



FORUM

The need for a hydromorphological approach to Chilean river management

La necesidad de un enfoque hidromorfológico para la gestión de los ríos chilenos

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ABSTRACT

The manuscript reflects the opinion of the authors about the need for a hydromorphological approach for the management of Chilean rivers. A brief state-of-the-art of the recent scientific advances on hydromorphological approach to river management is presented, as well as a general overview of the conditions of Chilean rivers and the mayor disturbances they suffer. Moreover, the need to take into account both direct and indirect services provided by rivers in the decision making process on river management is underlined. Hydromorphology is claimed to be a main element to be considered while assessing the ecological state of rivers. Understanding how the hydrological and morphological variables interact dynamically is indeed key to assess the presence or absence of dynamic equilibrium, a condition that, in turn, promotes both habitat diversity and self-sustainable aquatic and riparian ecosystems. The authors also emphasized the need for a change of paradigm in current Chilean rivers management practices, by developing a unified framework to assess hydromorphological and ecological river conditions. In addition, the implementation of specific legislation aimed at promoting ecological and geomorphological standards in river management practice, and the strengthening and widening of the academic teaching of fluvial ecology and geomorphology is suggested.

Key words: Chile, fluvial ecology, fluvial geomorphology, management, rivers.

RESUMEN

El manuscrito refleja la opinión de los autores acerca de la necesidad de aplicar un enfoque hidromorfológico para la gestión de los ríos chilenos. Se presenta una breve reseña de los últimos avances científicos sobre el enfoque hidromorfológico en la gestión de ríos, así como una visión general de las condiciones de los ríos chilenos y sus mayores perturbaciones. Por otra parte, se hace énfasis en la necesidad de incluir en la toma de decisiones los servicios directos como los indirectos proporcionados por los ríos. Se afirma que la hidromorfología es un elemento fundamental a considerar al determinar el estado ecológico de los ríos. La comprensión de cómo las variables hidrológicas y morfológicas interactúan de forma dinámica es sin duda clave para evaluar la presencia o ausencia de un equilibrio dinámico, una condición que, a su vez, fomenta tanto la diversidad de hábitat como el desarrollo sostenible de los ecosistemas acuáticos y ribereños. Los autores concluyen que es necesario cambiar el paradigma actual de gestión aplicado en los ríos chilenos desarrollando una estrategia que permita evaluar las condiciones hidromorfológicas y ecológicas de los ríos. Además, sugieren implementar legislación específica orientada a promover estándares ecológicos y geomorfológicos en la práctica de gestión, con el apoyo de un fortalecimiento y una ampliación de la enseñanza académica de la geomorfología y ecología fluvial.

Palabras clave: Chile, ecología fluvial, geomorfología fluvial, gestión, ríos.

THE RELEVANCE AND MULTIPLE SERVICES OF RIVER SYSTEMS

River systems convey as streamflow the precipitation collected in their watersheds. As such, rivers are the final expression of a wide range of geological, geomorphological, hydro-meteorological, ecological and biological processes acting at a variety of spatial and temporal scales over their drainage basins.

Rivers and their closely associated floodplains represent corridors of extraordinary ecological, environmental, social, cultural, and economic value. Far from being mere water conveyers, streams and rivers are complex ecosystems where the three-dimensional interaction of streamflow, geological substratum, relief, sediments, dead wood, and vegetation creates a heterogeneous array of ever-changing fluvial forms, which provide a shifting mosaic of habitat patches for aquatic and riparian organisms (Stanford et al. 2005). For example, the variable velocity, depth and turbulence maintain diverse substrates, thermal refugia, and hydraulic conditions that are essential for the various life-stages of aquatic biota (Jowett 1993).

At the same time, rivers supply humans with a set of resources and services such as water for domestic, agricultural, hydropower and industrial use, mining of sand and gravel, waterways for navigation, fishing, waste disposal, as well as recreational and aesthetic uses. Furthermore, rivers represent a fundamental source of cultural and social values for riverine communities. Degradation of these ecosystems has been so severe that massive investments in wastewater treatment and river restoration are now needed in many countries worldwide (Bernhardt et al. 2005, Palmer et al. 2005). For these reasons, it is imperative to ensure sustainability of river management strategies by means of systemic and integrated decision-making policies (i.e. EU Water Framework Directive, 2000/60).

It is known that rivers adjust their local forms and processes depending on ranges of available water and sediment (Leopold et al. 1964). Thus fluvial systems are sensitive to changes on magnitude, frequency and/or location of these two sources, and respond to a continuous feedback that seek a state of dynamic equilibrium (i.e. equivalent rates

of erosion and deposition at various spatial and temporal scales). Increases in human population and industrial, commercial, and residential development certainly results in heavy impacts on the amount of water and sediment available at different scales within the fluvial system. This, affect the river morphological and ecological regimes since the previous balance conditions are rearranged to fit new scenario. Despite these changes, and up to a few decades ago, the main indicators for assessing the quality of fluvial freshwater ecosystems were limited to water chemistry (mostly nutrients) and living organisms. Slowly, hydro-ecological indicators referring to minimum or ecological discharge and hydropeaking were implemented in order to assess the quality of river systems affected by human disturbances (e.g., hydropower generation and flow diversions) and recently, and especially due to the considerable impulse given by the European Water Framework Directive (EU 2000), hydromorphology has been introduced as one of the main elements to be evaluated, besides water quality and biological aspects, in order to assess the ecological state of river systems.

This recent focus on hydromorphology derives from the fact that several investigation have proven that providing natural hydrological and sedimentological regimes, river processes will, at some point, operate in a state of dynamic equilibrium and thus promote habitat diversity and sustainable functioning of aquatic and riparian ecosystems (e.g., Palmer et al. 2005).

FLUVIAL GEOMORPHOLOGY AND HYDRO-MORPHOLOGY

Fluvial geomorphology has been defined as the study of sediment sources, fluxes and storage within the river catchment and channel over short, medium and longer time scales and of the resultant channel and floodplain morphology (Newson & Sear 1993). More broadly, it examines and predicts the forms and processes that operate in river systems and the landforms that they create. Understanding the geomorphology of a fluvial system is therefore vital to the understanding of both the current processes and dynamics of rivers and how they may respond to future changes.