

Interactive comment on “The water footprint of electricity from hydropower” by M. M. Mekonnen and A. Y. Hoekstra

Anonymous Referee #2

Received and published: 2 November 2011

The manuscript addresses an important topic, is well written and adds useful knowledge to the water footprint research.

However, there are some points that need to be addressed/clarified:

- I have the feeling that the “traditional” separation of blue/green water is not directly applicable to this study and that a comparison with blue water footprints of bioenergy is, thus, questionable. The standard definition of green and blue water is by looking at the source of the water consumed: if the water is coming directly from precipitation, it is green; if the water is coming from rivers, groundwater or reservoirs, it is blue. In your system you have two inputs to the reservoir: inflow from the stream and rain on the lake/reservoir. You define both as blue, and thus implicitly state that there is no green

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water footprint of hydropower. But the evaporation from rain water in the reservoirs could also be considered as green water evaporation. My recommendation: try to separate evaporation from rainwater and evaporation from inflow. Or at least compare your water footprint calculations of hydropower (what you named blue water footprint) with the TOTAL water footprint of crops. And rename the quantity as total or green+blue water footprint of hydropower.

- I have a problem with the fact that the evaporation from a reservoir is exclusively unproductive and, thus, does not have any influence on the energy production. I mean, we do not need the reservoir to evaporate in order to produce electricity. This also makes the comparison with the water footprints of crops difficult: if you hinder a plant from transpiring, it would die and would not produce any yield, so the water footprint would be zero (mathematically actually infinite). If you hinder a lake from evaporating (hypothetically), the energy production would probably be totally unaffected and of the same order of magnitude than with full evaporation. I am aware that the water footprints of crops also consider the unproductive soil evaporation, but could you at least discuss on this point?

- Your literature review is rather short and does not give enough useful information about the stand of research on this topic. What are the shortcomings in the work of Gerbens-Leenes et al (2009a)? What were the main arguments in the corresponding session in the World Congress organized by the International Hydropower Association in Brazil? Are there other research groups working with alternative methods to quantify the water consumption of hydropower?

- Even if you write that the issue of accounting for multiple uses of reservoirs will be approached in future studies, this is a major shortcoming of your study and the discussion on this point is too short. Give some information on the other uses of the 35 reservoirs considered. Try to assess at least qualitatively the sensitivity of your results to the assumption. Also if you say that the reservoirs considered were mainly created for hydroelectricity, please give the source of this information (P8364 L26).

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- You should compare your results with other estimates, if available.
- As already pointed out by other comments, you should explain why you chose the definition of water footprint that you use, the pros and cons of other definitions, etc. If you do not want to use the difference in water consumption (before vs. after dam construction) you should not end the article with the recommendation that water footprint should be included in the evaluation of dams. This seems a good idea only if you can say something about the environmental consequences and/or the changes that the dam construction would lead to.
- It surprises me that you only consider 8% of the installed capacity and write that it is because of data availability. I think that you can get a lot more data than you are using. But even if you stay with your small sample, try at least to say something about the whole picture. I guess the reservoirs considered are the biggest ones and thus it is hard to use your numbers to get the complete picture? Or am I wrong and we could say that the water consumption of the total installed capacity for hydropower is of the same order of the water footprint of crops? (that would really surprise me).

Minor comments:

- You should provide a map with the location of each of the 35 reservoirs in the supplementary material. This will allow the reader to better interpret Table 1 and future studies to compare with your estimates.
- "Reservoirs in the tropics have generally a higher evaporation rate than reservoirs in temperate or sub-tropic climatic regions" (P8362 L9). Why is that? And are you considering the altitude of the reservoir? I would have expected the highest rates in the subtropics. . .
- I would recommend to move the paragraphs on data sources under the equation where those data are used (P8361 L9-20): "Data on installed hydroelectric capacity, actual hydroelectric generation. . ." after the equation 1 or 2. "Daily values of mean air

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temperature. . ." after equation 3.

- "...nearby climatic stations have been used, some of which are a bit far from the reservoir" (P8364 L25-26). In average how many kilometers? Up to how many kilometers? Dams are constructed usually in mountainous regions. Due to the strong environmental gradients in these regions, a small distance can have a large influence.
- "The study does not include an assessment of the supply-chain water footprint of hydroelectric generation, which is expected to be much smaller than the operational water footprint." (P8365 L25-26). Why? Are you also taking into account, for example, the water consumed to produce the technical equipment needed to operate and evaluate the plant? Do you know some studies to support this argument?
- Table 1: if I understood right 90 Gm3 yr-1 is the total of the column. So add "/Total" to the line heading.
- "This is not to suggest that in general it is advisable to allocate water to grow crops for. . ." (P8363 L28) Maybe it is more appropriate to include this part in the discussion?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 8355, 2011.

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