Hydrologic alteration values

Minho River, Portugal (Fig. 1).

Studied river = 62.5 km (Portuguese part)
(25 sampling units with 2.5 km each one)

Several dams along Minho River mainly constructed in 1950 and 1960.

Flow Data
94 year mean daily flow data were obtained from Portuguese Water Information System (SNIRH) and Spanish Water Information System (SIAS).

• Pre-Empact 1920-1966
• Post-Empact 1966-2014

Maps
• Historical maps 1898
• Contemporaneous maps 2016

Summary

Hydrologic alterations in large rivers result from a long history of human interventions (Poff et al., 2007). In this study, we evaluate the causes and effects of hydrogeomorphic alterations in the Iberian Minho River using a platform change analysis. We performed a temporal comparison using historical maps (nineteenth century) and contemporaneous maps. The results revealed a significant alteration in flow regime, active channel geometry and sinuosity indices, representing an overall degradation of river condition. We also noticed a drastic diminution in the number and total area occupied by lentic habitats causing fished habitat shifts. Changes were less evident in upstream sampling units due to diverse Land Use/Land Cover (LULC) changes combine with some geological constraints. These responses were consistent with reductions in intake and inter-annual discharge, flood disturbance decrease, and minimum flow increase during the summer season. This work allows to understand the evolutionary trajectory of large fluvial systems over more than 100 years and to implement concrete measures for sustainable river management.

Methodology

2.1 Indicators of Hydrological Alteration (HIA)

• 33 IHR and 34 Environmental Flow Components (EFC) by IHA software, Version 7.1, (Richer et al., 1996).

2.2 Maps Processing

• Georeferencing of historical maps through ground control points method (GCP), WGS84 coordinate system (Aguiar et al., 2016; Fernandes et al., 2011).
• Hydrogeomorphic features extraction
• Land Use/Land Cover (LULC) mapping

2.3 Longitudinal Alteration Index (LAI)

This index is measured by using (Eq. 1):

LAI = (La1898 - La41898) / La41898

2.4 Active Channel Alteration Index (ACAI)

This index is measured by using (Eq. 2):

ACAI = (Pa1898 - Pa41898) / Pa41898

2.5 River Width Alteration Index (RWAI)

This index is measured by using (Eq. 3):

RWAI = (W41898 - W42016) / W41898

2.6 Sinuosity Index (SI)

SI = (Channel Length) / (Valley Length)

Study Area and Sampling Design

Minho River, Portugal (Fig. 1).

Results

Fig 3. Hydrologic alteration indices are characterized by relatively high changes along the course (especially during October, June, August, September and November) (i.e., 1-day, 3-day, 7-day, 30-day and 90-day)

Fig 4. Percentage of the study area occupied by each LULC class in 1898 and 2007, and post impact period. Flow alteration is indicated through two river stages: pre-impact (blue line) and post-impact period. Significant decrease of SI (especially dikes, groins, etc.) is due to channel simplification and straightening (permanent), and increase of low flows along the whole river, while longitudinal alteration is more evident at the downstream part.

Fig 6. Longitudinal (green line) and active channel (blue line) alterations along the course, from upstream to downstream. Active channel alteration reveals high alteration along the whole river while longitudinal alteration is more evident at the downstream part.

Fig 7. Longitudinal (blue line) and active channel (green line) alterations along the course, from upstream to downstream. Active channel alteration reveals high alteration along the whole river while longitudinal alteration is more evident at the downstream part.

Fig 8. Percentages of the study area occupied by each LULC class in 1898 and 2007, and post impact period. Flow alteration is indicated through two river stages: pre-impact (blue line) and post-impact period. Significant decrease of SI (especially dikes, groins, etc.) is due to channel simplification and straightening (permanent), and increase of low flows along the whole river, while longitudinal alteration is more evident at the downstream part.

Five-monthly inter-annual flow variability, regarding pre- and post-impact period. Flow alteration is indicated through two river stages: pre-impact (blue line) and post-impact period. Significant decrease of SI (especially dikes, groins, etc.) is due to channel simplification and straightening (permanent), and increase of low flows along the whole river, while longitudinal alteration is more evident at the downstream part.

Conclusions

• Flow Alteration – High reduction of floods and increase of low flows—Main drivers of ecosystem integrity!
• Longitudinal Alteration Index (LAI) – Low for the upstream sections, High for the lower sections
• Active Channel Alteration Index (ACAI) – Along the whole river with a significant increase in the lower sections
• Sinuosity Index (SI) – Decrease of SI, critical situation at the lower part where river morphology tends to changes into a straight type.
• LULC – Significant changes for the forest an artificial land uses

References


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