

Evolution of channel morphology in a large river subject to rectification

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Many large rivers in Europe have been subject to heavy modifications for land reclamation and flood mitigation through centuries. As a consequence, the study of the pre-alteration morphological patterns and of the related channel evolution following the anthropic modifications is rather challenging. The Adige River is the second longest river in Italy and drains 12,100 km² of the Eastern Italian Alps. Currently, it features a straight to sinuous pattern and an average channel width of 40-60 m. A massive rectification scheme aiming at land reclamation of the Adige valley bottom was planned in the late 18th century, and implemented starting in the first decades of 19th century. Nowadays, it can be considered one of the most altered rivers in Italy, not only due to channelization but also to the presence of many hydropower reservoirs and check-dams along its tributaries.

This study aims to the reconstruction of the Adige River's evolutionary trajectory over the last 250 years, and comprehension of key control factors driving channel evolution.

A multi-temporal analysis of historical maps and orthophotos from 1776, to 2006 was performed in order to assess channel modifications. In addition, land use changes at the basin scale, years of occurrence of most relevant flood events, and climate variability over the investigated period were analyzed. The detailed topographical map surveyed in 1803 was taken as a reference, and the study sector (115 km long) was divided into 39 reaches. Active channel, bars, riparian vegetation and channel control works were geo-processed.

Results show that the Adige River suffered the most intense alteration from 1803 to 1855, and especially from 1847 to 1855. During this period channel narrowing ranged from 14% to 70%, coupled with pattern changes and decreases in the braiding, sinuosity and anabranching indices. Most important alterations occurred in the reaches presenting a multi-thread morphology in 1803, as their average width declined from 220 m to 110 m. On the contrary, reaches originally sinuous remained quite stable, decreasing from 100 m to 95 m. Overall, relevant channel morphology modifications took place by 1855, when channel configuration had shifted from alternating longitudinal sequences of multi-thread and single-thread, at the beginning of the 19th century, to mainly single-thread. Total length of multi-thread reaches shifted from 31% in 1805, to 22% in 1847, to 8% in the 1855. On the contrary, sinuous and straight patterns increased from 26% (in 1803) to 62% (in 1847), up to 77% of the whole studied river length in 1855. Nevertheless, overall increases in channel braiding and mean channel width was observed downstream of the confluences with the main tributaries.

Analysis of the evolutionary trajectory of channel morphology and of controlling factors, shows that human disturbances have largely prevailed over climatic influences in constraining the Adige's dynamics and morphology, mainly because of channelization causing sharp changes in channel pattern and width that occurred during the 19th century.