribution via atmospheric interactions.

Keywords: Groundwater Depletion, Combined Land-Atmosphere-Ocean Water Budgets, Global Major Aquifers, Regional Hydroclimate Changes, Global Sea Level Rise

