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Research article

Long-term river management legacies strongly alter riparian forest attributes and constrain restoration strategies along a large, multi-use river

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ABSTRACT

Many terrestrial ecosystems have undergone profound transformation under the pressure of multiple human stressors. This may have oriented altered ecosystems toward transient or new states. Understanding how these cumulative impacts influence ecosystem functions, services and ecological trajectories is therefore essential to defining effective restoration strategies. This is particularly the case in riverine ecosystems, where the profound alteration of natural disturbance regimes can make the effectiveness of restoration operations questionable. Using the case study of legacy dike fields, i.e., area delimited by longitudinal and lateral dikes, along the regulated Rhône River, we studied the impacts of long-term channelization and flow regulation on environmental conditions and riparian forests attributes along a 200 km climatic gradient. We characterized the imprint of human stressors on these forests by comparing the dike field stands to more natural stands in both young and mature vegetation stages. Across four reaches of the river between Lyon and the Mediterranean Sea, we found that channelization consistently promoted high rate of overbank sedimentation and rapid disconnection of dike field surfaces from the channel. The rapid terrestrialisation of dike field surfaces, i.e., the process by which former aquatic areas transition to a terrestrial ecosystem as a result of dewatering or sedimentation, fostered a pulse of riparian forest regeneration in these resource-rich environments that differs from more natural sites in structure and composition. Within the dike fields, older pre-dam stands are dominated by post-pioneer and exotic species, and post-dam stands support large, aging pioneer trees with a largely exotic understory regeneration layer. These patterns were associated with differences in the relative surface elevation among dike fields, whereas species shifts generally followed the river's longitudinal climate gradient. To enhance the functionality of these human-made ecosystems, restoration strategies should target the reconnection of dike fields to the river by dismantling part of the dikes to promote lateral erosion, forest initiation and community succession, as well as increasing minimum flows in channels to improve connection with groundwater. However, since a river-wide return to a pre-disturbance state is very unlikely, a pragmatic approach should be favoured, focusing on local actions that can improve abiotic and biotic function, and ultimately enhancing ecosystem services such biodiversity, habitat, and recreation opportunities.

1. Introduction

Over recent decades, efforts to restore degraded ecosystems have vastly expanded in scope and cost, with international ambitions rapidly increasing (e.g., Aichi Biodiversity Targets for 2011–2020 set by the Convention on Biological Diversity). However, within many ecosystems,

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