ASSESSING CUMULATIVE EFFECTS OF CANADIAN WATERS

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Canadian Water Network

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RESEARCH BACKGROUND

Cumulative effects are incremental and accumulating changes to the environment which are caused by both natural (e.g., seasonal cycles) and man-made disturbances (e.g., development activities)[1]. Cumulative Effects Assessment (CEA) is the process of monitoring, tracking and predicting accumulating environmental change relative to established limits. Historically in Canada, CEA was conducted through federal and provincial Environmental Impact Assessment processes by industry proponents applying for approval for a project development. However, the methodology for CEA failed to produce the intended outcomes – i.e., monitoring, tracking and predicting accumulating environmental change relative to limits.

Because the scope of CEA remains limited to local development projects seeking "one-off" regulatory approval, synergistic and accumulating environmental impacts are often overlooked. The need for CEA extends beyond the regulatory approval process for new project developments. Land use and watershed planning, compliance approvals, regional monitoring programs and community-based monitoring programs all need to understand and use CEA to meet their objectives.

The science of CEA requires:

- understanding the reference or previous environmental condition,
- measuring changes in response indicators relative to that condition,
- understanding relationships between stressors and response,
- developing limits,
- predicting alternate futures based on different development scenarios.

No one has successfully packaged the pieces of CEA into an effective process that can be implemented by end user groups. The most important needs are:

1. Defining the framework for CEA (i.e, core pieces, how and why the pieces need to fit together, and key outputs),
2. Demonstrating implementation, and
3. Developing an implementation tool for end users to use.

Monitoring, tracking and predicting cumulative effects of multiple natural and man-made influences on environmental components (i.e., air, land, water, and biodiversity) over space and time requires the integration of many complex pieces of information. It is an ongoing task which extends beyond research and political careers, and requires a commitment to solid science, process, and financial support. Decision-support software (DSS) is needed to support and direct the process. Governments (Aboriginal, provincial, federal) are the preferred champion of such DSS software as the stewards of the landscape. That said, the private sector has played an important role in piloting DSS for CEA which supports its consistent and ongoing development.

HOW SHOULD WE BE TRACKING OUR "ENVIRONMENTAL BANK ACCOUNT"?

Every year, people keep billions of dollars of their hard-earned income in bank accounts. They have confidence in the process banks have established to track their money, show changes in their balances, and to identify when their funds have reached a critical deficit. Cumulative effects assessment ***(CEA) is the process of tracking the environmental bank account***. CEA is the process of holistically tracking and predicting environmental change over time and space and relative to limits. Existing approaches have not given Canadians confidence that we know the health of our environment. Are there risks that need to be better managed and mitigated? This research developed an improved framework for conducting CEA and the software needed to support it. The framework was then tested in watersheds across Canada.

RESEARCH METHODS

DEVELOPING A COMMON FRAMEWORK

A national team of researchers and practitioners was assembled to align terminology and agree on key components required for CEA and their inter-relationships.

TESTING THE FRAMEWORK

Different components of the CEA framework were tested in watersheds of four provinces and two territories, including a transboundary river crossing into Alaska, USA. The primary watersheds tested included the Saint John River (New Brunswick), Grand River (Ontario), Peace, Athabasca and Slave Rivers (Alberta), Yukon River, and Fraser River (British Columbia).

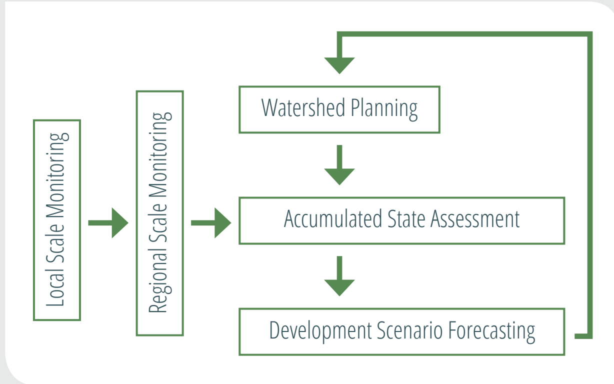


Figure 1. Key structural components of a framework for watershed CEA.

DESIGNING SUPPORTING SOFTWARE

The Healthy River Ecosystem AssessmenT System (THREATS) was developed to support the implementation of a CEA framework across Canada. Data were collected on:

- → Landscape – e.g., geology, vegetation
- → Known stressors – e.g., cities, roads, industrial activities, land use
- → Environmental indicators – e.g., water quantity, water quality, biological health such as fish

The data were integrated so it could be used across time, environmental components and federal, provincial, municipal, and Aboriginal jurisdictions.

RESEARCH FINDINGS

Four key structural components are required for CEA:

- → Monitoring at local scales consistent with the indicators used at regional scales
- → Land use (and watershed) planning
- → Assessment of accumulated environmental state
- → Modeling to predict future states of watersheds using various development scenarios (Figure 1)

Local monitoring is the responsibility of the proponents. It is specific to a development and at a smaller spatial scale. When local or site-specific monitoring occurs in a consistent manner, data integration results in a broader picture – e.g., environmental conditions for a sector of development. Many governments also conduct regional monitoring that integrates development and environmental response information across multiple sectors and broader time and space scales. Often these indicators are not consistent with those used at smaller scales and may not be of adequate resolution to assess local scale environmental changes.

CEA must occur at various scales, with consistency across those scales. Land use and watershed planning sets the expectation of what the land will look like and how it will be developed in the future. The intent of monitoring is to ensure development proceeds according to plan. Development forecasting is a modelling exercise to support land use planning by exploring different development scenarios for a landscape. Forecasting illustrates resource constraints and competing priorities, and acts as a “crystal ball” of how the environment may look if we allow development(s) to proceed in a certain way and time.

Functionally, CEA should quantify the accumulated environmental state, based on a comparison of current environmental response indicators (e.g., water quality, fish abundance) relative to a benchmark state (e.g., reference condition, previous condition, lesser developed state in time or space, etc.) (Figure 2). This comparison tells us how much the environment has changed. A similar comparison is conducted for indicators of development (e.g., effluent discharge volumes, sector footprints). Comparing the amount of change to a limit directs future actions. It also provides a starting point for prediction of future environmental changes associated with different development scenarios[2]. As development proceeds, we must continually assess over time if actual environmental changes align with predictions. If not, then adaptive management is required.

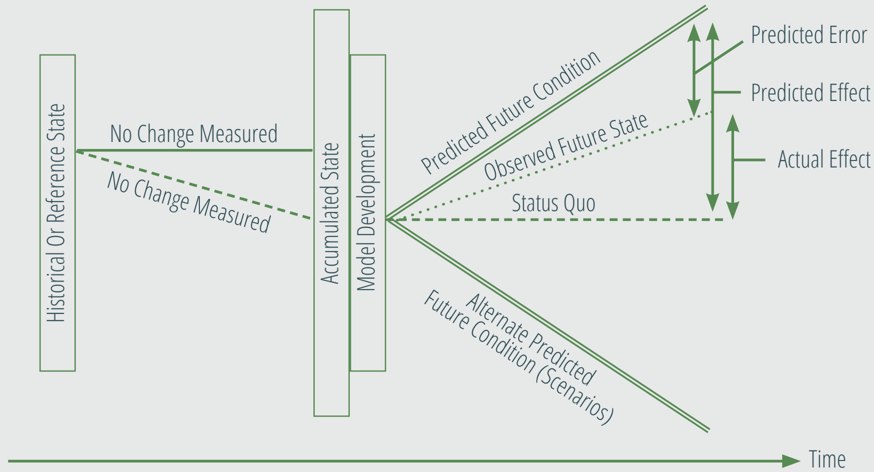


Figure 2. Key functional components of a framework for CEA

Collection of environmental data is of no value unless that information is compared to some form of a benchmark or limit. We all have limits to our bank accounts and an "environmental bank account" operates in the same way. Application of limits to environmental change and to development activities is sensitive, as this is the point where choices have to be made. Limits can be set to track change and mitigate effects before extreme action is required.

Many approaches have been suggested for establishing limits. Limits should apply at many levels, from a project to a sector scale, to the broader land use planning scale – regional plans, for example.

TESTING THE CEA FRAMEWORK

A special series on our work was published and included 9 separate but integrated pieces of work. A few are highlighted here.

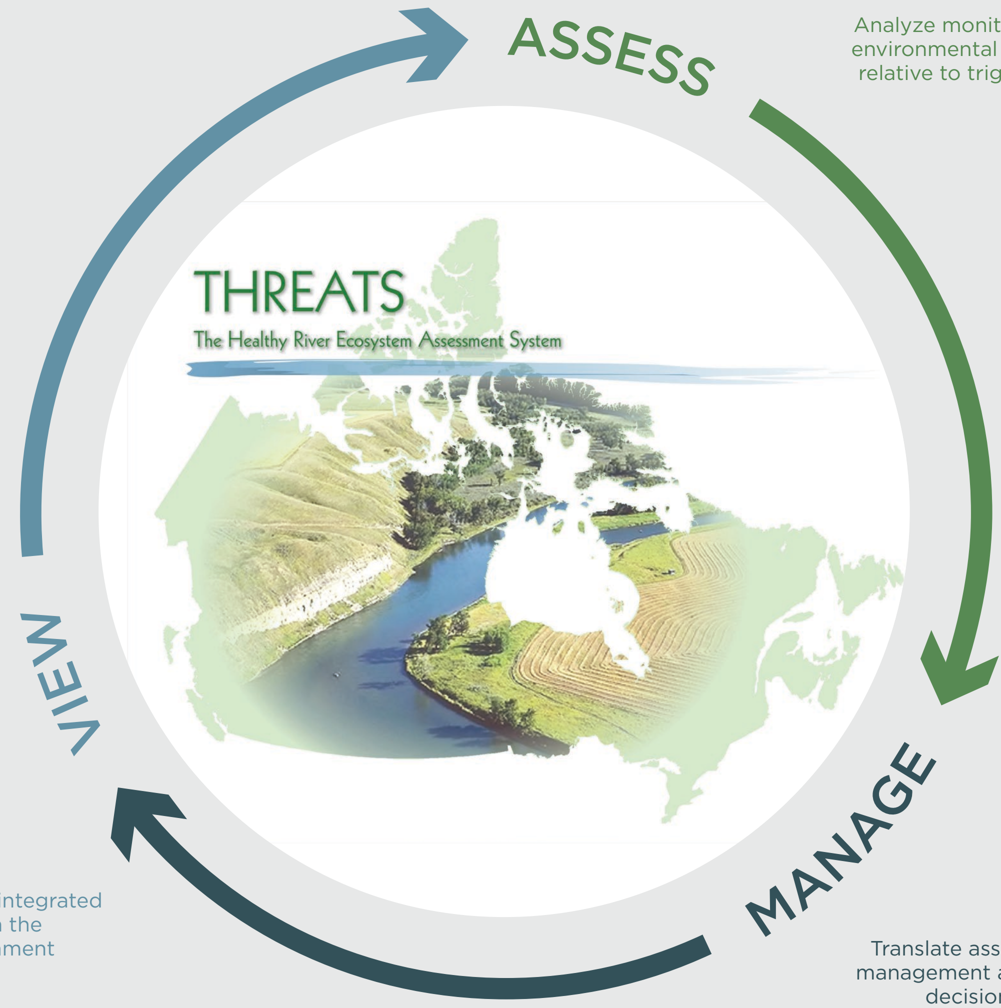
Ball et al.[3] examined CEA in practice through the environmental impact assessment process. They confirmed:

- Public information was difficult to obtain.
- Consistent terminology was not used.
- Ecosystem components and indicators were biased toward the regulatory agency involved.

Graduate students integrated the findings from their individual projects into a synthesis of CEA results and challenges[4]. They concluded that adoption of a standardized CEA framework and a standard set of ecosystem indicators was required. Issues of scale were examined, as well as the selection of aquatic environmental components and indicators for assessment, and challenges associated with determining reference conditions across six of the Canadian watersheds studied. Lack of long-term monitoring data and data inconsistencies were also identified as frequently limiting factors for the advancement of watershed CEA.

Initial development of the framework for watershed CEA began in the Peace-Athabasca-Slave River system, which is influenced by cumulative stressors such as the W.A.C. Bennett Dam and industrial activities, including pulp and paper processing and oil sands mining[5,6]. The approach addressed the problem of setting a historical baseline for water quality and quantitatively compared that baseline to the current state. Dubé et al.[7,8] then applied the accumulated state methodology to the Yukon River basin and determined reference conditions for water quality across the basin, quantified periods of time and locations where water quality was outside of a normal range, and incorporated Traditional Ecological Knowledge (TEK). TEK was obtained through a healing journey organized by the Yukon River Inter-Tribal Watershed Council. Members of the community travelled down the Yukon River for several days in canoes collecting water quality data and communicating stories on the river, its history, people and significance. Water quality data that were collected during the healing journey were compared to the long-term reference conditions to show how western science data aligned with the findings of TEK.

Figure 4: THREATS Decision Support Software to support watershed CEA



ASSESS
Analyze monitoring data to assess environmental changes and trends relative to triggers and thresholds

VIEW
View and explore integrated monitoring data in the geospatial environment

MANAGE
Translate assessment results into management actions for informed decisions on environmental management

One fundamental component of CEA that is most often minimized or least understood is the need for decision support software ***specific for CEA.*** CEA requires integration of the highest order. THREATS is one of the only tools in Canada customized for this purpose. It assesses multiple monitoring data sets on environmental indicators relative to various limits in a geographic information system (map-based platform). It can also assess changes in the footprint of development over time and space across Canada. On-going development was made possible with the leadership of Greenland Consulting International Ltd. and the University of Waterloo. (Figure 4). On-going development will focus on linking the existing capability of THREATS (to measure environmental change relative to limits) with predictive tools to forecast environmental changes anticipated with different land development scenarios. The vision is that end users with an interest in tracking the environmental bank account will have access to THREATS from their computers on a day to day basis. More information can be found by contacting Mark Palmer, President and CEO, Greenland International Consulting Ltd., ON, Canada (mpalmer@grnland.com).

MEANING FOR CEA PRACTITIONERS

IN CANADA, CEA IS AFFECTED BY A LACK OF UNDERSTANDING OF WHAT IT IS AND HOW IT CAN BE IMPLEMENTED.

CEA is fragmented by jurisdictional responsibilities and historical departmentalization of expertise and operation. This fragmentation has reduced our ability to understand the state of our environment and critical changes due to human activities. Furthermore, our ability to predict what may occur in the future is limited.

This research is relevant for those interested in the state of the environment now and in the future, including the general public, regulatory agencies at all levels, industry, First Nations and Métis, watershed groups, consultants, and academia.

Our work involving CEA scientists and practitioners – with a variety of backgrounds and viewpoints – successfully developed and tested an improved methodology and decision support software for implementation.

The framework was adopted by the Joint Oil Sands Monitoring Program currently led by Environment Canada and the Province of Alberta to address regional monitoring needs and stakeholder concerns in the oil sands region of northern Alberta[9].

The method was applied to the Peace-Athabasca-Slave River system at the request of the Government of the Northwest Territories to support transboundary negotiations with the province of Alberta.

It is anticipated that this work will also result in significant modifications to environmental impact assessment practice.

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