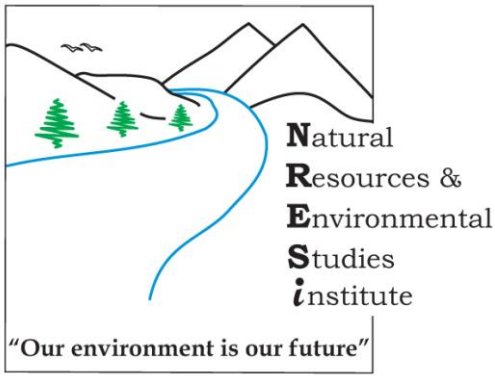

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CUMULATIVE ENVIRONMENTAL EFFECTS AND THE TYRANNY OF SMALL DECISIONS: TOWARDS MEANINGFUL CUMULATIVE EFFECTS ASSESSMENT AND MANAGEMENT

BY
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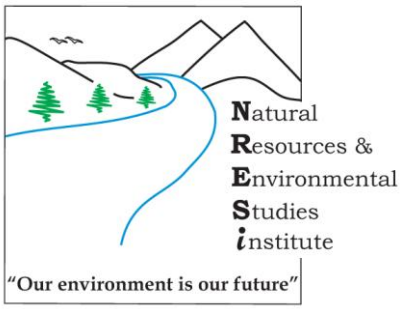

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Abstract

Recognizing that each additional disturbance in a region can represent a high marginal cost to the environment, there is an increasing awareness of the need to better assess and manage cumulative environmental effects. Yet, cumulative effects are one of the most perplexing issues in environmental assessment and natural resource management, and the practice of cumulative effects assessment has been falling significantly short of its promise. Practiced largely in the context of project-based decision making, the current approach to cumulative effects assessment does not provide the results needed to understand broader environmental change or to make longer-term decisions concerning the sustainability of current and future development actions. This paper attempts to unpack the current approach to cumulative effects assessment, and to identify a means to move toward more meaningful practice. It argues that cumulative effects assessment requires a much more integrative and strategic framework than what is currently practiced, operating at a regional scale and both informing and informed by higher level policies and plans and lower level project actions. In order for this to happen, we must rethink our assumptions about the nature of cumulative effects; move toward the integration of assessment, science, and management; and invest in the capacity needed to implement and sustain cumulative effects assessment systems and practices.

Introduction

At least one of Canada's major western river systems is more than 100% allocated for water usage (Schindler and Donahue 2006). Between 1966 and 1976, and 1996 and 2006 cumulative annual flow in the Athabasca River decreased by more than 500 m^3/s and temperature increased by 1.4°C (Squires et al. 2010). There are more than 1,500 gas wells and over 3,000 km of roads in a 1,900 km^2 area of native prairie and active sand dunes in southwest Saskatchewan (Noble 2008). In hindsight, the cumulative effects of seemingly small and isolated decisions are easily recognizable. When planning for the present and future development of the environment and natural resources, however, cumulative effects seem quite elusive.

The notion of cumulative effects is by no means new, and cumulative effects assessment (CEA) has been central to debate in Canadian environmental assessment (EA) for more than 35 years. However, and notwithstanding the volumes of academic literature on the subject, numerous case studies, increased public awareness, and evolving guidance and regulation, cumulative environmental effects appear to go 'unchecked' when decisions are being made about proposed development actions.

The effects of human development on the landscape, when assessed, continue to be assessed and managed on a project-by-project basis with little regard for *desirable* futures, outcomes, assimilative capacity, or the effects that might result from proposed initiatives in combination with other past, present, and future anthropogenic-induced disturbances. As a result, recent reviews of the state CEA in Canada suggest that CEA is simply not working; it remains limited in spatial and temporal scale, and reactive and divorced from the broader planning and decision-making context (see Harriman and Noble 2008).

This paper attempts to 'unpack' the current practice of CEA in Canada, and proposes a means to rebuild and move forward toward meaningful CEA and management. In the section that follows, the nature of cumulative environmental effects is introduced. This is followed by a critical analysis of CEA and the factors contributing to its current state of practice. Attention then turns toward requisites for meaningful CEA, arguing the need to: rethink our assumptions about cumulative effects; integrate the current silos of CEA assessment, science, and management; and invest in the capacity-building requirements to implement and sustain effective CEA systems and practices.

Cumulative Environmental Effects

There is no universally accepted definition of cumulative effects, and various definitions have been proposed including:

- the accumulation of human-induced changes in Valued Ecosystem Components (VECs) across space and over time that occur in an additive or interactive manner (Spaling and Smit 1993);
- changes to the environment caused by an action in combination with other past, present and future human actions (Hegmann et al. 1999);
- effects of a project under review in combination with the effects of other past, present or future human activities (US NEPA CEQ Regulations); and
- the temporal and spatial accumulation of change in environmental systems in an additive or interactive manner (Spaling and Smit 1995).

Peterson et al. (1987), Sonntag et al. (1987), and Hegmann et al. (1999) further identify four broad types of cumulative effects: i)

linear additive effects, that are incremental additions to, or deletions from, a fixed storage where each increment or deletion has the same individual effect; ii) *amplifying or exponential effects*, where each incremental addition to, or deletion from, a resource base has a larger effect than the one preceding; iii) *discontinuous effects*, where incremental additions have no apparent effect until a certain threshold is reached, at which time change occurs rapidly; and iv) *structural surprises*, when changes occur as a result of multiple stressors or activities in a defined region. Simply put, cumulative effects are not only additive in which individual actions contribute incremental levels of disturbance, but also synergistic in which the total effect of interactions can be greater than the sum of effects of individual processes (Seitz et al. 2011).

Now common terminology within the impact assessment and environmental management community, it was not until the mid-1980s, as a priority of the Canadian Environmental Assessment Research Council (CEARC) (Duinker 1994), that cumulative effects and CEA started to receive any real attention. Cumulative effects assessment is broadly understood to be the process of systematically assessing impacts resulting from incremental, accumulating, and interacting stressors over space and time (Noble 2010, Squires et al. 2010). It refers to the process of analyzing and assessing cumulative environmental change (Spaling and Smit 1993)—that is, identifying environmental effects, and pathways that lead to those effects, in order to avoid, wherever possible, the potential triggers and stressors that lead to cumulative effects.

When CEA first emerged in Canada it was largely concerned with stressor-based impact prediction or predicting the direct, indirect, and cumulative impacts and interactions resulting from the actions of a single project development (see Dubé 2003). The objective was, and often still is under project-based EA, to identify how stressors associated with a proposed physical undertaking might affect environmental components, and how such impacts might accumulate or interact with other environmental components affected by the same undertaking within the local spatial and temporal environment of the proposed project.

The assessment of cumulative environmental effects is now an accepted part of many project-based EA systems and regulations across Canada (see Hanna 2009). In 1995, CEA became mandatory in Canada for all EAs completed at the federal level under the *Canadian Environmental Assessment Act*:

> *"Every screening or comprehensive study shall include a consideration of any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out"*. Sec. 16(1) (a)

In practice, however, reviews of the state of CEA in Canada suggest that the practice of CEA is falling significantly short of its promise.

The State of Cumulative Effects Assessment

Recent literature identifies several areas of deficiency in how we approach and manage cumulative environmental effects, including a weak interpretation of cumulative effects and a sustained focus on project approval rather than sustainability (e.g., Baxter et al. 2001, Dubé 2003, Noble 2005, Duinker and Greig 2006, Seabrook et al. 2006, Harriman and Noble 2008). Seitz et al. (2011) point out specific shortcomings concerning the lack of due consideration of cumulative effects in development decisions, arguing that amongst the major shortcomings is the limited spatial and temporal scale of assessment, the lack of a sound scientific basis, and the lack of consideration of the interacting effects of

multiple stressors over space and time. As a result, and for various reasons discussed below, Duinker and Greig (2006: 153) suggest that "…continuing the kinds and qualities of CEA currently undertaken may be doing more harm than good."

Not seeing the forest for the trees

The first issue concerns the scope of current EA practice and what *doesn't* get assessed. Cumulative effects are often characterized as 'death by a thousand cuts', or the 'tyranny of small decisions'; but cumulative effects are rarely recognized as such in practice. For many small projects (e.g., access roads, culverts, oil exploration blocks), assessments are too restricted in both time and resources to effectively integrate CEA science – if such projects are assessed at all (Seitz et al. 2011, Noble et al. 2011).

In southwest Saskatchewan, for example, a 1,940 km^2 land base, consisting of many rare and endangered environmental features, and landscapes of significant Aboriginal value (Scientific Advisory Committee 2007), is subject to the pressures of approximately 1,500 natural gas wells, cattle grazing, and more than 3,000 km of roads and trails (see Noble 2008). Natural gas development in the region commenced in the early 1950s; current production is estimated at over 180 billion ft^3 with proven, probable and possible reserves estimated at nearly 670 billion ft^3 (see GLJ Petroleum Consultants Ltd 2006). Gas leases and land leased for future gas development account for approximately 70% of the total land base (Scientific Advisory Committee 2007). Of the 1,500 wells in the area, only 5 proposals were subject to full environmental assessment (MacFarlane 2006), all of which concluded non-significant environmental impacts. There was no discussion of potential cumulative effects.

Part of the reason for this type of cumulative effects scenario is that in many EA systems potential cumulative effects are simply 'screened out'; individual developments are evaluated independently of other activities on the landscape, and thus deemed 'unlikely' to cause significant adverse environmental effects. There is no real opportunity for the consideration of cumulative effects. Most jurisdictions in Canada, and internationally, allow for more or less ambitious streams of assessment depending on the nature of the proposed development and the potential for unknown or significant effects. At the Canadian federal level, for example, there are four different types of assessment, each addressing projects of increasing complexity and significance: screening assessment, comprehensive study, mediation, and review panel. Approximately 99 percent of all federal EAs are screening assessments – the most basic level of assessment, designed for routine undertakings where the level of uncertainty is considered low (see Herring 2009), and significant effects, in particular cumulative effects, are seen as unlikely.

In 2007, for example, the Saskatchewan Ministry of Highways and Infrastructure received approval for an approximately 110 km highway-twinning project to improve the transportation corridor between two of the province's major urban centers. A permit was granted for highway twinning in the absence of any environmental assessment. The only requirement for managing the project's potential impacts was set out in the construction permit, stating: "wetland and upland mitigation guidelines for road construction" shall be adhered to (see Nielsen 2010). The project was approved in absence of EA based on the notion that, should proper mitigation be followed, significant effects were unlikely. As of late 2009, approximately 23 km of highway have been twinned and are in use. Nielsen (2010) has since shown that more than 120 wetlands, wholly or in part (50.08 ha), are located within the 31 m highway right-of-way construction zone and

will be directly affected; 458 wetlands (1,115 ha) are located within 500 m of the highway and considered at risk in terms of functional loss due to project actions and other induced actions (e.g., agricultural land drainage practices) associated with new road and ditch constructions (see Noble et al. 2011). Under such approaches to project assessment, potential cumulative effects are screened-out of not only impact assessment, but also impact management.

Conflicting mandates

The second issue concerns the often-conflicting mandates of the processes in place to assess and approve development projects, and the intent of CEA. The goal of proponents when entering into EA is to secure project approval – to minimize the potential environmental effects of their project, or at least propose to do so, to the point of public and regulatory acceptability (Gunn and Noble 2010). The focus of assessment is thus on assessing and finding ways to minimize or manage project stressors. Viewed in this way, cumulative effects are understood to be accumulated 'environmental stressors' and refer to the direct and incremental effects of that project within the project's activity area, in combination with other projects. The proposed project serves as the focus of assessment, and emphasis is often on mitigating the additive contributions of the project. Under this sort of practice, Seitz et al. (2011) argue that scientific integrity in assessing and evaluating cumulative effects is typically limited to the extent necessary to obtain project approval:

> *"Project proponents are required under the* Canadian Environmental Assessment Act, *and also under various provincial EIA laws and regulations, to include CEA in evaluating the environmental impacts of their projects; however, the ultimate goal for proponents is to obtain project approval. As such, CEA in practice frequently operates in such as way that meets the needs of project proponents in securing project approval, rather than assessing cumulative effects"* (Seitz et al. 2011)

In contrast, cumulative effects can be viewed from the perspective of the environmental response of a *single receptor* to *total stressors* in a region. Under this view, CEA is focused first on the ways in which an environmental component or variable (e.g., water quality) responds to the various contributions and withdrawals of human actions (e.g., projects, land disturbances, run-off), and then on managing and directing current and future developments and land-uses (e.g., management strategies, targets, thresholds) that may cause further impact on that component or variable of concern (Canadian Council of Ministers of the Environment 2009, Noble and Gunn 2010). Assessing and managing the cumulative effects of all actions from the point of view of the environmental receptor is the key mandate - as opposed to evaluating, and minimizing to the point of acceptability, the individual stressors of a single project.

Matters of scale

In practice, cumulative effects are typically assessed at the spatial scale of the individual project, which is characteristic of project-based EA (Dubé 2003, Seitz et al. 2011). This project scale alone, however, is highly inadequate for capturing and managing cumulative effects; individual projects contribute only a small amount of impact or disturbance to resources and ecosystem functioning when considered next to the interacting processes that occur among multiple disturbances (Duinker and Greig 2006, Seitz et al. 2011, Noble et al. 2011). In recognition of the complexity of pathways and often-synergistic nature of cumulative environmental effects, there is general

agreement that CEA must go 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., Kennett 2002, Dalal-Clayton and Sadler 2005, Duinker and Greig 2006, Canadian Council of Ministers of the Environment 2009). This is recognized also by the *Canadian Environmental Assessment Act*, at least in principle, which states:

> *"The results of a study of the environmental effects of possible future projects in a region, in which a federal authority participates, …may be taken into account in conducting an environmental assessment of a project in the region, particularly in considering any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out."* (sec. 16 (2))

Adopting a regional approach to assessing and managing cumulative effects under the current constraints of EA practice is, however, overly ambitious. Notwithstanding the intent, CEA is often well beyond an individual project proponents' capabilities, and requires the participation and cooperation of regulators, stakeholders, and developers to establish environmental objectives and manage development on a regional basis, guided by broader environmental planning and sustainability goals. The problem, explains Creasey (2002), is that effectively assessing and managing cumulative effects requires going beyond a proponent's responsibility to manage incremental project effects, and having to address impacts beyond its immediately observable footprint. Problems surface when proponents attempt to address regional environmental management; that is, the effects of activities other than the one(s) that they have proposed. Assessing cumulative effects beyond the project is a complex undertaking that requires a level of conceptualization, analysis, and coordination that is beyond the knowledge, capacity, and mandate of project proponents (Gunn and Noble 2009a); unfortunately, neither is it always within the purview of provincial or regional authorities[1]. More regionally-based approaches to CEA necessitates information sharing and knowledge on a scale much greater than what is traditionally practiced in project-based EA; it requires knowledge of the current actions and proposed development plans of entirely different industries.

In the case of Cardinal River Coals (CRC) Ltd.'s Cheviot Coal Mine in west central Alberta, for example, the proponent expressed two valid concerns about its requirement to assess potential cumulative effects: first, many factors affecting the regional environment were not solely the result of activities associated with the proposed project; second, information essential to understanding the effects of other land uses within the region was not available to the proponent (Kennett 2002, Logan and Ferster 2002). With no formal mechanism in place to acquire regional information, the proponent was left to depend upon the goodwill of other industries and organizations to support its assessment of cumulative effects (Creasey and Ross 2009).

The message here is not that proponents should not be required to consider the implications of their projects in the larger, regional context, but that the mandates of project-based EA and of CEA do not always align. What is needed and typically *expected* of CEA is often beyond the scope and mandate of an individual proponent; yet, legislated project-based EA is currently the

[1] See, for example, Creasey and Ross' (2009) discussion of the challenges to proponent-based CEA at the Cheviot Coal mine, Alberta (also discussed in this report); and Law et al.'s (2005) analysis of CEA and monitoring under the Cumulative Environmental Management Association in Alberta's Oil Sands region.

primary vehicle for CEA implementation. Neither project-based EA nor the institutions in place to manage the process operate at the appropriate scale or hierarchy to address cumulative environmental change (Horak et al. 1983).

Improved efficiencies at the cost of effectiveness

The third issue concerns the mantra of efficiency, and the push toward making EA faster, more predictable, less expensive, and less intrusive. There either is a belief that 'fast EA is better EA', in the sense that it doesn't get in the way of project timelines, or there is a gross misunderstanding that process efficiencies and outcome effectiveness are necessarily related. Either way, fueled by a stagnating economy, there is increasing pressure to streamline or completely avoid EA applications.

In March 2009, for example, a regulatory reform package under the *Canadian Environmental Assessment Act* provided targeted adjustments to the federal EA process for projects funded under the *Building Canada* plan. The regulatory package exempts certain developments from EA. Such projects are deemed to have 'insignificant' environmental effects. The exemption is in effect until at least March 2011. Examples of exempt projects include a variety of buildings, roads, bus and rapid transit systems, and new water supply systems. Typically, such projects involve less than $10 million in federal investment. It is estimated that as many as 2,000 infrastructure projects over two years may be exempted from the requirement for federal environmental assessment. In the absence of individual assessment, the cumulative effects of these many small-scale infrastructure projects on the landscape go unchecked.

More recently, in March 2010, coinciding with the Federal budget, the Minister of Finance announced $11 million to support the acceleration of the review process for resource projects in the North and proposed several new initiatives to improve the federal regulatory system, reducing red tape and the administrative burden for potential developers. In his announcement the Minister noted: "The resource potential in Canada's North is world class, yet potential investors in northern resource projects face complex and overlapping regulatory processes that are unpredictable, costly and time consuming."

Similarly, in British Columbia, in October 2010, Premier Campbell announced a major restructuring of ministries within the provincial government with respect to the management of natural resources [2] . The restructuring would create a new ministry, Natural Resource Operations, which would take over many of the responsibilities of current resource ministries including Agriculture, Forestry, Energy, and Environment. The premier noted: "This new structure will streamline government processes for critical natural resource industries to ensure we can better attract global investment and turn proposed projects and investments into actual worksites and jobs." Concern has been raised by various organizations over the reorganization and the potential tradeoff of environmental precaution in favour of efficient resource development approvals[3].

Neither the economy nor any industry is likely to collapse due to the pressures of EA (O'Riordan 1982). This 'get to yes' syndrome for project approval may be at the cost of doing effective EA, and the avoidance of potential cumulative effects. There is far too much attention on improving efficiencies in

[2] See Government of British Columbia, Office of the Premier, News Release 2010PREM0191-001330, October 25, 2010 'Premier Campbell announces cabinet changes', available at www.news.gov.bc.ca.

[3] See http://greenpolicyprof.org/wordpress/.

the EA process to ensure that EA gets done on time and does not interfere with proposed development timelines, and that consultation obligations are being met, than there is on ensuring that the best decisions are being made in support of sound environmental management. There is, of course, a need to 'do things right', and an efficient EA process is important to timely and informed decision making. At the same time, however, it is necessary to 'do the right things' and ensure that EA, when applied, is a useful tool for making informed decisions about proposed development initiatives. Delays in EA are not caused so much by EA itself as by the failure of the planning and decision-making system to accommodate its findings - the goal is simply to prevent "environmentally-idiotic" decisions (O'Riordan 1982).

Toward Meaningful Cumulative Effects Assessment

If we are to advance CEA practice and management beyond the current state, toward meaningful CEA, then there is a need to: *i)* re-think our assumptions about cumulative effects and about what we think we know about complex environmental systems; *ii)* integrate the current silos of assessment, science, and management in CEA practice; and *iii)* build the capacity to actually implement and sustain CEA systems and frameworks. 'Good' CEA and management, at a minimum, is:

- Futures-oriented: concerned about possible futures and the means to shape sustainable outcomes.
- Alternatives-based: focused on identifying and systematically assessing alternative development scenarios associated with different initiatives, management plans, or courses of action.
- Integrative: part of, and provides overall guidance to, the development of regional strategies and initiatives.
- Adaptive: expecting to modify and adapt regional plans and development initiatives as new knowledge is gained through implementation, monitoring, and feedback.
- Valued ecosystem component (VEC)-centered: focused on effects to VECs that are of scientific relevance and public concern.
- Multi-scaled: able to account for perturbations and processes operating at multiple spatial scales within and outside the region.
- Ecosystem-based: defined by ecological rather than political or administrative boundaries, with attention to important ecosystem relationships and pathways and processes of change.
- Multi-sector: encompassing of the activities, policies, and plans of multiple sectors that may exist in a region or that may influence regional processes of change and decision-making.
- Multi-tiered: informed by, and informs, other existing or proposed policies and plans influencing the region, and is deliberately tiered toward downstream development assessment and decision making processes.
- Opportunistic: embracing of the opportunity to examine regional development through broader stakeholder debate, and to create or modify institutional arrangements in support of sustainability.

(See Noble and Storey 2001, Dubé 2003, Duinker and Greig 2006, Retief 2007, Harriman 2009, Noble and Gunn 2010).

Rethinking our assumptions and approach to cumulative effects

First, *meaningful* action in assessing, preventing and managing cumulative effects requires that we rethink our assumptions about, and approach to cumulative environmental effects (Table 1). As Ross (1994: 6) points out, "the environmental

effects of concern to thinking people are…not the effects of a particular project; they are the cumulative effects of everything." In particular, there is a need to think about limits of environmental systems in terms of the types, amounts and rates of development that can be accommodated, rather than make development decisions based on perceptions of an abundant capacity to absorb incremental human impact. As such, our focus must be beyond the project level to encompass regional-scale considerations of cumulative environmental change (e.g., Dubé 2003, Dalal-Clayton and Sadler 2005, Duinker and Greig 2006, Harriman and Noble 2008).

This regional scale is defined by ecologically significant boundaries, such as watersheds or eco-regions, and not ones necessarily defined in terms of project or administrative boundaries. But, at the same time, it is important in CEA to be sensitive to multiple scales so as to not dismiss the significance of smaller scale, and often seemingly slower-paced change. In other words, when focusing attention beyond the individual project at the regional scale, local disturbances (e.g., project specific perturbations) must not 'fall out' as broader landscape-scale disturbances become the focus (Therivel and Ross 2007).

Appreciating the complexity of cumulative effects, it is important to accept that direct cause-effect linkages may not always be discernable. There is a need to shift our focus away from detailed impact predictions, and following-up for accuracy, and focus foremost on identifying spatial and temporal patterns and trends of disturbance that can be projected forward under different assumptions about growth and development (Seitz et al. 2011). This may require, for example, identifying landscape metrics (e.g., edge density, impervious surfaces, surface disturbance, industrial footprint) (see Vos et al. 2001) as indicators in regression and correlation analyses to provide an indication of 'cause-and-effect' relationships between cumulative change and cumulative effects.

The management of cumulative effects then becomes the practice of avoidance and minimization, as opposed to mitigation, and

Table 1. Characteristics of status quo cumulative effects assessment versus requirements for effective cumulative effects assessment.

	Status quo CEA	Required CEA
Assumptions	abundance	limits
Receptors	single media	environmental systems
Spatial context	project	multiple scales
Temporal context	past, present	past, present, future
Scope	regulated activities	all disturbances
Assessment	stressors *or* effects	stressors *and* effects
Futures	predicted impacts	possible outcomes
Management	mitigation	avoidance
Monitoring	regulatory compliance	thresholds and capacity
Responsibility	individual proponents	multi-stakeholder
Performance	increased efficiency	increased efficacy

attention is focused on monitoring thresholds and capacity as opposed to monitoring only individual development projects for compliance with specified regulatory standards. Efficiency must become secondary to efficacy if we are to become serious about cumulative effects.

Integrating CEA silos

Second, the current state-of-the-art of CEA operates in three silos. Project proponents operate in the silo of *stressor-based* approaches to identify and mitigate project stressors, with governments as gatekeepers. The scientific and academic community operate in the silo of *effects-based* science to understand ecosystem functioning and environmental effects in response to landscape disturbances. Land-use planners and managers are focused on broader *environmental planning* and social matters, while incremental impacts at the project level continue to accumulate. These silos need to be better integrated if cumulative effects are to be identified, assessed, and effectively managed.

Stressor-based approaches (see Dubé 2003) occur within the silo of project assessment. Impacts are analyzed on a stressor-by-stressor basis, which are 'summed-up' to determine the total impact of a project. Environmental components are considered only if they are likely to be significantly affected by the project. The problem is that many cumulative effects are not *directly* associated with the impacts of any individual project or stressor *per se*. As a result, environmental components that are only indirectly affected are not considered, regardless of the potential for cumulative interaction (Baxter et al. 2001). For small projects, assessments are too restricted in both time and resources to effectively integrate the science needed to assess and understand cumulative effects – if such projects are assessed at all (Seitz et al. 2011). Divorced from science and the broader planning context, stressor-based approaches offer little understanding of cumulative environmental effects (Creasey 2002, Duinker and Greig 2006, Harriman and Noble 2008).

Opposite stressor-based assessment is effects-based science, concerned with measuring actual environmental responses (see Dubé 2003). Emphasis is on understanding the conditions of a particular environmental parameter, as a function of all stressors in a region, and comparing that condition to some reference condition in order to determine cumulative change. Effects-based approaches have the potential to establish carrying capacities or critical thresholds, and to assess potential cumulative threats through regional monitoring (Quinn et al. 2002, Seitz et al. 2011). In practice, however, effects-based studies are often "one-offs" with some, but typically limited influence on development decision-making and, in particular, on the design and approval of individual development projects (Noble 2008). Rarely is there authority to implement recommendations (Spaling et al. 2000), and the process itself is often focused on measuring change in past and present conditions, rather than also modeling potential system response to different future scenarios of disturbance (Harriman and Noble 2008).

The third silo concerns land-use planning and management. There is considerable potential at this high-level to integrate cumulative effects into development planning and policy-making; however, as Schindler and Donahue (2006) argue with reference to Canada's waterways and watersheds, land managers and policy makers seldom, if ever, consider the cumulative effects of human activity. They go on to say that there is little integrated planning and that science is often poorly represented in the planning process. Though challenging, the science of CEA must be understood by land-use planners and managers and used to inform land-use decisions and plans and policies for future development (see Seitz et al. 2011). This can be conflicting for those that must

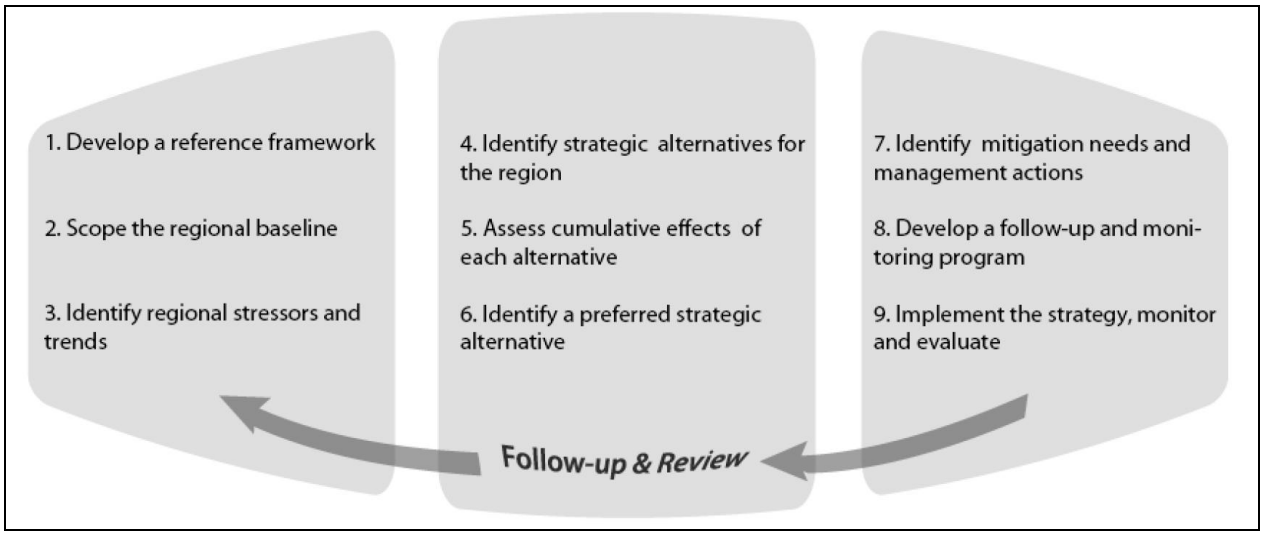

Figure 1. Simplified regional strategic environmental assessment framework
Source: Gunn and Noble (2009b)

identify and translate strategic visions and goals into operational mandates and decisions, particularly when everyone's primary interest is to deliver on their particular policy or plan mandate (Harriman and Noble 2008).

A strategic framework for CEA

Each of the above silos is valuable in its own right; however, the current piecemeal approach is at odds with the pursuit of effective CEA and management. There is a need to better integrate assessment, science, and planning and to do so at the regional and strategic tier if any of these silos, individually, is to be meaningful in facilitating the early identification, possible avoidance, and eventual management of cumulative environmental effects. Assessing and managing cumulative effects requires a proactive and futures-oriented approach. It requires a supporting strategic framework to identify and systematically assess alternative trajectories and future outcomes within a region, prior to taking decisions and implementing a predictive framework to evaluate the impacts of project-specific development activities (Harriman and Noble 2008).

In 2008-2009 the Canadian Council of Ministers of Environment sponsored a program of research to develop a more integrative and strategic framework for assessing and managing cumulative environmental effects – Regional Strategic Environmental Assessment (R-SEA) (see Gunn and Noble 2009b). The intent was not to introduce a new layer of legislated assessment for cumulative effects, but to re-conceptualize the relationship between the current silos of cumulative effects initiatives. The product was a framework (Fig. 1) and methodological guidance [4] to systematically evaluate the cumulative effects of multi-sector land and resource uses and surface disturbances in a region – evaluating past, present and alternative future scenarios and conditions of development, asking 'what if' questions about cumulative change to inform regional sustainable development (Gunn and Noble 2009b).

[4] See CCME (2009) and appended background papers, and Gunn and Noble (2009b), for a discussion of R-SEA methodological guidance and supporting tools.

Table 2. Characteristics of regional-strategic environmental assessment

Typical proponent	• Government; regional planning or administrative authority; public-private partnership; group of industry partners
Trigger	• Cumulative change; development of a sustainability strategy; large scale resource development initiative; need for regional policy, plan or program development or review
Alternatives considered	• Region-based alternatives or future scenarios driven by broader sustainability or policy-oriented goals and objectives
Scope	• Regionally relevant VECs and indicators of disturbance (e.g., species guilds, ecosystem services, environmentally sensitive areas, fragmentation, surface disturbances)
Temporal bounds	• Past conditions, current conditions, and longer-term futures
Spatial bounds	• Planning or resource region as defined by natural entities such as watersheds or other eco-regions
Sources and pathways of effects	• Activities of multiple sectors and disturbances, including natural change
Impact analysis	• Associations and relationships between VEC conditions (effects) and stressors (e.g., surface disturbances); scenario-based and futures-oriented, considering implications of and for other regional policies, plans, projects and exogenous factors
Key CEA questions	• What are the potential cumulative effects of alternative future scenarios? • What are the social, economic, and ecological opportunities and constraints to current and future development plans and initiatives?
Planning orientation	• Regional development, regional planning, regional environmental sustainability
Management focus	• Identifying and monitoring 'preferred' land-use patterns and rates of development (or conservation); enhancing regional sustainability; risk reduction or avoidance; policy and plan development to direct future land-use activities and decision making; inform project-based EA inputs and monitoring requirements

As a strategic approach, R-SEA has different features to other types of environmental studies and assessments for cumulative effects (Table 2), and recognizing this difference is crucial to ensuring successful CEA and management. R-SEA is intended to be an integrative, regionally based assessment process, operating above the project tier and ensuring that knowledge and understanding about the cumulative effects of future development possibilities inform the creation and implementation of regional planning and conservation initiatives, and trickles down to improve impact assessment efficacy and project-based decision making (Gunn and Noble 2009b).

Simply put, R-SEA is about setting an appropriate pace for a range of regional development options (e.g., by setting either targets for development and/or limits on development), based on knowledge of ecological, social, and economic thresholds, values, and capacities. This includes determining an appropriate or acceptable mix of types of development, including spatial-temporal configurations, and taking measures to influence both the positive, by enhancing,

and the negative, by avoiding or mitigating, the cumulative effects of development on the environment.[5] The goal of adopting such an integrative and strategic approach to CEA and management is to ensure that planning and development in a region occurs within the context of the most *desired* rather than the most likely outcomes, and potential cumulative effects are treated or avoided at their source.

Developing capacity to act

Good CEA means not only good science and assessment methods, it also means sound institutional arrangements and the capacity to implement and sustain CEA systems and frameworks (see Peterson et al. 1987, Dixon and Montz 1995). Based on experiences with floodplain management in the UK, for example, Hughes et al. (2001) and Adams et al. (2005) report that major challenges in scaling-up from the project to the region lies not solely in understanding ecological interactions, but also in the additional institutional complexity that is involved in broader scale planning and management processes and structures.

There has been limited attention to the institutional and capacity requirements necessary to support effective CEA and management. Based on recent research by Sheelanere (2010) for CEA in the South Saskatchewan Watershed, recently validated in the Athabasca, Lower Fraser, and Grand River Basin watersheds[6], a preliminary list of requisites might include:

- A lead agency with the authority, mandate, and the capacity to commission CEA, guide monitoring programs, and influence decisions about land use and project development.
- Multi stakeholder collaboration, with well-defined roles and responsibilities for the lead agency, project proponents, scientists, and other interest groups in terms of establishing the scope of CEA, identifying appropriate indicators, informing assessment processes, decision making, and implementing, maintaining, and maintaining monitoring programs.
- The establishment of regional baselines and agreed-upon indicators and thresholds to prioritize and identify areas of concern, and to help trigger management interventions before cumulative effects exceed acceptable limits.
- Monitoring at the regional and project scale to understand and manage cumulative effects, and to feed back into management plans and programs.
- Data management and coordination to facilitate standardization and data sharing amongst regulators, proponents, scientists, and the public.
- Effective linkages between regional CEA outcomes and inputs to project-based assessment, monitoring and decision-making.
- Financial and human resources to implement and sustain, over the long term, EA programs and requirements (e.g., monitoring programs, landscape modeling, reporting, communication, data management and coordination).

Though this list is demanding, so are cumulative effects.

[5] For an application of R-SEA for cumulative effects assessment, see Noble's (2008) report on the Great Sand Hills lessons and experience.

[6] The South Saskatchewan Watershed study is part of a larger Social Sciences and Humanities Research Council of Canada funded project at the University of Saskatchewan to examine requisites and capacity for watershed scale CEA. Results from the South Saskatchewan (Sheelanere 2010) have been validated by the researchers in the Lower Fraser, Athabasca, and Grand River Basin watersheds.

Conclusion

Assessing and managing cumulative environmental effects has been a pressing environment and resource problem in Canadian EA for more than 35 years. Notwithstanding the volumes of attention to the subject, CEA seems to be progressing at glacial pace – if not retreating. This paper set out to 'unpack' the current practice of CEA, and identify a means to rebuild and move forward toward meaningful CEA and management.

Arguably, the knowledge needed to advance the current state-of-the-art of CEA does exist, but this knowledge is contained within the individual silos of project assessment, regional effects-based science, and land-use planning and management. Current project-based EA is simply the wrong scale at which to manage cumulative effects, but, as the only legislated process for CEA, it is an easy target. The inability for project proponents to address broader, regional scale cumulative effects as part of their project assessments, and the complexity of such an undertaking, has been well demonstrated. Rather than acknowledge this problem of scale, however, the knee-jerk response appears to be increasing the efficiency of EA by screening out small projects, which may indeed be cumulatively significant, rather than providing a larger context for project developers in which to adequately asses and manage the cumulative contributions of their projects to the regional environment.

Though advances have been made in effects-based science for CEA understanding and monitoring, the timing and nature of such science is not always responsive to the needs of proponents and regulators when making decisions about individual project proposals. What is important to science for evaluating cumulative change is not always viewed as important to the affected public or to proponents and regulators in assessing project impacts and securing project approvals. Cumulative effects assessment requires more than knowing the 'what was' and 'what is' in the current baseline environment, it requires also an inherently futures-oriented analysis of 'what if' under different possibilities of development, considering the impacts of proposed projects.

There also appears to be a disconnect between land-use planning and management and CEA science and project impact assessment. There is an opportunity at the level of policy and land-use planning to integrate cumulative effects science and considerations in the development of land-use plans, strategies, and visions for future regional development. Based on experiences in Canada's prairie region and western watersheds, this doesn't appear to be the common practice. Moreover, there appears to be limited direction, or influence, from policies and plans in terms of guiding project specific actions and approvals downstream – particularly the acceptability of project actions within a broader environmental and cumulative effects context.

In order to move forward, and toward a more integrative and more strategic approach to CEA and management, there must exist institutional capacity and the will for the types of actions and collaborations necessary for CEA advancement. Seitz et al. (2011) argue that governments must assume leadership: establishing objectives and thresholds based on sound scientific guidance and social policy; ensuring that point-specific project-based EAs are relevant to evaluating and monitoring cumulative effects at the broader regional scale; and providing direction to development decision making through terms of reference set based on knowledge gained from broader CEA programs. This means that project proponents may have to bear an additional cost, meeting not only their project obligations but also being engaged in broader cumulative effects monitoring programs. Scientists must also do a better job of providing useful metrics

and tools for assessing and predicting effects within time frames that suit both broad-scale CEA and management, and point-specific project proposals. Finally, land-use planners and managers must give due consideration to cumulative effects, and the implications of CEA science, when developing broad policies and plans, and these policies and plans must be sufficiently informative to guide decisions about the nature and acceptability of future land use and project-specific developments.

In conclusion, the scope and requirements of CEA and management are big; CEA is beyond the reach of any single organization, and no organization currently has the mandate to do it. This mandate must come from government, meaning that the current role of government in facilitating land-use planning and development in support of sustainability, and the relationship between government, scientists, and proponents, may require some significant change. Solving the cumulative effects problem and the tyranny of small decisions requires a much more integrative and strategic framework – a framework that can operate at the regional scale, both informing and informed by higher level policies and plans and lower level development projects. This requires that we rethink our assumptions about cumulative effects; move toward integration of CEA knowledge in the current silos of assessment, science, and management; and invest in the capacity-building requirements to implement and sustain effective CEA systems and practices. We do have the knowledge to do this, but we have failed to act on it. Unfortunately, far more attention has been given to critiquing CEA and simplifying processes than to advancing value-added CEA systems and practices to ensure substantive outcomes.

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