

Interactive comment on “Climate-driven interannual variability of water scarcity in food production: a global analysis” by M. Kummu et al.

Anonymous Referee #1

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There are several major issues with this paper that preclude it from publication at this time.

1. Novelty. This paper claims (page 6944, line 13, and elsewhere) to analyze the inter-annual variability of global water scarcity for the first time. However, to my knowledge, other papers have done this, such as Wada et al 2011. In fact, the analysis by Wada et al 2011 is performed at the monthly time-scale for the past several decades and additionally incorporates changing water demand over time, thus making it more sophisticated than the constant treatment of population, land-use, diet (economic growth), and agricultural management in this paper.

2. Purpose. I do not understand the purpose of the paper, which is to determine

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whether a food production unit (FPU) is water scarce, based upon the ability of the FPU to be self-sufficient in terms of food production. This assumes that global food production would operate under a system of autarky, i.e. in the absence of any trade, even re-distribution within a single country. This assumption seems completely unrealistic, unwarranted, and even undesirable.

To this point, calculations in the paper of global human population numbers subject to chronic water scarcity based upon this autarky assumption are mis-leading (section 3.3). People in these areas may not face water scarcity, due to the spatial separation between agricultural production and consumption. Similarly, domestic water demand is often given priority, even in areas with limited agricultural supplies.

Rather than determining water scarcity based upon theoretical food self-sufficiency, it would make more sense to determine whether hydro-climatic conditions will enable theoretical yield values to be reached, such as on areas deemed “water scarce” by Foley et al 2011.

3. Methodology. If this paper quantifies the impact of hydro-climate variability on water availability and demand (3rd sentence abstract), then some demand factors must be incorporated into the analysis. These demand factors must then vary over time, since the major purpose of the paper is to obtain inter-annual water scarcity estimates.

Constant population, land-use, diet, and crop management is too simplistic for an inter-annual analysis. Similarly, there are several empirical constants that simplify the analysis, but lead to questionable results. For example, fixing the fraction of caloric consumption to 80% vegetable and 20% meat and fixing water availability to 40% of the sum of runoff and water storage (page 6938, line 12).

Additionally, it is not clear if groundwater is included as an explicit source of blue water. Groundwater is not mentioned on page 6937, lines 9-16, but is an important water source for agriculture. In LPJmL crop irrigation requirements are always assumed sufficient (implicitly assuming fossil groundwater is used), which over-estimates the

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water available for food production.

References:

Wada, Y., van Beek, L.P.H., and M.F.P. Bierkens: Modelling global water stress of the recent past: on the relative importance of trends in water demand and climate variability, *Hydrol. Earth Syst. Sci.*, 15, 3785-3808, 2011.

Foley et al: Solutions for a cultivated planet, *Nature*, 478, 337-342, doi:10.1038/nature10452, 2011.

Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, 10, 6931, 2013.