Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-398-RC2, 2018

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Assessment of food trade impacts on water, food, and land security in the MENA region" *by* Sang-Hyun Lee et al.

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Received and published: 21 December 2018

This paper analyzes the virtual water trade (VWT) in the MENA (Middle East and North Africa) region with data from 2000 to 2012. They use previously-compiled data and analyze the importance of VWT in MENA countries' food supply. More novel, they determine the degree of dependence of MENA countries on single exporters, and the centrality of different exporters for the VWT throughout MENA. The study usefully visualizes and analyzes existing VWT data, and would be a good addition to the literature on VWT and how to analyze it. I have mostly minor corrections for language (see attached pdf) but also some questions about the results from water footprints, and suggestions for further interpretation of some data, including whether there is historical precedent for countries that depend on a few exporters to be more vulnerable to food

shortages from embargoes or other trade policy.

The water footprints of a given crop vary widely by country: for barley, green WF ranges from 193.6 to 6417.6 m3/ton. Adding together green and blue still gives a very wide range: ∼8200 m3/ton in Libya vs 1000 m3/ton in Saudi Arabia. Are these numbers and their spatial variability realistic? Is it possible that producing barley in Libya consumes 8 times as much water as in Saudi Arabia? I don't imagine that potential ET varies that much over the region. Is the very wide range in WF because yields are so much higher in Saudi Arabia, but water consumption is assumed to be independent of yield? Some explanation is needed.

I found the methods description for Eigenvector centralities confusing (L176-193). Please rewrite for clarity.

Some numbers are claimed to be significant, but without context. For example, Saudi Arabia saves 2 billion m3 per year by importing barley. Is that big number? Compared to what?

The authors correctly note that it is important to identify countries that rely on only a few exporters. I'm not so sure that this means that countries with high dependence on one exporter should re-evaluate their policy, since I don't know enough about international trade strategy. Is there literature that can show that, historically, countries that rely on a single exporter are vulnerable to food sanctions? Can the authors cite historical precedent? Also, I found the shift in exporting countries from the US and Australia to other nations of potential importance to explain, both its causes and consequences. Is there more you can say about that in the paper?

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-398/hess-2018-398-RC2-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-

398, 2018.

Assessment of food trade impacts on water, food, and land security in the MENA region

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Abstract

The Middle East and North Africa (MENA) region has the largest water deficit in the world. It also has the least food self-sufficiency. Increasing food imports and decreasing domestic food production can contribute to water savings and hence to increased water security. However, increased domestic food production is a better way to achieve food security, even if irrigation demands increase in accordance to projected climate changes. Accordingly, the trade-off between food security and the savings of water and land through food trade is considered as a significant factor for resource management, especially in the MENA. Therefore, the aim of this study is to analyze the impact of food trade on food security and water-land savings in the MENA region. We concluded that the MENA region saved significant amounts of national water and land based on the import of four major crops, namely, barley, maize, rice, and wheat, within the period from 2000 to 2012, even if the food self-sufficiency is still at a low level. For example, Egypt imported 8.3 million ton/year of wheat that led to 7.5 billion m^3 of irrigation water and 1.3 million ha of land savings. In addition, we estimated the virtual water trade (VWT) that refers to the trade of water embedded in food products and analyzed the structure of VWT in the MENA region using degree and eigenvector centralities. The study revealed that the MENA region focused more on increasing the volume of virtual water imported during the period 2006–2012, yet little attention was paid on the expansion of connections with country exporters based on the VWT network analysis.

Keyword: *Food security; Food self-sufficiency; Food trade; Virtual water; MEAN.*

1 Introduction

Primary resource gaps for the MENA region in terms of safe and affordable access to water, food, energy, and nutrition, are expected to grow owing to demographic, population, and climate changes. These primary resources are highly interlinked and create a high-degree of risks and vulnerability. The food portfolio in the MENA region has been complicated by an increased degree of risks owing to the geopolitical challenges and inability to satisfy needs with domestic production. This is in part due to lack of adequate arable land and water resources. As such, trade has been a major part of the food security portfolio, and has created another level of complexity that has been understudied.

The VWT refers to the trade of water embedded in food products (Allan, 1993; Aldaya et al., 2010; Antonelli and Tamea, 2015). Therefore, food trade drives water conservation or loss in terms of VWT, and it is an important element of both food and water security in water-scarce regions (Konar et al., 2012; Hanjra and Qureshi, 2010; Hoekstra, 2003). The concept and quantitative estimates of virtual water can help to realistically assess water scarcity for each country, projecting future water demand for food supply, thus increasing public awareness on water and identifying water-wasting processes in production (Oki and Kanae, 2004). For water-scarce countries, achieving water security by importing water intensive products could be a more attractive option compared to producing all water-demanding products domestically (Hoekstra and Hung, 2005). The global volume of international crop-related virtual water flows averaged 695 billion m^3/year over the period 1995–1999, which

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Fig. 1.