

Marginal yield recessions can achieve agricultural water savings

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Abstract: Agricultural irrigation is one of the leading causes of water crises. However, the irrigation water saving potential without compromising yield, and its subsequent impact on basin-scale water availability remains unclear. By integrating a process-based agricultural model (APSIM) with satellite remote sensing data from 2000-2019, this study simulates crop yields for maize, wheat, and rice under various irrigation scenarios across over 2 million grid cells in China's major river basins, including the Songhua, Liao, Hai, Huai, Yellow, Yangtze, and Pearl River Basins. Based on the difference between calculated irrigation thresholds and actual irrigation amounts, the irrigation water saving potential was derived, and its impact on basin-scale water availability was assessed using changes in river runoff and terrestrial water storage. The irrigation water saving potential shows an upward trend across all basins from 2000 to 2019. Over the two-decade period, the accumulated irrigation water saving potential reached 19.45 billion m³ in the arid and semi-arid regions of the Yellow River Basin, offsetting 41.18% of the total decline in water availability during this period. Even more significantly, savings of 29.97 billion m³ and 46.87 billion m³ were achieved in the agriculturally intensive Hai River Basin and Huai River Basin, accounting for 43.16% and 65.98% of the water availability loss over the same twenty-year span, respectively. This increasing trend in ineffective agricultural water consumption is attributed to irrational irrigation systems. If this irrigation water saving potential were restored, the downward trend in water availability within basins would be alleviated. This effect would be most pronounced in the Huai and Hai River Basins. Our research provides guidance for the future management and allocation of agricultural water resources within river basins.

Keywords: agricultural water resources, irrigation, water availability