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Assessment of dam impacts on sediment dynamics and channel geometry in complex anthropogenic systems: feedbacks from comparative study of the Sacramento and the Ain Rivers

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Numerous studies have demonstrated the complexity of river adjustments downstream dams (Williams and Wolman, 1984; Brandt, 2000; Petts and Gurnell, 2005), depending on many parameters such catchment geology context (Grant et al., 2003), land use, pre-dam sediment supply and transport regime, degree of hydrologic alteration (Church, 1995; Schmidt and Wilcock, 2008), and dam characteristics and operation (Brewer and Lewin, 1998). Dam impact is particularly difficult to evaluate in river systems where human pressures are old and manifold, and where dam-induced impacts can be compounded by other human influences, such as in-channel aggregate mining (Kondolf 1997). In such cases, it may be challenging to sort out the causal links between dam-induced disruptions and resulting channel adjustment. To illustrate these problems, we introduce two complex case studies, the Ain (France) and Sacramento (California) Rivers, both freely meandering rivers regulated since mid-20th century, whose sedimentary and morphologic dynamic have been modified in different ways since the end of the 19th century. Dam impacts can be distinguished from the effects of other factors such as floodplain disconnection by flood-control infrastructure, land-use changes, and artificial meander-bend cutoff. The Ain River evinces a significant sediment deficit, which results in bed degradation, decrease in area of gravel bars , and reduced lateral channel migration. As a result, sediment supply is reduced not only from trapping by upstream reservoirs but also by reduced bank erosion. In the case of the Sacramento, the impact of the dam is not as clear as on the Ain due to major effects of prior pressures on the channel. Using aerial imagery and field measurements (grain-size measurements. . .), we led a spatiotemporal study of several morphologic parameters (active channel narrowing, gravel bar areas . . .) to underline the relative contribution of dams to the contemporary channel evolution. These analyses are now used as fundamental basis to define sediment management plans pertinent and adapted to each context. Moreover, in such complex river systems, by underlining dam effects among several potential causes and adjustments, these studies provide strong arguments to involve dam and river managers into river dynamic restoration plans.