Advancing Cumulative Effects Research at Natural Resources Canada: Challenges, Discoveries, and Moving Forward

Brian Eddy, Christina Clarke, Colter Kelly, Sarah Ryan, Effah Antwi, Wenjun Chun, Curtis McKinney, Michael Parsons, Christine Rivard, Lisa Venier

The Challenge

Canada has now entered a period of energy transition from fossil fuels to low carbon energy sources for both domestic use and global export. This transition requires multiple types of clean growth initiatives using renewable energy sources such as wind, solar, geothermal, and biomass. Hydrologic resources and sustainable forestry practices will also be necessary, along with the development of critical minerals to support the technology enabling the transition. Due to these factors, the pace of anticipated natural resource development over the coming decade is unprecedented.

Many of these anticipated new projects will be in regions with past or existing natural resource development, which will likely result in the effects of each individual project interacting with the effects of other projects in various and potentially poorly understood ways. This overlap of effects is broadly referred to as *cumulative effects* (CE; Sinclair et al., 2017). The Canadian Council of the Ministers on the Environment defines CE as "*...changes in the environment caused by multiple interactions among human activities and natural processes, which accumulate across time and space*" (CCME, 2014).

The current approach to managing natural resource development in Canada, including impact assessments, focuses primarily on a single project at a single point in time, with the proponent responsible for data collection and analysis on the areas under their care and control (Noble, 2010; IAAC, 2020).The main mechanism to consider CE is during project-level impact assessments, which may be insufficient for assessing long-term impacts, as the scope is too narrow, the scale is too small, and often past, current, and potential future projects are not sufficiently considered (Noble, 2010). This type of problem has been described as a resulting from a "tyranny of small decisions" (Noble, 2010). A case in point is the precedent setting Yahey v. British Columbia (2021) decision, in which the B.C. Supreme Court ruling established that the "*cumulative impacts of industrial development meaningfully diminished [Blueberry River First Nation's] exercise of its treaty rights,*" emphasizing the growing need to better manage projects and their CE.

The Government of Canada (GoC) strengthened provisions for regional and strategic assessments in the *Impact Assessment Act*, 2019 (the Act). Although regional-based approaches are encouraged to better manage CE, as well inform future decision-making of project-level impact assessments, only one terrestrial regional assessment has been announced (Regional Assessment in the Ring of Fire Area) since the Act came into force and has not yet advanced past the terms of reference. Additionally, there is often a significant gap in scientific data, knowledge and methods available on a regional scale to adequately assess CE.

Access to regional scale information about processes and interactions that occur at different spatial and temporal scales is required for comprehensive CE assessment. Scientific understandings of CE from combined past, present and future activities and associated pressures on valued ecosystem components is needed, above and beyond the effects of individual project activities (Therival and Ross, 2007). To establish a robust baseline and understand the complexity and interaction of effects, a wide range of scientific research, technical advice, and generation of knowledge on physical, biological, and human components are required.

Therefore, researchers from many disciplines are needed to identify, predict, and evaluate the potential effects of multiple development activities on the environment, develop future scenarios modelling, as well as guide future monitoring (Eddy et al., 2014). In addition, an evaluation of the value components and the relationships between each of the components will require a transdisciplinary approach that considers a diversity of perspectives, including Indigenous (First Nations, Inuit, and Métis) knowledge systems. Taken together, the scientific information generated may be used to support risk analysis and decision-making in land-use planning related to sustainable natural resource development and promote Indigenous self-determination.

Approach

With expertise related to geoscience (e.g., minerals, energy, groundwater), forestry (e.g., forest management, timber supply, and biodiversity), geomatics (e.g., remote sensing, GIS, open data platform), and interdisciplinary sciences (integrating, for instance, climate change, sustainability assessments, socio-economic structures and considerations, natural resource development), Natural Resources Canada (NRCan) has a broad scientific research portfolio that provides a strong foundation for more comprehensive knowledge generation to support CE assessment. Reflective of the diverse and interdisciplinary nature of CE, a committee comprised of scientists within NRCan with expertise in diverse fields was established to provide interdisciplinary perspectives on CE research issues. Known as the *Selecting Terrestrial Areas for Cumulative Effects Research (STACER)* committee, the committee initially aimed to develop a process to identify areas for future CE research in terrestrial areas of Canada to help focus the department's CE research.

As part of this initiative, the committee sought to provide strategic guidance in selecting areas of past, current, and anticipated industrial development, to support anticipated need for scientific data, knowledge, and technical advice, focusing on areas in which researchers could:

- Improve our understanding of baseline conditions, trends, and possible future states of Canada's terrestrial environment in relation to natural resource development.
- Generate information/knowledge that can inform impact assessment processes, including regional assessment;
- Generate information/knowledge that can advance GoC and NRCan science and policy priorities; and
- Generate information/knowledge that can help Indigenous groups better understand the impacts of CE on their lands and communities.

To do this, a GIS mapping exercise was initially carried out to visualize and analyze areas favourable for NRCan's CE research. GIS data layers were acquired on past, present and future natural resource projects, along with communities, infrastructure, and locations of Indigenous communities based on publicly available datasets (Beneteau, 2022; Eddy et al., 2023; NRCan, 2022[1]; NRCan, 2022[2]; NRCan, 2022[3]; NRCan, 2022[4]). Data layers were weighted and combined in a GIS overlay analysis to map favourable regions. Weighting prioritized future project areas, where regional or individual project-level impact assessments would be anticipated, with preference for locations where future projects overlap with past and currently active resource project areas. Highest scores were assigned to locations where past, present and future projects coincide. This approach reflected the desire to consider the CE of different combinations of past, present and future development activities. The map in Figure 1 shows one result that reveals numerous locations in all regions of Canada that could serve as potential CE research study areas.

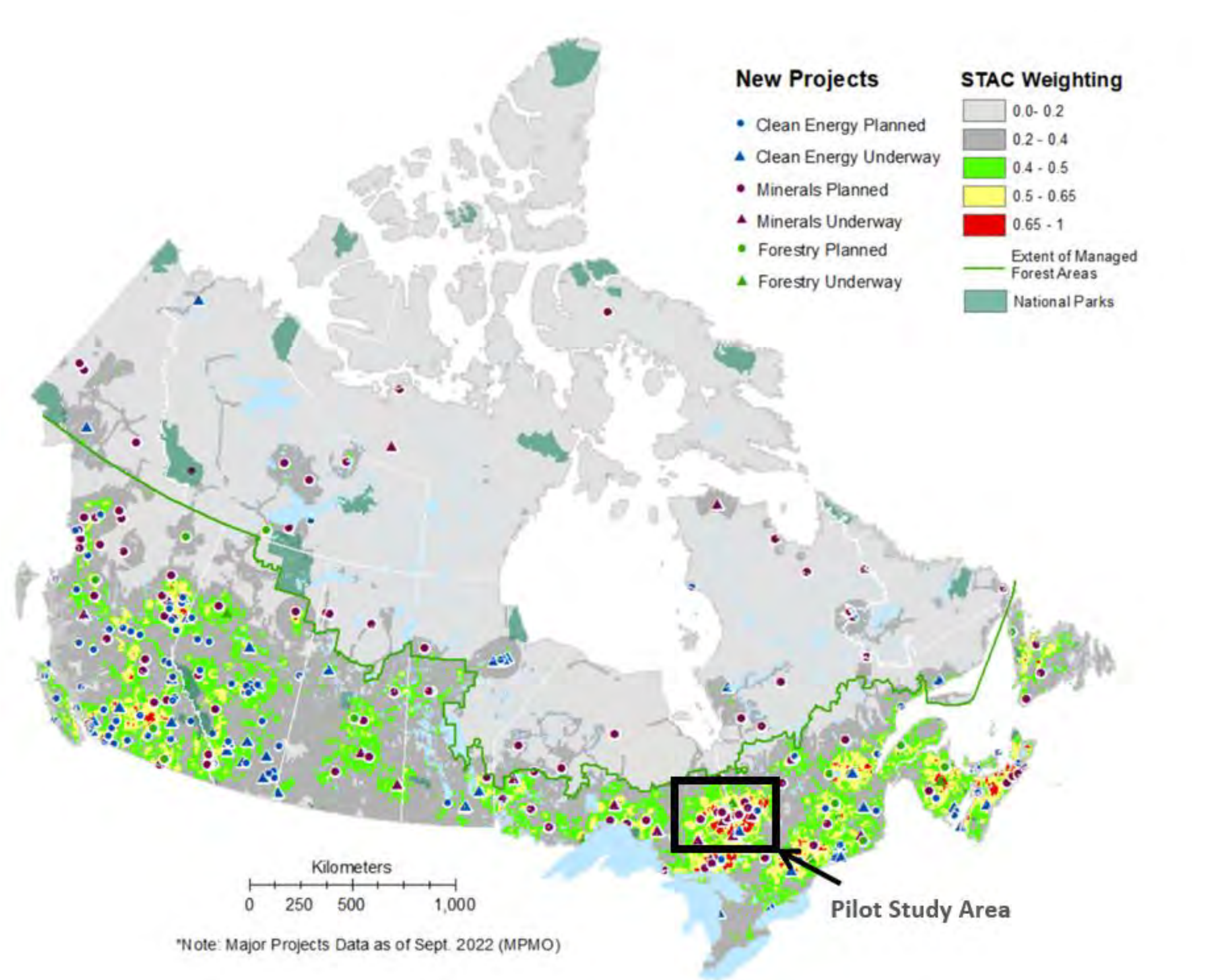

Figure 1. GIS analysis revealing numerous areas favourable for CE research in the vicinity of anticipated future resource development projects. (Note: Pilot Study Area is discussed further in the text)

Discovery

Although the GIS mapping exercise proved helpful in identifying favourable areas, the committee uncovered several challenges when trying to narrow down a selection of candidate study areas. This was due to the extent of Canada's landmass and the wide range of resource development settings and diverse research interests. Additionally, committee members identified the need for a framework to support interdisciplinary/multidisciplinary research at the departmental level. Such a framework could provide researchers within NRCan the organizational support for collaborating across the department. Although researchers from across the department have managed to collaborate informally in the past, a CE assessment requires a more formalized framework at the department level that is separate from individual programs.

Realizing these needs, the STACER committee adopted the use of an *Adaptive Management with Information Ecology* (AMIE) framework (Figure 2; Eddy et al, 2014) as a tool to guide their work moving forward. The AMIE framework illustrates how diverse types of research are needed to support decision-making for both regional and project-level assessments. The primary level of the framework pertains to the realm of fundamental natural and social scientific research (e.g. sector-based primary research). The secondary level pertains to more applied and integrative multi-disciplinary research organized around decision support components on the tertiary level. The tertiary level is the realm of actual decision-making and engagement which requires information support from both primary and secondary levels. Currently in IA and CE assessments, research is typically fed directly from the primary level to the tertiary level without any integrative or mediative processing that would normally be provided by secondary level research.

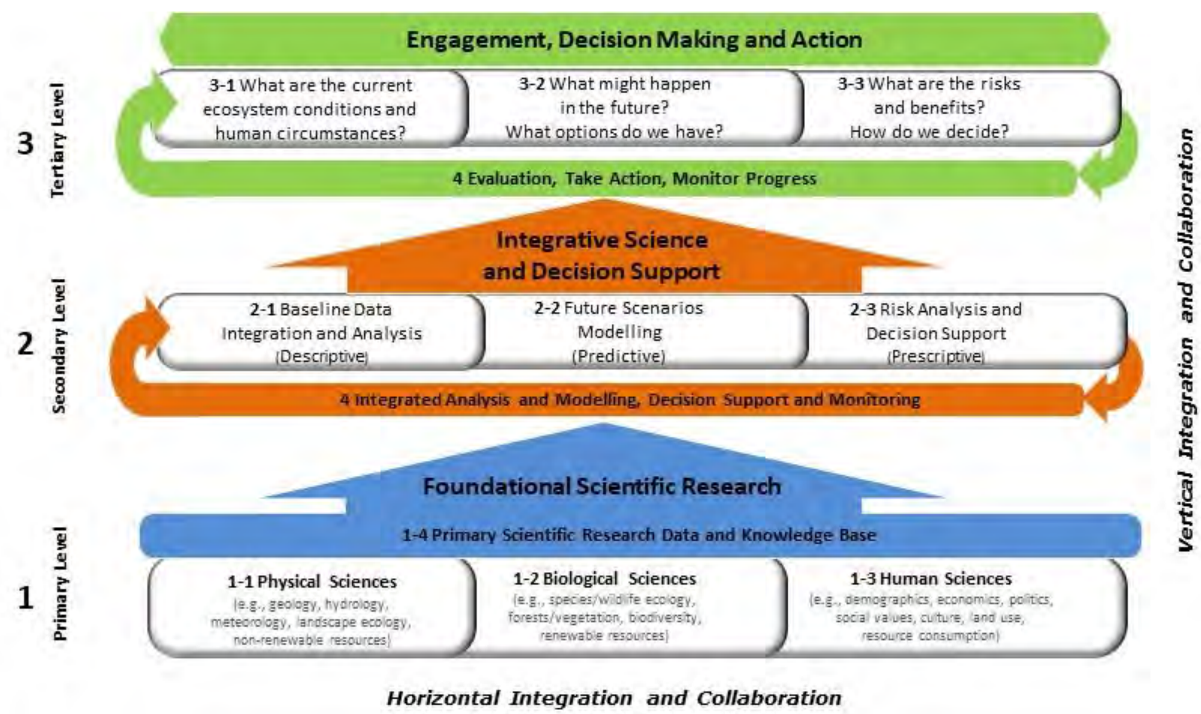

Figure 2: Schematic of the AMIE Framework from Eddy et al. (2014)

The STACER initiative was repositioned to support this as a new multidisciplinary research framework, recognizing the importance of all levels of research in understanding CE.
As a result, the committee recommended a staged approach following the guidance provided by the AMIE framework. It was agreed that priority should be given to orienting individual CE research projects on the primary level towards working in geographic areas of anticipated future projects, preferably where current and past activities are also present. Issues surrounding potential secondary level collaborative CE research could be addressed through the initiation of a pilot study to explore both scientific and organizational considerations, which would also need to be considered for the development of a departmental-level framework. To date, the committee has begun two initiatives to address these recommendations.

Moving Forward

To support on-going, sector-based primary level research, the STACER committee will continue with the implementation of an on-line GIS map that will be used to collect information on current CE research projects at NRCan (Figure 3). The on-line map, known as the STACER map, will be available to CE researchers at NRCan to assist in identifying locations for research projects in relation to resource development settings. The map contains multiple layers of information on past, present, and future resource projects, along with information on communities, infrastructure, Indigenous communities, and selected environmental themes. The use of the STACER map will be supplemented with a corresponding survey to be conducted among current CE researchers to capture pertinent information related to how current research projects may potentially support future regional and project-based impact assessments. This information will be collected in a database which will be used both for reporting to senior management and for researchers to share information to foster potential collaborations in geographic areas where project areas overlap or are in close proximity.

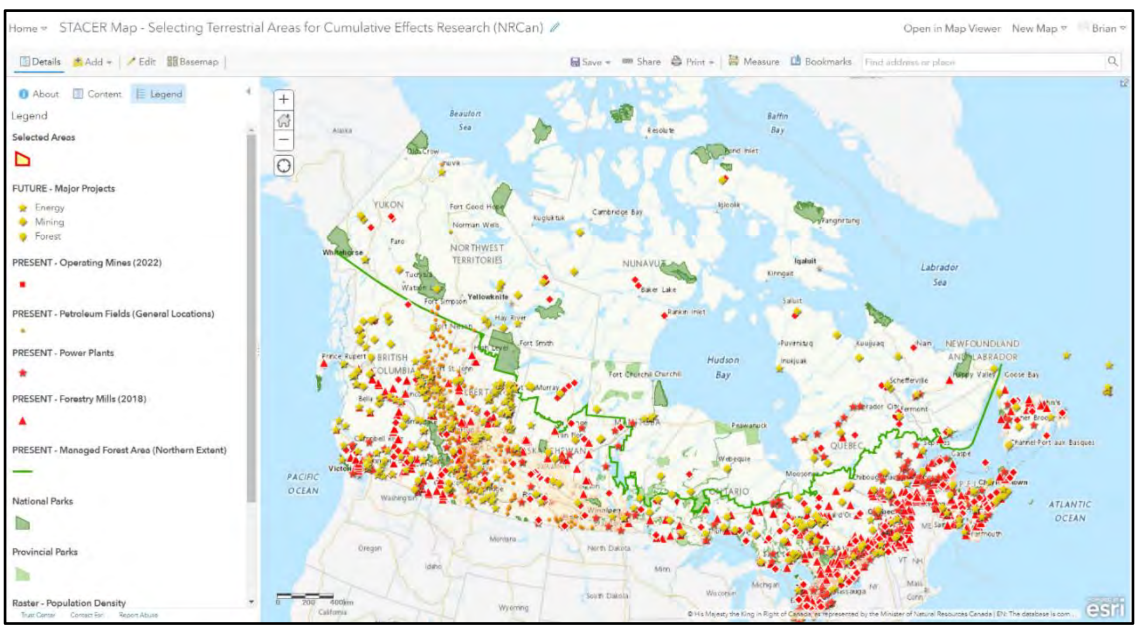

Figure 3. Screen capture of the on-line GIS-based map 'STACER' (Selecting Terrestrial Areas for Cumulative Effects Research). This view shows locations of current and potential future resource project locations along with parks, communities and selected administrative boundaries.

For secondary level initiatives, the committee has recommended scoping a pilot project in the Abitibi Resource Belt region between northern Ontario and Quebec (see box insert in Figure 1). This region was selected because of its intense past and current resource development activity in multiple resource development (including minerals, forestry, and energy) and more than a dozen new projects, including critical minerals, identified for future development. The CE of future projects in this region are expected to compound effects from the numerous past and current project activities in complex ways which makes the Abitibi Resource Belt a suitable candidate for a pilot project. The Geological Survey of Canada (GSC) of NRCan has already initiated a CE project in this region based on this rationale. The information gathered from the initial scoping exercise will be used to report back to the committee and consult with both scientists and management to examine scientific and organizational requirements to develop and implement a departmental level multidisciplinary research framework.

Summary

Natural Resources Canada's mandate is to improve the quality of life of Canadians by ensuring the country's abundant natural resources are developed sustainably, competitively, and inclusively. Recognizing the anticipated pace of development over the coming decade, the challenges surrounding the CE of multiple natural resource developments across Canada are characteristic of a "wicked problem" (Kawa et al. 2021) that needs to be addressed to ensure long-term environmental and socio-economic sustainability. A wide range of scientific research, technical advice, and generation of new scientific data and knowledge on physical, biological, and socio-economic components are needed as the foundation to understand CE. The multi-tiered approach taken under the guidance of the AMIE framework and the two initiatives discussed above provide a way forward for the STACER for the near future. It is anticipated that this initiative will encourage better use of resources and improve linkages with federal decision-making to support sustainable resource development and the protection of vulnerable social and environmental components identified by IA processes surrounding multiple natural resource development projects.

For more information contact:
Brian.Eddy@NRCan-RNCan.gc.ca or Christina.Clarke@NRCan-RNCan.gc.ca

Acknowledgments
The Authors would like to thank past members of the STACER committee for their contributions to the design and development of this initiative: Sara Ryan, Alison Milan, Daniel Silver, Sophie Silwa, Chris Mancuso, Rafee Hoque, Olivier Paré.

References:

Beneteau, D. 2022. CIM: Historical Canadian Mines Data Hub. Univ. of Saskatchewan. https://www.cim.org/the-hub/

Canadian Council of Ministers of the Environment (CCME). (2014) Canada-wide definitions and principles for cumulative effects. Retrieved April 2024 from https://ccme.ca/en/res/cedefinitionsandprinciples1.0e.pdf

Eddy, B. G., Hearn, B., Luther, J. E., van Zyll de Jong, M., Bowers, W., Parsons, R., Piercey, D., Strickland, G., & Wheeler, B. (2014). An information ecology approach to science–policy integration in adaptive management of social-ecological systems. Ecology and Society, 19(3). http://www.jstor.org/stable/26269643

Eddy, B.G., Muggridge, M., LeBlanc, R., Osmond, J., Kean, C., and Boyd, E. 2023. The CanEcumene 3.0 GIS Database. GeoDiscovery Portal, Natural Resources Canada. https://open.canada.ca/data/en/dataset/3f599fcb-8d77-4dbb-8b1e-d3f27f932a4b

Impact Assessment Act (IAA). (2019) SC 2019, c 28, s 1, retrieved April 2024 from https://canlii.ca/t/543j0

Impact Assessment Agency of Canada (IAAC). (2020) Guide to Preparing an Initial Project Description and a Detailed Project Description – Practitioner's guide to the Impact Assessment Act. Retrieved April 2024 from Guide to Preparing an Initial Project Description and a Detailed Project Description - Canada.ca

Kawa, N. C., Arceño, M. A., Goeckner, R., Hunter, C. E., Rhue, S. J., Scaggs, S. A., Moritz, M. (2021). Training wicked scientists for a world of wicked problems. Humanities and Social Sciences Communications, 8(1).

Noble, B. (2010). Cumulative environmental effects and the Tyranny of small decisions: Towards meaningful cumulative effects assessment and management. Prince George: Natural Resources and Environmental Studies Institute, University of Northern British Columbia. Occasional Paper No. 8.

NRCan, 2022[1]. Mines, Energy and Communication Networks in Canada - CanVec Series - Resources Management Features. GeoDiscovery Portal, Natural Resources Canada. https://open.canada.ca/data/en/dataset/92dbea79-f644-4a62-b25e-8eb993ca0264

NRCan, 2022[2]. National Forest Information System (NFIS). Natural Resources Canada, Canadian Forest Service. https://ca.nfis.org/index_eng.html

NRcan, 2022[3]. Principal Mineral Areas, Producing Mines, and Oil and Gas Fields (900A). GeoDiscovery Portal, Natural Resources Canada. https://open.canada.ca/data/en/dataset/000183ed-8864-42f0-ae43-c4313a860720

NRCan, 2022[4]. Major Projects Inventory. GeoDiscovery Portal, Natural Resources Canada. https://open.canada.ca/data/en/dataset/f5f2db55-31e4-42fb-8c73-23e1c44de9b2

Sinclair, A. J., Doelle, M., & Duinker, P. N. (2017). Looking up, down, and sideways: Reconceiving cumulative effects assessment as a mindset. Environmental Impact Assessment Review, 62, 183-194.

Therivel, R., Ross, B. (2007). Cumulative effects assessment: does scale matter? Environmental Impact Assessment Review. 27 (3), 365–385.

Yahey v British Columbia, 2021 BCSC 1287 (CanLII), retrieved April 2024 from https://canlii.ca/t/jgpbr