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Machine learning for predicting vegetation distributions in the Iberian Peninsula

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Vegetation plays a major role in the water cycle through transpiration. In a global sense, evapotranspiration accounts for two thirds of the precipitation over the continents, with higher figures in arid than humid climates. Vegetation functional types (i.e. tree, shrub, grass) differ in their transpiration rate and resilience to water and climatic conditions, from which a connection between the vegetation distribution and the water cycle emanates. Hence, the interest of hydrologists in understanding the reasons why vegetation distributes differently across watersheds of diverse climates. This understanding is of key importance in the assessment of the effects of global change on the water cycle as vegetation is expected to vary due to climate change; therefore, we need models that can generate vegetation distributions under changing climatic conditions.

Plant optimization theories predict vegetation distributions based on the hypothesis that vegetation optimizes a state variable, e.g. productivity or water stress. The applicability of these theories is constrained to arid and semi-arid climates, in which water availability is the limiting factor for plant development. Furthermore, they usually require a simple hydrological model to quantify the required water fluxes. In this context, machine learning arises as a powerful set of techniques to apply for predicting vegetation distributions in ecosystems where other climatic, topographic or edaphic descriptors might be those defining the spatial distribution of vegetation. This set of techniques does not require assuming a hypothesis as optimization theories do; instead, they can identify from a list of predictors those of higher importance in the vegetation distribution.

In this research, we apply machine learning for predicting the spatial distribution of vegetation functional types in two different climates of the Iberian Peninsula: Oceanic (Cfb) and warm-summer Mediterranean (Csb). As predictive variables we use descriptors of the hydrology, edaphology and morphology obtained from meteorological records, soil data bases and a digital terrain model. The target variable is the vegetation functional type obtained by classification of Landsat images. The result is a model that predicts the climax vegetation of a point in space characterised by a set of descriptors; applied in a catchment scale, it predicts a map of potential vegetation to be used as input in a hydrological model.

The fitted model could predict climax vegetation distributions for climate change scenarios, which in turn would feed a hydrological model to appraise the combined impacts of vegetation and climate change in the water cycle.

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