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Potential Impacts of Food Production on Freshwater Availability

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The sustainability of freshwater use is often evaluated based on the total volume of water consumption or withdrawal. However, the renewable freshwater resource and potential impacts of water depletion differ with location and water source. In addition, most estimates of the environmental impacts of water use have focused on depletion from a single-source perspective without separating geographically different water sources. Therefore, comprehensive potential impacts from multiple water sources remain unclear. In this study, we quantified the potential impacts of the global food production on freshwater availability (water availability footprint), applying the Water Availability Factor (fwa). Each water source including rainfall, surface water, and groundwater had individual fwa, which is calculated based on the geophysical hydrological cycle, to reflect the differences among renewable freshwater resources by place and source. The fwa for each water source was estimated based on land area or time period required to obtain the reference volume of freshwater. The reference volume was regarded as 1 m3 of rainfall over an area of 1.0 m2 (1,000 mm/year), based on the global mean annual precipitation. This concept is consistent with the Ecological Footprint (EF), which measures how much biologically productive land area is required to provide the resources consumed. The EF concept is measured in global hectares, a standardized unit equal to one hectare with global average bioproductivity. We found that the current agriculture consumes freshwater resources at 1.3 times the rapid rate than sustainable water use. This rate can also indicate environmental water scarcity. Among environmentally water-scarce countries, well-financed countries tend to import cereal products as virtual water to compensate for their domestic water resources. Among water-abundant countries, well-financed countries tend to export cereal products by exploiting their freshwater availability. The fwa concept provides a non-conventional approach to compare and integrate the potential impacts of freshwater use from various sources and climatic conditions. The results should focus attention on the need to address not only physical but also social and environmental water-scarcity issues.