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## Spatial-temporal variations in green and blue water resources, water footprints and water scarcities in a large river basin—a case for the Yellow River Basin

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Blue water (surface and ground water) and green water (water stored in unsaturated soil layer and canopy evapotranspiration from rainfall) are the two sources of water generated from precipitation and communicating vessels that define the limits of water resources for both human activities and ecosystems. However, the blue and green water evapotranspiration in irrigated fields and their contribution to blue and green water flows have not been identified in studies conducted on blue and green water resources. In addition, information on intra-annual variations in blue and green water footprints (WFs) is limited. In particular, there is a lack of information on water consumption obtained from hydrological model-based blue and green water assessments at the basin scales. In this study, the Yellow River Basin (YRB) over 2010-2018 was considered as the study case, and the inter- and intra-annual variations in blue and green water resources, WFs and water scarcities were quantified at sub-basin levels. Water resources and WFs were simulated using the Soil and Water Assessment Tool (SWAT) model. The results revealed that the annual average blue and green water resources of the YRB were  $119.33 \times 10^9 \text{ m}^3 \text{ yr}^{-1}$  and  $296.94 \times 10^9 \text{ m}^3 \text{ yr}^{-1}$ , respectively, over the study period. The total amount of green water flow was larger than the total amount of blue water flow each year. The blue and green WFs of the crops in the middle reach were significantly larger than those of the crops in the upper and lower reaches. The annual blue and green water scarcity levels under the consideration of the overall YRB were low. However, several areas in the middle reaches were subject to both blue and green water scarcities at least modest level for a minimum of three months a year. The northern region of the YRB was subject to significant and severe blue water scarcity throughout each year.