The impacts of global crop production on water and land use

A new study has estimated the water consumption and land use for the production of 160 crops that constitute most of the world’s cropland. The results suggest that, collectively, wheat, rice, cotton, maize and sugar cane account for 49% of water scarcity and 42% of land resource stress caused by worldwide crop production.

Currently, agricultural production is responsible for 85% of the world’s consumption of freshwater. With increasing populations and demand for food, this consumption is projected to double by 2050, alongside increasing land use for agriculture. To promote sustainable agriculture, there is a need for very precise estimates of water and land use and their environmental impacts. This will help local management and the life cycle assessment of regional products.

The study, conducted under the EU PROSUITE project¹, modelled global water consumption and land use during the cultivation phase of 160 crops. The model was performed at a high spatial resolution (with precise information about specific locations) to incorporate the large variation between locations. The combination of local and global data can help compare environmental impacts to inform the allocation of investment in sustainable agriculture.

To assess the impact of water use it applied a measure called RED (Relevant for Environmental Deficiency) water, which represented the amount of water deficiency for both human users and ecosystems. The impact of land use was assessed by potential net primary production (NPP) of natural vegetation in respective areas.

The analysis revealed that wheat, rice, cotton, maize and sugar cane accounted for 49% of the water scarcity (as measured by RED water) and 42% of land resource stress caused by worldwide crop production. On a global average, maize performs better than rice and wheat in terms of their combined impact on land and water.

However, there were substantial differences between crops depending on location, for example, wheat production in central and northern Europe is mostly rain fed and has minimal impact on water scarcity. In arid regions such as Texas, USA, or northern India, wheat production has a much larger impact on water scarcity.

The study also identified crops that are contributing to water shortages, but are of low economic value. For example, oil crops grown in developing countries, such as castor and safflower use, 15.8 and 9.8 m³ of water per US dollar of economic turnover on global average. Most crops assessed (83%) use between 0 and 2 m³ of water per US dollar.

Gaps in data on water consumption, land use and their impacts mean that there are uncertainties in the model but, as data improve, so too will the model's accuracy. RED water is an appropriate measure for a water footprint, as it accounts for water consumption for irrigation and its effects specific to the crop and location. However, it does not account for socio-economic differences, such as the level of wastewater treatment and, as such, may overestimate scarcity in some instances. Nevertheless, by combining local and global assessments, the model can help inform locations for feasible and sustainable agricultural expansion.

1. PROSUITE (PROspective SUstainability Assessment of TEChnologies) is supported by the European Commission under the Seventh Framework Programme. See: www.prosuite.org


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