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The water footprint of human-made reservoirs for hydropower, irrigation, water supply, flood prevention, fishing and recreation on a global scale

Rick Hogeboom (1), Luuk Knook (2), and Arjen Hoekstra (1)

(1) Twente Water Centre, University of Twente, Enschede, The Netherlands, (2) Rijkswaterstaat, Utrecht, The Netherlands

Increasing the availability of freshwater to meet growing and competing demands is on many policy agendas. The Sustainable Development Goals (SDGs) prescribe sustainable management of water for human consumption. For centuries humans have resorted to building dams to store water in periods of excess for use in times of shortage. Although dams and their reservoirs have made important contributions to human development, it is increasingly acknowledged that reservoirs can be substantial water consumers as well.

We estimated the water footprint of human-made reservoirs on a global scale and attributed it to the various reservoir purposes (hydropower generation, residential and industrial water supply, irrigation water supply, flood protection, fishing and recreation) based on their economic value.

We found that economic benefits from derived products and services from 2235 reservoirs globally, amount to 311 billion US dollar annually, with residential and industrial water supply and hydropower generation as major contributors.

The water footprint associated with these benefits is the sum of the water footprint of dam construction (< 1 % contribution) and evaporation from the reservoir's surface area. The latter was calculated as an ensemble mean of four different methods for estimating open water evaporation.

The total water footprint of reservoirs globally adds up to $\sim$104 km^3yr^{-1}. Attribution per purpose shows that, with a global average water footprint of 21,5 m^3GJ^{-1} hydropower on average is a water intensive form of energy.

We contextualized the water footprint of reservoirs and their purposes with regard to the water scarcity level of the river basin in which they occur. We found the lion's share (55%) of the water footprint is located in non-water scarce basins and only 1% in year-round scarce basins. The purpose for which the reservoir is primarily used changes with increasing water scarcity, from mainly hydropower generation in non-scarce basins, to the (more essential) purposes residential and industrial water supply, irrigation and flood control in scarcer areas.

The quantitative explication of how the burden of water consumption from reservoirs is shared between its beneficiaries as proposed in this study, can contribute to reaching the desired sustainable management of finite freshwater resources as proposed by SDG 6.