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Mathematical modeling riparian vegetation zonation in semiarid conditions based on a transpiration index.

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Initially riparian vegetation modeling was focused on the study of ecological patches without taking into account the interactive effects of structures and processes in between them (Tabacchi *et al*., 1998). One of the greatest challenges, when carrying out a riparian ecosystem restoration, is to understand the physical and ecological processes of a system and the interaction and feedback within these processes. Jorde (2002) pointed out the importance of addressing complex linkages between processes and biotic interactions in research and in the development of restoration projects over larger spatial and temporal scales in the future.

According to Tabacchi *et al*. (2000), the water cycle in riparian zones depends on three important relations: the water absorption by the plants, water storage and atmospherical return by evaporation. During recent years a variety of ecological models have taken into account the changes in the plant species as consequence of changes in the environmental variables and hydrological alterations (Baptist, 2005; Braatne et al., 2002; Glenz, 2005; Hooke et al., 2005; Murphy et al., 2006). Most of these models are based on functional relationships between river hydrology and vegetation species or communities. In semiarid regions we make the hypothesis transpiration will be one of the key factors determining the riparian vegetation presence and therefore, we will not consider in our model other factors as recruitment, flood damages, etc.

The objectives of this work are: firstly to develop a model capable of simulating several riparian vegetation types which can be applied in a wide range of conditions across Mediterranean environments; and secondly to calibrate and to validate the model in several Mediterranean river stretches of the Iberian Peninsula, both in undisturbed and disturbed flow regimes.

To achieve these objectives the following methodology has been applied. The model has been conceptualized as a static tank flow model based on the actual evapotranspiration of the riparian plants. This tank represents a portion of soil of the superficial root layer. The lower capacity limit of this tank is the permanent wilting moisture of the soil sample. On the other hand the upper capacity limit is the field capacity moisture. The tank's input flows are the precipitation, the root water rise and the capillary water rise. In contrast output flows are the actual evapotranspiration and the excess water of the tank. The most relevant model parameters are the soil retention curves, vegetation functional type parameters (specially related to root depths and the transpiration efficiency factors) and the daily hidro-meteorological data, which are water table elevation, precipitation and potential evapotranspiration.

The model runs for a limited amount of vegetation functional types. In our simulations the following four functional types were used: Riparian Herbs; Riparian Juveniles and Small Scrubs, Riparian Trees and Big Shrubs; and Terrestrial Vegetation. The general model output variable is an evapotranspiration index based in the quotient between the current and the potential evapotranspiration. This index is used to determine the suitability of the simulated vegetation functional types to certain environmental conditions. Secondly, a sensitivity analysis was made for determining the most relevant model parameters. Finally the model has been calibrated and validated using as objective function a confusion matrix which compares the observed and the simulated riparian vegetation zonation.

The calibration/validation processes have been carried out in seven study sites of the Jucar River Basin District. Four of those sites have a natural flow regime and three of them a regulated flow regime due to the presence of dams. Results have shown that the model is capable of providing effective simulations in compared to the observed riparian vegetation.