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Institutional requirements for watershed cumulative effects assessment and management: Lessons from a Canadian trans-boundary watershed

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ABSTRACT

Watersheds are under increasing stress from the cumulative environmental effects of water and land use disturbances caused by both anthropogenic and natural causes. Yet, while the science of watershed cumulative effects assessment and management (CEAM) is advancing much less is known about the institutional and capacity requirements to implement and sustain watershed CEAM. Based on lessons from a transboundary watershed in western Canada this paper presents eight institutional requirements, or requisites, for the implementation of watershed-based CEAM. We suggest that effective watershed CEAM requires government leadership to move beyond the current inward focus on project approvals toward an outward focus on the cumulative effects of all disturbances in a watershed; complementary monitoring programs at the project and watershed scale, and a means to ensure the sharing of monitoring data across watershed stakeholders; and a nested planning framework to coordinate watershed planning objectives with individual project impact assessment and decision making. Results of this paper show that simply scaling up from individual project-based assessments to the watershed scale exposes many institutional constraints that can impede CEAM action.

Introduction

The cumulative effects of freshwater withdrawals and watershed alterations, combined with the stress of anthropogenic disturbances on the landscape, are placing the sustainability of global freshwater systems at risk (Schindler and Donahue, 2006; Gleick et al., 2007). The need to assess and manage cumulative effects on freshwater systems is timely (e.g., Dubé et al., 2006; Squires et al., 2010; Noble et al., 2011). However, there are constant and consistent messages that the current practice of watershed cumulative effects assessment and management (CEAM) is simply not working (Dubé, 2003; Seitz et al., 2011).

Part of the challenge is that the cumulative effects of multiple stressors on freshwater systems are seldom, if ever, considered by land use planners and policy makers (Schindler and Donahue, 2006). Rather, development activities are typically considered on a project-by-project basis with little regard for the effects that may result in combination with other past, present, and reasonably foreseeable planning and development actions (Duinker and Greig, 2006). As a result, CEAM for freshwater systems has been narrow and reactive as well as divorced from the broader planning and decision-making context. Moreover, CEAM is poorly equipped to deal with cumulative change at a watershed scale (Seitz et al., 2011).

In Canada, there have been several science-based initiatives to advance watershed CEAM and monitoring programs (e.g., Culp et al., 2000; Munkittrick et al., 2000; Dubé et al., 2006; Squires et al., 2010), all based on the premise that the watershed provides an appropriate context to effectively understand and manage cumulative effects to freshwater systems. However, watershed-scale CEAM in Canada has experienced only mixed success (Ayles et al., 2004; Ball, 2010; Schindler, 2010). There are two foundations to CEAM: the science aspect of understanding cumulative effects pathways and stress–response relationships; and the institutional aspect of CEAM implementation, including impact assessment, evaluation and monitoring to effectively manage cumulative effects. We argue that although the science to advance watershed CEAM is receiving increased attention, what is needed to implement and sustain watershed CEAM programs has yet to be addressed in any substantive way (Noble et al., 2011; Seitz et al., 2011). Institutional constraints, often discussed in terms of capacity in the water resource management literature (see Timmer et al., 2007; de Loë et al., 2002; Patrick et al., 2008), can pose significant barriers to the assessment and management of cumulative environmental effects (Noble, 2010).

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This paper presents eight institutional requirements, or requisites, for the implementation of watershed-based CEAM. The requisites are developed based on a case study of the South Saskatchewan watershed, a transboundary watershed in western Canada; however, we suggest that the requisites are not unique to the South Saskatchewan context. The South Saskatchewan watershed, like most of Canada's watersheds, is subject to multiple jurisdictions and land uses and is characterized by growing concerns over water security amid a future of climate uncertainty (Wheaton et al., 2008; Patrick, 2011). In the sections that follow we first provide context for the current state of watershed-based CEAM in Canada, followed by a description of the study area and research methods. We then present eight requisites for effective watershed CEAM, and discuss the implications for advancing watershed-based CEAM practice.

Watershed cumulative effects assessment and management

The health of a river system is largely a function of in-stream use, allocation and interactions and processes that occur on the landscape within the boundary of the river system. Cumulative effects to watersheds thus include any changes that involve watershed-scale processes (Reid, 1993), and also landscape disturbances that occur in the drainage area with potential to adversely affect water quality or quantity (Seitz et al., 2011). Although individual project proponents are often required to consider the potential cumulative impacts of their projects under legislated environmental assessment (EA), specifically for large projects such as pipelines and mining operations, project-based EA alone is simply too restrictive to effectively address cumulative environmental change (Gunn and Noble, 2009; Franks et al., 2010). For example, many of the individual point and non-point source stresses that contribute to cumulative effects in a watershed, including many small road projects, agricultural operations and storm water drainage alterations, are either deemed individually too insignificant to trigger an EA process or they simply fall outside the scope of EA requirements (Noble et al., 2011). In the Canadian context, these limitations to project-based EA have been exacerbated by recent reforms to EA regulations that further exempt many small projects from assessment in order to add efficiencies to the regulatory process.[1]

There is now a collective understanding that CEAM must advance beyond the evaluation of site-specific, direct and indirect project impacts to encompass broader regional understandings and considerations of the sources of cumulative environmental change (e.g. Dubé et al., 2006; Canadian Council of Ministers of the Environment, 2009; Gunn and Noble, 2009; Seitz et al., 2011). But, the majority of CEAM initiatives for watersheds, particularly in the Canadian context, have been "one-offs" lacking integration into broader watershed planning, and have had limited influence over development decisions taken at the project level (Schindler and Donahue, 2006; Noble, 2010; Seitz et al., 2011). This, we argue, is an implementation gap and in particular one that revolves around a poor understanding of the specific institutional requirements not only to support, but also to deliver, effective CEAM.

Institutional and capacity-related issues are a prominent concern in water resource management (de Loë and Kreutzwiser, 2005; Patrick et al., 2008), and arguably amongst the most significant challenges to watershed CEAM. Based on experiences with floodplain restoration in the UK, for example, Adams et al. (2005) and Hughes et al. (2001) report that the major challenge in scaling up from the project scale to the watershed scale lies not solely in understanding ecological interactions but also in the additional institutional and management complexity that is involved in such broader, watershed-based planning and management processes. The urgency of advancing CEAM to include the regional scale was emphasized on the international stage in 2008 at a global conference on CEAM organized by the International Association for Impact Assessment, the world's leading authority on impact assessment. Identifying the institutional and capacity needs to support CEAM was identified as one of three priorities for advancing CEAM, and the watershed was noted as an important spatial unit of application.[2]

There is a growing body of literature informing the 'science' of CEAM (Moss and Newig, 2010; Squires et al., 2010; Greig and Duinker, 2011) and on the need to advance CEAM from the project to the regional scale (Duinker and Greig, 2006; João, 2007; Gunn and Noble, 2011). However, there remains limited understanding of the institutional aspects of CEAM and of the capacity requirements to implement and sustain CEAM beyond the scope and scale of the individual development project. Investigation of the underlying requisites for successful CEAM at the watershed-scale is long overdue.

Study area and methods

South Saskatchewan watershed

The South Saskatchewan watershed (SSW) extends across the southern regions of the provinces of Alberta and Saskatchewan (Fig. 1). Originating on the eastern slopes of the Rocky Mountains, the South Saskatchewan River flows 1392 km before joining the North Saskatchewan River, which drains into Hudson Bay, Manitoba. The total population of the SSW is approximately 2.2 million, of which the majority resides in urban centers (Bruneau et al., 2009). Agriculture, including crop production and livestock grazing, is the primary land use (Martz et al., 2007). Other land and water uses include coal-fired and hydroelectric power generating stations; oil and gas extraction; manufacturing and processing; as well as several gravel and potash mines.

The 2010 'State of the Watershed Report' (Saskatchewan Watershed Authority, 2010) classifies the overall condition of the watershed as 'stressed', meaning that the watershed has shown no significant degradation of function or in the services it provides, but has lost its resistance to change. Water quality in the watershed is classified as 'healthy' based on the Canadian Water Quality Index (Saskatchewan Watershed Authority, 2010), but with growing concerns over nutrient loading due to agriculture and urban runoff. The continuing practice of wetland drainage to increase farmland area also remains a significant concern. Under an intra-provincial agreement, 50 percent of the flow of the South Saskatchewan River must be passed on from Alberta to Saskatchewan. In dry years this poses a significant management challenge given water demands in Alberta (Schindler and Donahue, 2006). Squires et al. (2010) report that summer flows in the South Saskatchewan have been reduced by 84% since the early 20th century, and its major tributaries have all been subjected to multiple impoundments and large withdrawals. Agricultural activities account for approximately 85% of total water withdrawals (Martz et al., 2007). These and other water quantity and quality concerns, as well as the multi-jurisdictional boundary of

[1] For example, the 2009 Canadian federal budget bill implementation statute, and Bill C-9 for the 2010 federal budget, included provisions for EA exemptions for many small infrastructure project and the ability to avoid detailed EAs on large projects by breaking them up into smaller projects. For further discussion see Noble (2010), and Hazell (2010) 'How to get rid of pesky environmental laws in a minority parliament', available at http://www.canadianlawyermag.com.

[2] See http://www.iaia.org/iaia08calgary/ for on-line conference proceedings and speaker audio presentations.