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Divergence of riparian forest composition and functional traits from natural succession along a degraded river with multiple stressor legacies

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Prolonged exposure to human induced-stressors can profoundly modify the natural trajectory of ecosystems. Predicting how ecosystems respond under stress requires understanding how physical and biological properties

of degraded systems parallel or deviate over time from those of near-natural systems. Utilizing comprehensive forest inventory datasets, we used a paired chronosequence modelling approach to test the effects of long-term channelization and flow regulation of a large river on changes in abiotic conditions and related riparian forest attributes across a range of successional phases. By comparing ecological trajectories between the highly degraded Rhône and the relatively unmodified Drôme rivers, we demonstrated a rapid, strong and likely irreversible divergence in forest succession between the two rivers. The vast majority of metrics measuring life history traits, stand structure, and community composition varied with stand age but diverged significantly between rivers, concurrent with large differences in hydrologic and geomorphic trajectories. Channelization and flow regulation induced a more rapid terrestrialization of the river channel margins along the Rhône River and accelerated change in stand attributes, from pioneer-dominated stands to a mature successional phase dominated by non-native species. Relative to the Drôme, dispersion of trait values was higher in young forest stands along the Rhône, indicating a rapid assembly of functionally different species and an accelerated transition to post-pioneer communities. This study demonstrated that human modifications to the hydro-geomorphic regime have induced acute and sustained changes in environmental conditions, therefore altering the structure and composition of riparian forests. The speed, strength and persistence of the changes suggest that the Rhône River floodplain forests have strongly diverged from natural systems under persistent multiple stressors during the past two centuries. These results reinforce the importance of considering historical changes in environmental conditions to determine ecological trajectories in riparian ecosystems, as has been shown for old fields and other successional contexts.

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