

Title of the project:

The contribution of (non-sustainable) groundwater to the blue water footprint of crops

Assignment no.: 36.18**Internal/external:**

Internal

Head graduation committee:

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Name(s) of participating companies or institutes:

IIASA, Austria

Start of the project:

Flexible

Short description and objective of the project:**Introduction**

The pressure on global freshwater resources is still increasing. In the past century, global withdrawals have increased nearly sevenfold, while future influences of climate change, population growth and economic developments are expected to increase the demand for freshwater resources even more (Gleick, 2000). High resolution assessment of the way and purposes to which we allocate water is needed to get a grasp of the extent of water stress and to assess the sustainability of current allocation strategies.

The water footprint (WF) is a comprehensive indicator of freshwater resources appropriation that is helpful in this regard. Water footprint accounts give spatiotemporally explicit information regarding how water is appropriated for various human purposes (Hoekstra et al., 2011). Globally, the agricultural sector is the biggest freshwater consumer, accounting for about 85% of the global blue water consumption (Shiklomanov, 2000). For this reason, the focus of this research is on the water footprint of crops.

Previous studies have provided global estimates of the WF blue, green and grey components of most crops grown worldwide (Mekonnen and Hoekstra, 2011). In these analyses and according to the WF Assessment definitions, the blue water component represents the amount of water from irrigation that evapotranspired during crop growth. The source of this water may either be surface or groundwater. So far, blue WF accounts have aggregated the surface and groundwater contribution. We would like to split these to blue water sources into a surface water and a groundwater component of each crop. Where river discharge can be seen as a sustainable source for irrigation as long as environmental flow requirements are met, groundwater on the other hand may only be regarded as sustainable as long as its consumption does not exceed recharge. Beyond the renewable groundwater portion, farmers often resort to abstracting fossil groundwater from storage to meet excess demand (Wada et al., 2012). Since this fossil groundwater is a non-sustainable resource, it is interesting to know not only what part of the blue water footprint of crops is surface water or groundwater, but also what part of the groundwater is renewable and what not.

Objective

The objective of this MSc research is to investigate how the blue WF of crops can be accounted for in terms of the relative contribution of surface, renewable groundwater and non-renewable (fossil) groundwater.

Possible approach

- Take WF_{blue} of 126 crops at 5'x 5' arc minutes from Mekonnen and Hoekstra (2011) as basis;
- Downscale¹ PCR-GLOBWB groundwater depletion (non-renewable groundwater) data (Wada et al., 2012) to 5'x 5' arc minute spatial resolution to obtain non-renewable groundwater consumption;
- Use gridded abstraction maps and irrigation efficiency data – at 5'x 5' arc minutes – to calculate total groundwater consumption;
- Subtract total groundwater consumption from total blue water consumption and non-renewable groundwater consumption from total groundwater consumption to obtain the split the blue WF in three components (surface water, renewable groundwater, and fossil groundwater).
- For each crop, globally;
- Place results in context of sustainability.

¹This MSc project provides a good opportunity for the candidate to work on his/her GIS skills (ArcGIS, QGIS).

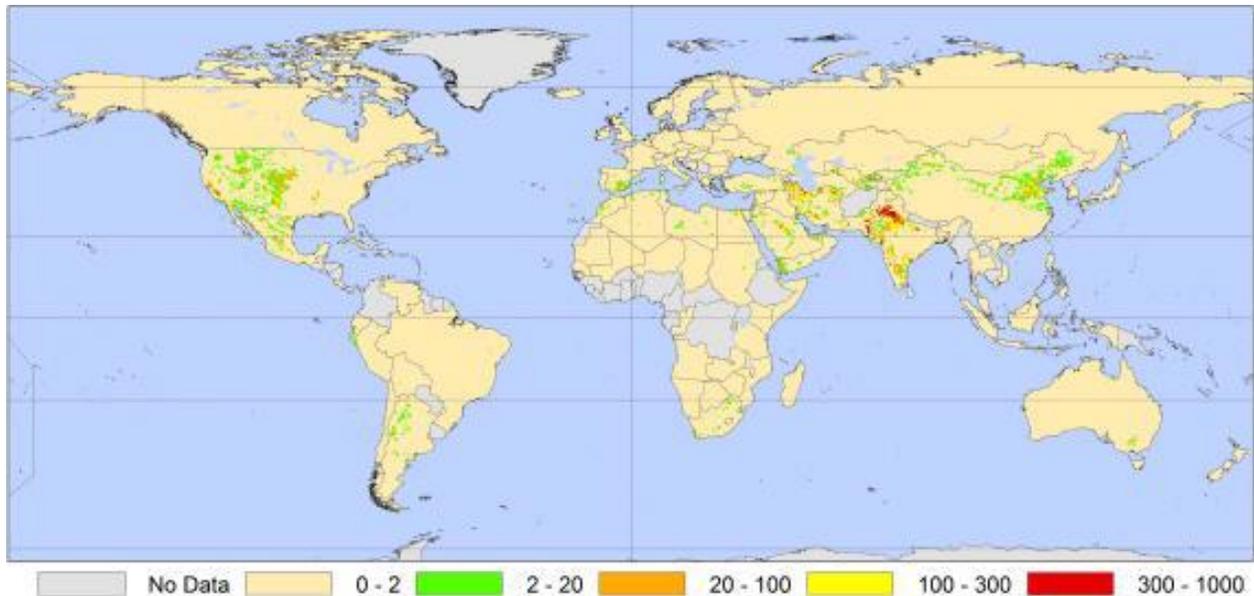


Figure 1: Nonrenewable groundwater abstraction for irrigation for the year 2000 ($10^6 \text{ m}^3 \text{ yr}^{-1}$). Wada et al (2012)

References

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- Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. and Mekonnen, M.M. (2011). *The water footprint assessment manual: Setting the global standard*, Earthscan, London, UK.
- Mekonnen, M.M. and Hoekstra, A.Y. (2011). The green, blue and grey water footprint of crops and derived crop products. *Hydrology and Earth System Sciences*, 15(5): 1577-1600.
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- Wada, Y., L. P. H. van Beek, and M. F. P. Bierkens (2012), Nonsustainable groundwater sustaining irrigation: A global assessment, *Water Resour. Res.*, 48.

