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Creating a catchment scale perspective for river restoration

L. Benda[1], **D. Miller**[1], **and J. Barquín**[2]

[1]Earth Systems Institute, Mt. Shasta, California, Seattle, Washington, USA
[2]IH-Cantabria, Universidad de Cantabria, Avda. Los Castros s/n, 39005, Santander (Cantabria), Spain

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Abstract. One of the major challenges in river restoration is to identify the natural fluvial landscape in catchments with a long history of river control. Intensive land use on valley floors often predates the earliest remote sensing: levees, dikes, dams, and other structures alter valley-floor morphology, river channels and flow regimes. Consequently, morphological patterns indicative of the fluvial landscape including multiple channels, extensive floodplains, wetlands, and fluvial-riparian and tributary-confluence dynamics can be obscured, and information to develop appropriate and cost effective river restoration strategies can be unavailable. This is the case in the Pas River catchment in northern Spain (650 km^2), in which land use and development have obscured the natural fluvial landscape in many parts of the basin. To address this issue we used computer tools to examine the spatial patterns of fluvial landscapes that are associated with five domains of hydro-geomorphic processes and landforms. Using a 5-m digital elevation model, valley-floor surfaces were mapped according to elevation above the channel and proximity to key geomorphic processes. The predicted fluvial landscape is patchily distributed according to hillslope and valley topography, river network structure, and channel elevation profiles. The vast majority of the fluvial landscape in the main segments of the Pas River catchment is presently masked by human infrastructure, with only 15 % not impacted by river control structures and development. The reconstructed fluvial landscape provides a catchment scale context to support restoration planning, in which areas of potential ecological productivity and diversity could be targeted for in-channel, floodplain and riparian restoration projects.

Correspondence to: L. Benda
(leebenda@earthsystems.net)

1 Introduction

There is a growing consensus that a catchment scale perspective that considers the complete fluvial landscape is critical for successful river restoration (Logan and Furze, 2002; Bannister et al., 2005; Kondolf et al., 2007; Nilsson et al., 2007). The fluvial landscape includes all landforms and biologic communities that affect and are affected by the flow of water, sediment and organic materials within the hierarchically branching network of river corridors. The fluvial landscape is comprised of active and former river and side channels, off-channel water bodies, confluence environments, wetlands, floodplains, terraces, and riparian vegetation (Fausch et al., 2002; Benda et al., 2004a), and subsurface patterns of hyporheic flow and associated organisms (Poole et al., 2006).

The processes and landforms that comprise the fluvial landscape vary with location in a catchment governed by hillslope and valley topography, river network structure, channel elevation profiles, basin scale, and the stochastic nature of climate (Frissel and Nawa, 1992; Reeves et al., 1995; Naiman et al., 1992; Poff et al., 1997; Benda et al., 1998; Ward et al., 2002). The fluvial landscape is thus a dynamic entity, formed and altered over time by the storms, erosion and floods that bring water, sediment and organic material downslope and downstream from all points in a catchment.

Regulating discharge with dams and weirs, hardening channel banks with revetments, constructing dikes and levees, dredging channels, and draining wetlands have furthered human occupation and development of productive, flood prone lands. However, these activities individually, and in concert, have acted to eliminate the fluvial landscape or to obscure evidence of it over the last couple of centuries (Sedell and Luchessa, 1981; Logan and Furze, 2002). River control activities have reduced in-channel and off-channel