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Mapping global agricultural economic water scarcity to identify target areas for sustainable irrigation expansion

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With continuing growth in food demand and limited potential for cropland expansion, sustainable irrigation becomes an increasingly important strategy to ensure a reliable and resilient global supply of food in a changing climate. We here define and introduce the original concept of 'agricultural economic water scarcity' as the condition whereby croplands exposed to green water scarcity are not irrigated even though a sufficient amount of renewable blue water resources for irrigation is locally available. These conditions occur for instance as a result of a variety of socio-economic and political factors that impede irrigation. To date, little attention has been given to the analysis of this phenomenon and its role in the global geography of water scarcity. Here, we develop and apply a monthly agro-hydrological model to quantify and map croplands affected by agricultural green, blue, and economic water scarcity. By doing so we firstly provide a comprehensive, spatially explicit, global mapping of agricultural economic water scarcity across the global croplands. We then assess the water and food security implications of increased food production from irrigation expansion over economically water scarce croplands. Our results show that up to 25% of global croplands face agricultural economic water scarcity. Two thirds of economically water scarce lands are located in Sub-Saharan Africa, Eastern Europe, and Central Asia. Here, a sustainable irrigation expansion could increase food production and feed an additional 850 million people, while preventing further aggravation of blue water scarcity. The application of the concept of agricultural economic water scarcity has the potential to identify target areas for sustainable water and food security policies at global, regional, national, and local scales.