Hidden effects of water impoundment on surrounding vegetation and water consumption

Fernando Jaramillo[1,2]

Corresponding author: fernando.jaramillo@natgeo.su.se

[1]*Department of Physical Geography and Bolin Centre for Climate Research, Stockholm University, SE–106 91, Stockholm, Sweden.*
[2]*Baltic Sea Centre, Stockholm University*

Evapotranspiration is the water flux from the Earth's surface to the atmosphere. Calculating changes in evapotranspiration in time can also serve as a proxy of the human impact on the water cycle; they also represent human water consumption when driven by anthropogenic activities. Evapotranspiration changes can be used to assess the sustainability of human water consumption. For instance, a global analysis of changes in evapotranspiration has shown that current human water consumption may have already exceeded a safe operating space for humankind due to unaccounted evapotranspiration from reservoirs and irrigation. Two hypotheses exist to explain this finding. First, the hydroclimatic effects of water impoundment may be responsible for increasing evapotranspiration beyond the surface of the water-impounded reservoirs. For instance, we calculated changes in evapotranspiration and water consumption from a reservoir in China to find that the reservoir had increased evapotranspiration, explained only by the additional effects of the reservoir that extend beyond the water surface. To determine if vegetation changes related to the reservoir impoundment were the reason for increasing evapotranspiration, we further developed a dendrochronological study, measuring the growth of trees around the reservoir. Surprisingly, we found that tree growth after impoundment could only be explained by a simultaneous effect of favourable regional climate conditions and the reservoir's impoundment. Nevertheless, this effect appears to depend on the reservoir's location and hydroclimatology, as a reservoir in a more humid region in Colombia does not show this effect. The second hypothesis is that the increase in evapotranspiration is an artefact of changes in water storage due to impoundment, as water from the reservoir may infiltrate the surroundings and be accounted erroneously as water losses to the atmosphere. We used Interferometric Synthetic Aperture Radar (InSAR) to detect any potential ground uplift or subsidence surrounding Lake Mead in Nevada, United States, and verify this effect. Although we did not find evidence of this effect, we noticed that the ground surrounding the reservoir subsided or uplifted following the changes in the water load within the reservoir. Such deformation can also become a proxy of water changes in the reservoir and its surroundings. Our accumulated results show that water regulation for agriculture or hydropower may be an important component of water change in the Earth system.