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Application of a simple dynamic vegetation model to an experimental plot and validation through satellite data and field observations

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It is well known that the vegetation plays a key role in the catchment's water balance particularly for semi-arid areas that generally are water-controlled ecosystems. For this reason, the number of hydrological models which include vegetation as a state variable has increased substantially in the last decade.

However, many of the available dynamic vegetation models are quite complex.To cope with the difficulty of estimating a large number of parameters and inputs, the authors focused on the use of a parsimonious model called LUE-model. This model is based on the amount of photosynthetically active radiation absorbed by green vegetation (APAR) and the Light Use Efficiency index (the efficiency by which that radiation is converted to plant biomass increment) in order to compute the gross primary production (GPP). The advantages of this simple conceptualization are: (1) the low number of parameters, (2) it could be easily coupled with a hydrological model and, (3) as it is based on APAR, it is directly connected with satellite data.

This model has been calibrated and validated using remote sensing data and afterwards further tested against field observations. Plant transpiration and soil moisture were obtained in an experimental plot of a semi-arid catchment (La Hunde, East of Spain), during the period from 27/03/2009 to 31/05/2011, covered by Aleppo pine.The satellite data used in this study were: the Normalized Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI), both included in the products MOD13Q1 and MYD13Q1.

Concerning NDVI, its own definition links this index to the "greenness" of the target, so that it appears highly linked to chlorophyll content and vegetation condition. Recent studies about Aleppo pine have shown that NDVI is sensitive to water stress, because the photosynthetic pigment is it. For this reason, the model simulated LAI was corrected by a plant water-stress factor. After such correction, the correlation coefficient with NDVI (obtained by satellite) and modelled LAI was r=0.54. On the other hand, taking into account that the EVI is highly sensitive to canopy structural variations, we compared the modelled LAI and the EVI (obtained by satellite). Thereby, the correlation coefficient between the EVI and the modelled LAI was r=0.51. Finally, the model simulated soil moisture content was compared with the observed one, giving a correlation coefficient of 0.79, while the correlation coefficient between simulated transpiration and the observed one was 0.54.

All these results suggest that this parsimonious model is able to adequately reproduce the dynamics of vegetation (the correlation coefficient with the satellite and field transpiration data are acceptable) and also reproduces very well the soil moisture variations. In other words, it has been shown that a parsimonious model with simple equations can be achieved very good results in general terms and it was possible to assimilate satellite and field observations for the model implementation.