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Asymmetry of agricultural water consumption in arid regions during alternating decadal scale wet and dry periods: explanation using behavioral economics

Fuqiang Tian

Tsinghua University, Institute of Hydrology and Water Resources (IHWR), Department of Hydraulic Engineering, Beijing, China (fq.tian@gmail.com)

Increase of human water consumption for agriculture and consequent degradation of the ecological environment is a common feature in many arid regions. Understanding the driving mechanisms behind this phenomenon is of critical importance for regional sustainable development. In this study, analyses of temporal patterns of human water consumption are carried out in three hyper-arid inland basins, i.e. Aral Sea Basin in Central Asia, and the Tarim and Heihe River Basins in Northwestern China. Multi-decadal time series of hydrological and human consumption data are divided into decadal sequences of wet and dry years. During the wet phases, the greater water availability inspires economic expansion and human water consumption experiences growth at a rate faster than that of incoming water. During the dry phases, however, the expanded economy (e.g., irrigation land expansion in an agriculture-based economy) has been managed to sustain or even to increase production by over-exploitation of water with sophisticated technologies. Inability to reduce human water consumption at a rate commensurate with the decrease of incoming water supply leads to serious ecosystem degradation. This asymmetric human water consumption response of society to decadal scale hydrologic variability can be explained in terms of prospect theory drawn from behavioral economics, which states that people tend to be risk averse when facing gains and show risk preference when facing losses. In the three socio-hydrological case studies, direct economic gain/loss has relatively low value but high certainty when compared to indirect economic loss/gain (such as environmental or sustainability loss/gain), which has high value but with high uncertainty. According to prospect theory, people tend to gain direct economic benefits at the expense of environmental degradation and at the risk of system collapse. The outcomes of this study have major implications for water resources management at long time scales, and in particular calls for increased understanding of human-water system interactions and feedbacks at the decadal time scale.