

The Ebro River in the 20th century or the ecomorphological transformation of a large and dynamic Mediterranean channel

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ABSTRACT: In the first decades of the 20th century, the Ebro River was the Iberian channel with the most active fluvial dynamics and the most remarkable spatial-temporal evolution. Its meandering typology, the dimensions of its floodplain, and the singularities of its flow regime produced an especially interesting set of river functions.

The largest dynamics of the Ebro River are concentrated along the meandering profile of the central sector. During the 20th century, this sector experienced a large alteration of its geomorphological structure. We present here an analysis of this evolution through the cartographic study of a long segment of the river (~250 km) in 1927, 1956 and 2003. The results show a large reduction in bank sinuosity, a progressive loss of fluvial territory, and a large decrease in channel width. These changes are especially clear in the areas previously most ecologically connected with the active channel. The fluvial territory of the river in 2003 was approximately half that found during the first decades of the 20th century. Forest plantations, which were non-existent in 1927, occupied more than 1500 ha of the study area in the last decade.

This intense geomorphological transformation becomes ecologically visible in (i) a 35% reduction of the area occupied by riparian vegetation; (ii) a loss of the heterogeneity of riparian forest spots, which were formerly structured in an irregular mosaic far from the river thalweg; and (iii) a modification of the riparian forest structure, which is currently linear, uniform, thin and very close to the river axis. The ecomorphological alteration was intensified by the remarkable reduction in bank length (13%) and the reduced dynamism of the present river system, indicated by an increase in the percentage of fluvial territory occupied by riparian forests and a reduction in the area occupied by the active channel. Copyright © 2002 John Wiley & Sons, Ltd.

KEYWORDS: Mediterranean river; channel change; fluvial morphology Ebro; riparian forest; fluvial territory

Introduction

The links between the geomorphological changes in rivers and the evolution of their fluvial ecology is becoming progressively better known. Physical processes are responsible for maintaining the basic attributes of river systems and their spatial-temporal dynamics. These processes protect the ecological integrity of rivers (Amoros and Petts, 1993; Petts, 2000).

The core elements in the relationship among the geomorphological and sedimentary dynamics, composition, structure and functioning of river systems were first discussed by Petts (1979) and Ward and Stanford (1983), and developed by Ward *et al.* (1999). Later work reinforced the importance of lateral connectivity and recognized the ecological implications of channel–floodplain interaction (Ward and Stanford, 1995; Steiger *et al.*, 2005; Brierley *et al.*, 2006). Brandt (2000)

discusses the relationship of river regulation and alteration to the geomorphic response of rivers. He proposed a classification system that included nine possible behaviors of the channel in response to changes in the flow regime and the solid transport regime.

Brandt (2000) shows that many channels do not respond clearly to an alteration in the flow of a river caused by the construction of a dam. The origin of these uncertainties may be a lack of adequate information or the difficulty of distinguishing the natural or artificial basis of the largest changes. Church (1995) argued that a key aspect of these analyses should be the extension of observations beyond the limit of 25–50 years used in many papers.

In the 1980s, the analyses conducted led to an understanding of the geomorphic response of channels to dam construction. However, two basic questions had not yet been answered