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Interactions between physical-virtual water flows and associated hydro-economic efficiencies towards SDGs: a study for the Yellow River Basin

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Water over-exploitation and pollution in many river basins have been increasingly driven by remote pressures because of intensifying trade that embedded marked volumes of virtual water (VW) flows. However, limited attention has been dedicated to evaluating the associated economic efficiencies and their relationships to water flows. This paper presents a quantifying framework that accounts for the economic-socio-hydrological processes by integrating assessments of water footprints (WFs), VW flows and economic water values. The framework is applied for the Yellow River Basin (YRB), focusing on crop production and consumption in three current typical climatic years, as well as under different socio-economic scenarios for 2050 towards UN Sustainable Development Goals (SDGs). The crop-related physical water flow, physical-virtual water transferring flow and economic value flow are comprehensively shown for the basin. The annual green and blue WFs accounted for 66% and 46% of the precipitation and irrigation withdrawal for croplands, respectively. The net benefit of green water was 2.3 times higher than that of blue water. Blue water supply and demand had higher correlations to associated economic efficiencies. The drier the year, the higher economic benefits of irrigation water. The higher cost and price of irrigation, the less water demand and the higher irrigation efficiency. As a net VW importer, the YRB got net income from domestic VW flows, while expends more in the international VW flows. All the considered scenarios towards SDGs suggest higher water cost and price in responses to less blue WF and irrigation withdrawal. Results indicate importance of management of interlinks among physical water, VW flows and associated hydro-economic efficiencies to achieve both sustainable water-food nexus and economy.