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Influence of vegetation dynamic modeling on the allocation of green and blue waters

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The long history of the Mediterranean region is dominated by the interactions and co-evolution between man and its natural environment. It is important to consider that the Mediterranean region is recurrently or permanently confronted with the scarcity of the water. The issue of climate change is (and will be) aggravating this situation. This raises the question of a loss of services that ecosystems provide to human and also the amount of available water to be used by vegetation. The question of the water cycle, therefore, should be considered in an integrated manner by taking into account both blue water (water in liquid form used for the human needs or which flows into the oceans) and green water (water having the vapor for resulting from evaporation and transpiration processes).
In spite of this, traditionally, very few hydrological models have incorporated the vegetation dynamic as a state variable. In fact, most of them are able to represent fairly well the observed discharge, but usually including the vegetation as a static parameter. However, in the last decade, the number of hydrological models which explicitly take into account the vegetation development as a state variable has increased substantially.
In this work, we want to analyze if it is really necessary to use a dynamic vegetation model to quantify adequately the distribution of water into blue and green water. The study site is located in the Public Forest Monte de la Hunde y Palomeras (Spain). The vegetation in the study area is dominated by Aleppo pine of high tree density with scant presence of other species. Two different daily models were applied (with static and dynamic vegetation representation respectively) in three different scenarios: dry year (2005), normal year (2008) and wet year (2010). The static vegetation model simulates the evapotranspiration considering the vegetation as a stationary parameter. Contrarily, the dynamic vegetation model connects the hydrological model with a parsimonious dynamic vegetation sub-model which assumes the vegetation biomass as a state variable.
Using both models, we estimated the amount of 'blue' water and the amount of 'green' water (according to the previous definitions) in each scenario. Comparing the results, we observed that the static model underestimated the amount of green water in any case (dry, normal or wet year). In fact, the value of the ratio between blue and green water is higher in all scenarios for the static option (0.23 in the dry year, 0.42 in the normal year and 0.96 in the wet year) than the obtained ones for the dynamic model (0.098, 0.29 and 0.76, respectively). It means that we are overestimating the amount of water available for human needs if we assume vegetation as static. This type of error can be very dangerous for water resources predictions with future climates, especially in Mediterranean areas due to their water scarcity.