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An Assessment of Global Net Irrigation Water Requirements from Various Water Supply Sources to Sustain Irrigation

Sayaka Yoshikawa (1), Jail Cho (2), Hannah Yamada (1), Anupam Khajuria (1), Naota Hanasaki (3), and Shinjiro Kanae (1)

(1) Tokyo Institute of Technology, Tokyo, Japan (sayajo@chikyu.mei.titech.ac.jp), (2) Pukyong National University, Busan, Republic of Korea, (3) National Institute for Environmental Studies, Ibaraki, Japan

Water supply sources for irrigation, such as rivers, reservoirs, and groundwater, are critically important for agricultural productivity. The current rapid increase in irrigation water use threatens sustainable food production. In this study, we estimated the time-varying dependence of irrigation water requirements from water supply sources, with a particular focus on variations in irrigation area during the period 1960–2050 using the global water resources model, H08. The H08 model simulates water requirements on a daily basis at a resolution of $1.0^{\circ} \times 1.0^{\circ}$. The sources of irrigation water requirements in the past simulations were specified using four categories: rivers (RIV), large reservoirs (LR) with a storage capacity greater than 1.0 km^3, medium-size reservoirs (MSR) with storage capacities ranging from 1.0 km^3 to 3.0 M m^3, and non-local non-renewable blue water (NNBW). We also estimated future irrigation water requirements from the above four water supply sources and an additional water supply source (ADD) in three future simulation designs; irrigation area change, climate change, and changes in both irrigation area and climate. ADD was defined as the difference between NNBW in the 1990s and NNBW in the 2040s, because it was difficult to distinguish the types of future water supply sources except for RIV. The simulated results showed that RIV, MSR, and NNBW increased significantly through the 1960s to the early 1990s globally, but LR increased at a relatively low rate. After the early 1990s, RIV approached a critical limit due to the continued expansion of the irrigation area. Furthermore, MSR and NNBW increased significantly following the expansion of the irrigation area and the increased storage capacity of the medium-size reservoirs. After the 2020s, MSR could be expected to approach the critical limit without the construction of medium-size reservoirs. ADD would account for 11–23% of the total requirements in the 2040s. We found that an expansion of the irrigation areas and climate change would considerably increase irrigation water requirements from ADD.