Author: Virginia Garófano Gómez; Supervisor: Francisco Martínez Capel

PhD Thesis: *Riparian vegetation patterns according to hydrogeomorphological factors at different spatial and temporal scales in Mediterranean rivers*

Abstract

The riparian corridors in semi-arid Mediterranean environments are ecosystems of high biodiversity and complexity. A variety of natural disturbances create a spatial and temporal environmental mosaic with few parallels in other systems. However, they are threatened because of high levels of human intervention. River damming (and related flow manipulation) is considered as one of the most prominent human impacts on riparian corridors. The aim of this thesis was to analyse the riparian ecosystem by covering different spatial and temporal scales and focusing on the factors that influence their vegetation distribution, structure, composition, quality and dynamics in free-flowing and hydrologically altered reaches of Mediterranean rivers. It focuses specifically on the Júcar River Basin District (Eastern Spain).

The specific objectives of this thesis were: **A**) Determining the positional patterns of woody riparian species in the transversal floodplain gradient and defining groups of species with similar response to the physical habitat conditions; **B**) Comparing the response of coincident species between free-flowing and hydrologically altered sites; **C**) Defining response curves and hydrological guilds of species in free-flowing rivers; **D**) Determining the main factors driving the riparian and instream habitat quality and longitudinal patterns of the floristic composition and instream habitat characteristics in a hydrologically altered river segment; **E**) Describing the spatiotemporal changes in riparian structure and complexity, and temporal changes in the stream flow regime within the riparian corridor of a hydrologically altered river reach.

The aforementioned objectives were tackled with different methodologies that involved the combination of different data sources and an important effort in field data collection in different study locations of the Cabriel, Mijares and Serpis rivers. To meet objectives **A** and **B**, soil sampling and geo-referenced vegetation survey by cross-sectional transects was conducted in two free-flowing and three regulated sites. Data analyses were performed with multivariate and robust statistics. To meet objective **C**, the aforementioned geo-referenced survey (along with a dendrochronological sampling) was coupled with a hydraulic model in the two free-flowing sites in order to obtain the time series of water elevations at which every single plant had been exposed during its lifetime. The species response and their possible aggregation into hydrological guilds was compared through robust statistics in terms of inundation duration, inundation duration during the growth period, continuous inundation duration, inundation frequency and plant elevation above base flow. To meet objective **D**, the regulated section (Beniarrés dam – Sea; 40 km) of the Serpis River was divided into segments. In each one, a flora inventory was conducted and hydromorphological indices were applied. Different multivariate statistics allowed the grouping of sites according to their floristic composition and instream habitat characteristics. The main factors controlling the spatial patterns of the floristic composition, instream habitat characteristics, riparian habitat quality and instream habitat heterogeneity were discussed. To meet objective **E**, historical flow series and their human manipulation were combined with historical aerial images (depicting changes in land cover), ground observations of the species – age composition and morphology of the riparian corridor of the Mijares River over the last 60 years. A variety of landscape metrics and flow indices were extracted to identify and summarize spatio-temporal changes in the riparian structure and in the stream flow regime.

The transversal-scale study helped to understand the riparian zonation of each site in terms of morphology and soil characteristics, revealing that flow alteration may result into changes of the positional patterns of woody riparian species. Three hydrological guilds were defined, 'highly tolerant to inundation', 'intermediate tolerant' and 'transitional between floodplain and terrestrial'. The longitudinal-scale study suggested that the response of the vegetation to a hydrologic change is highly dependent on the local geomorphology. The main factors driving hydromorphological and floristic patterns were artificial and highly variable flow regimes (identified in sites with the worst riparian and instream quality), the presence of lateral structures in the river channel and geomorphological characteristics. As major effects after flow regulation, the spatiotemporal-scale study revealed an increase in the cover and density of woody vegetation, a shift in species composition and a decrease in bare sediment areas (essential for recruitment of riparian pioneer species) coupled with a synchronous reduction in the complexity of the riparian corridor. These changes can be related to the decrease in the magnitude and variability of river flows over the last six decades. Only a better understanding of the ecohydrological processes and the implications of hydrological alteration can support the effective management and integration of Mediterranean riparian systems into water management decisions.