Alternative ways to set the blue water footprint cap at sub-catchment level

A case study for the Yellow River Basin in China

The temporal and spatial variability of Blue Water Availability (BWA) indicate that the Blue Water Footprint (BWF) cap should be calculated at monthly and sub-catchment level. How to allocate the BWA over sub-catchments remains an issue. In previous studies the BWF cap of an area was based on the BWA at that location and time. Thereby, the water scarcity increased from upstream to downstream due to unlimited upstream consumption. The objective of this study is to examine the effect on blue water scarcity of defining alternative monthly BWF caps at sub-catchment level. The BWF caps are defined for four allocation principles. The Yellow River Basin (YRB) from 2010 to 2014 is taken as a case study. The allocation principles expressed as scenarios, either did or did not account for other sub-catchments in BWF cap setting.

The natural runoff is simulated using the hydrological model SWAT. The BWA is allocated over the sub-catchments according to four scenarios for the calculation of the BWF caps: 1) natural conditions and *not accounting* for other sub-catchments (default scenario), 2) presence of reservoirs and *not accounting* for other sub-catchments (reservoir scenario), 3) presence of reservoirs and *accounting* for other sub-catchments based on relative population (population-based scenario) and 4) presence of reservoirs and *accounting* for other sub-catchments based on relative past demand of blue water in the form of BWF (demand-based scenario). The four scenarios are assessed for two different methods to compute Environmental Flow Requirements (EFR): the presumptive standard approach (PRE) and the variable monthly flow method (VMF). The former is more precautious than the latter and reserves more blue water for the environment.

Figure 1 displays the average blue water scarcity during spring in the YRB for the VMF method. The default scenario shows the largest water scarcity over sub-catchments due to a mismatch in timing between BWA and BWF. The reservoir scenario decreases the water scarcity by changing the timing of BWA and its spatial distribution over sub-catchments. The water scarcity decreases, and it is more equally divided over the sub-catchments for scenarios that take other sub-catchments into account. A more equally distributed water scarcity indicates smaller extreme values, both high and low. This means that the regional differences in the severity of environmental damage due to blue water consumption decrease. The overall water scarcity and regional differences decreases from the population-based to the demand-based scenario. Finally, the water scarcity is larger when applying PRE compared to VMF.

A scenario that considers other sub-catchments mitigates regional differences between upstream and downstream BWF caps and decreases the overall water scarcity. A scenario that considers other sub-catchments and based on demand shows the most equal distribution of water scarcity.

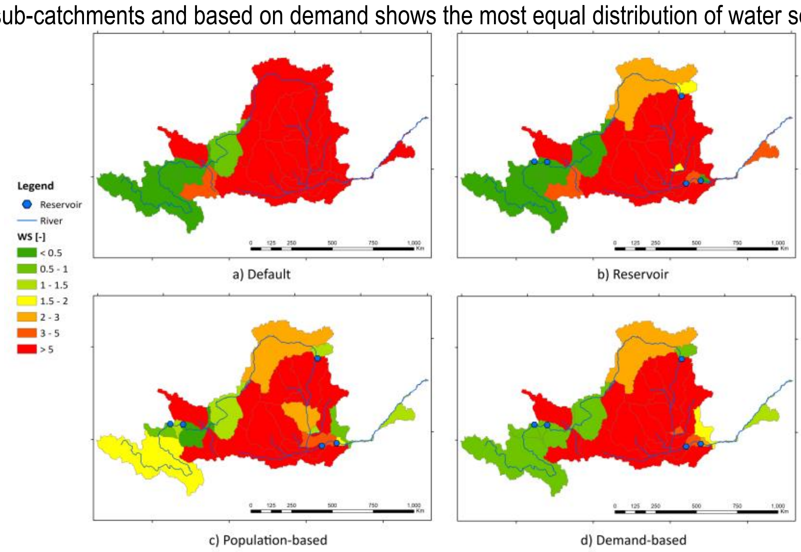

Figure 1: Average blue water scarcity spring (March-May) per sub-catchment of the YRB from 2010 to 2014, using BWF caps according to a) default scenario, b) reservoir scenario, c) population-based, and d) demand-based using VMF. The classes <0.5 and 1-1.5 indicate low, 1-1.5 moderate, 1.5-2 significant, and 2-3, 3-5, and > 5 severe blue water scarcity.

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