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How much water is used in global irrigated and rainfed agriculture?

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Global food production relies on both "blue" water (available in rivers, lakes and aquifers) and "green" water (soil water evaporating or transpiring through plants). This study quantifies for the first time, spatially explicitly and consistently, how much water currently is consumed by the Earth's vegetation, differentiated between water consumption by irrigation, rainfed agriculture, and natural ecosystems. We use the dynamic global vegetation and water balance model LPJmL (Lund-Potsdam-Jena managed land), which simulates the growth and abundance of natural and agricultural vegetation and the related water fluxes in a single framework. For the present study, the model was enhanced by a river routing model, lakes and reservoirs as additional water storage pools, and modules to consider blue water withdrawals for households and industry. Since on irrigated land agricultural plants use both blue water stemming from irrigation and green water as infiltrated from precipitation, a method was developed to quantify their individual fractions. We performed three different simulations: 1) natural and agricultural vegetation with irrigation as dependent solely on computed blue water stored in rivers, lakes and reservoirs; 2) natural and agricultural vegetation with a potential irrigation assuming that enough water is available in every irrigated place; and 3) potential natural vegetation, for which the green water flux compared to 1) and 2) is determined. We show that global agricultural water use is by far dominated by green water (though the blue water component predominates in certain regions). We also find that the conversion of land cover for agricultural use has reduced the global green water flow by ca. 5%. The simulation results highlight the importance of green water in global food production and ecosystem conservation, as well as the need for a focus on better management of green water resources.