CROP-WATER MANAGEMENT TO REDUCE BLUE WATER SCARCITY:

A CASE STUDY FOR THE YELLOW RIVER BASIN

Water scarcity in crop-intensive basins has raised wide attention as it threatens food security to meet the increasing global population demand. The Yellow River basin (YRB) is one of these basins that serve as a major food production basin but face severe blue water scarcity. Researchers have explored the reduction in the blue water footprint (WF) of crop production, however it is not clear how much reduction is needed to alleviate the water scarcity in the YRB. This study aims to assess the blue water scarcity in the YRB and its alleviation by crop-water management.

We analyzed the reference blue water scarcity following the 'water footprint (WF) assessment' framework. The blue water scarcity is analyzed temporally (yearly and monthly) and spatially (grid cell). Two strategies that can best reduce the crop blue WF are formulated. The first strategy is to limit the irrigation water while maintaining a stable yield by deficit irrigation and organic mulching. The second strategy is to close the yield gap (the difference between observed yield and maximum attainable yield in the region) by assuming that the biophysical factors, such as fertilizers, pesticides, and weed control, are optimized. Further, an additional scenario for each strategy is designed to adjust production to the reference level with proportional cropping area change. This additional scenario compensates for the changes in total production brought by the two strategies and compares the blue WFs (m3) to the reference at the same level of production.
The four scenarios in this study are:

i) Strategy 1, area as the reference (S1).
ii) Strategy 1, area adjusted (S1AA).
iii) Strategy 2, area as the reference (S2).
iv) Strategy 2, area decreased (S2A-).

The blue water scarcity of the scenarios is then compared to the reference temporally (yearly and monthly) and spatially (grid cell). The effect of crop-water management on the blue water scarcity in the YRB is finally assessed.

Results show that the YRB has severe blue water scarcity for 2006 and 2007, and significant blue water scarcity for 2009. There is a lag of three months between available water and the total blue WF due to the mismatch of the precipitation season and the cropping season. Spatially, half of the basin suffers from severe blue water scarcity throughout the whole year. Winter wheat and maize, which cover 50% of the total blue WF from March to August. After application of the scenarios in the YRB, the blue WFs of crops are effectively reduced. In general, S2A- is the most effective to reduce both the blue WF in m^3 and m^3/t. Scenarios are effective in terms of narrowing down the differences between the total blue WF and the maximum available blue WF. Scenarios flatten the peak water demand for cropping from March to June in all three years (Figure1). Monthly blue water scarcity is brought one level down of most months in three years. However, there are still five months each year that suffer from severe blue water scarcity under any of the scenarios, and these months align with the growing season. Spatially, scenarios have limited effects on water scarcity. Crop-water management cannot reduce the WF to the level to maintain the entire YRB sustainable due to the unevenness distribution of water scarcity. However, crop-water management can alleviate the blue water scarcity in YRB to a great extent.

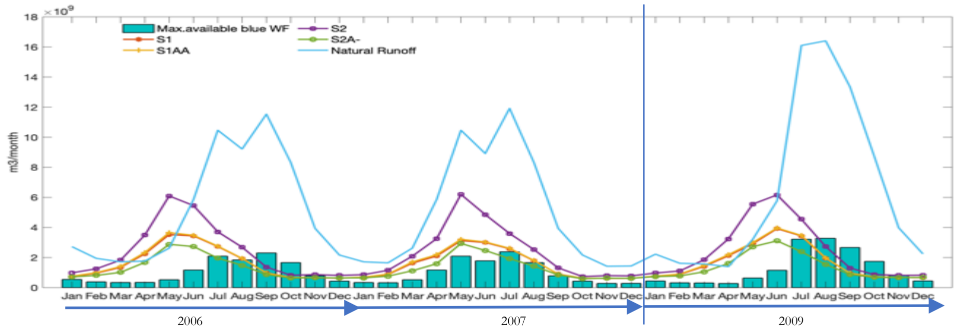

Figure 1: Monthly total blue WF, natural runoff and maximum available blue WF within YRB in 2006 (dry year), 2007(wet year) and 2009 (average year) by application of the crop-water management scenarios.

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