Title MSc project: The impacts of green water consumption on blue water availability

Assignment number	**Internal project**
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Required courses Water and Climate or Water Footprint Assessment	
Involved organisations UT-MWM	**Start of the project** flexible

Short description project aim and motive

Humanity consumes about 9.1 trillion m^3 of water annually. The consumption of blue water leads to severe water scarcity across regions around the world, threatening freshwater ecosystems. The impact of green water consumption is still unclear, despite accounting for over 87% of total water consumption. Green water is the direct use of rainwater and mainly consumed in the form of evapotranspiration (ET). ET from the natural land still occurs even without any human activities. For example, considering natural grassland converted into rainfed crop later on, both have ET but only the latter one is for human consumption. Thus, the impacts of green water consumption are not as straightforward as blue water consumption.

One way to assess the impact of green water consumption is to use the changes in ET because of human activities. That is to say, compare the ET with and without human activities. Some studies use net green water consumption or the changes in blue water availability as the impact indicator. The reason is that ET changes affect the water cycle at the local scale, including generated runoff and thus blue water availability. Currently, how green water consumption affects blue water availability, especially the historical analysis is absent at the global scale.

Research objective

This research aims to quantify green water consumption and assess the impacts of green water consumption on blue water availability at the global scale from 1990-2019.

Data availability

Green water consumption primarily consists of three parts: crop, pasture, and forestry (for wood). Data on the green water consumption of crops and pasture is available within the ET-MWM group. Green water consumption of forestry needs to be quantified. Information on the blue water availability at natural conditions is available at the ET-MWM group, but the corresponding ET under natural conditions needs to be obtained from ISIMIP (https://www.isimip.org/).

Approach

The work will consist of the following steps:

- Get familiar with current databases and know how to use Python to deal with NetCDF raster data.
- Choose and implement an appropriate method to quantify the green water consumption of forestry (please refer to the references, Potential methods for green water consumption of forestry, to see how this part was estimated previously within the ET-MWM group).
- Choose an appropriate method to reevaluate blue water availability given changes in ET (only consider the natural land use conditions without blue water consumption but with green water consumption, at the annual basis).
- Calculate blue water availability after adding green water consumption.
- Analyze the changes in blue water availability because of the green water consumption across spatial and temporal scales.
- Write thesis.

References

Blue water availability calculation:

Hogeboom, Rick J.; Su, Han; Prunes, Enrique; Dilks, Dave; Townsend, Allen (2024): Dataset of Science Based Target Network's Freshwater Quantity Target. Version 1. 4TU.ResearchData. dataset.
https://doi.org/10.4121/089afa18-bbd5-493e-8a6c-39e1ca7b2a59.v1

Potential methods for green water consumption of forestry:
Schyns, Joep F., Martijn J. Booij, and Arjen Y. Hoekstra. "The water footprint of wood for lumber, pulp, paper, fuel and firewood." Advances in water resources 107 (2017): 490-501.
https://doi.org/10.1016/j.advwatres.2017.05.013

Komatsu, Hikaru, et al. "Simple modeling of the global variation in annual forest evapotranspiration." Journal of Hydrology 420 (2012): 380-390.
https://doi.org/10.1016/j.jhydrol.2011.12.030

Concept of net green water consumption and changes in blue water availability (page 82, box 4.4):
Hoekstra, A., Chapagain, A. K., Aldaya, M. M., & Mekonnen, M. M. (2012). The water footprint assessment manual: Setting the global standard. Routledge.
https://waterfootprint.org/resources/TheWaterFootprintAssessmentManual_English.pdf

Dataset on global wood harvesting:
Iliusi Vega del Valle, Christopher Reyer, Mahé Perrette (2022): ISIMIP3a wood harvesting input data (v1.2). ISIMIP Repository
https://data.isimip.org/search/tree/ISIMIP3a%2FInputData%2Fsocioeconomic%2Fwood_harvesting/

Field Code Changed