RESOURCE ECONOMICS AND ENVIRONMENTAL SOCIOLOGY

Social Impact Assessment Methods for Predicting Cumulative Effects involving Extractive Industries and Indigenous People

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Project Report #20-02

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DEPARTMENT OF RESOURCE ECONOMICS AND ENVIRONMENTAL SOCIOLOGY

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Abstract

Many resource projects are located in regions inhabited by Indigenous people, whose livelihoods, culture, and spirituality are deeply affected by these projects. Researchers and consultants have developed numerous qualitative and quantitative Social Impact Assessment (SIA) methods to predict or verify cumulative social outcomes of those projects as they relate to the interests and concerns of Indigenous people. Yet there remains a lack of consensus on the best practices for SIA in this context. Given how wide-ranging these methods are, a review of the literature to identify, synthesize, and summarize SIA methods in this context is urgently needed. The variety of approaches identified in the literature reflects the worldviews of Indigenous and non-Indigenous people who design and implement these methods, as well as the growing urgency to reconcile resource development with Indigenous people and their traditional lands. With these issues in mind, this report provides a systematic review of methods addressing cumulative social effects related to natural resources extraction and Indigenous groups. First, we highlight theoretical frameworks and identify areas of potential impact that need to be addressed and cumulative effects that arise within the frameworks. Some frameworks have roots embedded in Indigenous rights and justice theory, while other frameworks focus on the economic cycles of extractive industries. Secondly, we present participatory geographic information system (SIA-GIS) methods as a powerful tool for connecting physical science and social science elements of assessment. Thirdly, we provide a section presenting community engagement methods to select indicators and construct narratives for identifying historical cumulative effects. Finally, we explore modelling approaches to SIA and how they relate to regional planning.

1. Introduction

The temporal and spatial accumulation of different industrial-scale activities in the same region or place can cause numerous landscape changes (Roudgarmi, 2018). When this occurs, the biophysical environment can be impacted in several ways, interfering with terrestrial and aquatic species, fish spawning, animal behaviours, nesting grounds, ice and water regimes, rivers, soil characteristics, forest patterns, and other ecological services. These cumulative changes, resulting from industrial activity, can affect the way people use the land for economic, social, cultural, or spiritual purposes. In this sense, Franks et al. (2011) refer to cumulative social impacts (or cumulative social effects, which is the term adopted here) relating to the incremental, combined, and successive changes to people's livelihoods. Thus, cumulative effects assessment (CEA) is viewed as a management tool to be incorporated into the process of decision making and project monitoring (Canter and Ross, 2010). Social Impact Assessment (SIA), which is the tool used to identify, predict, analyze, and measure the environmental and social consequences of development activities (Esteves et al., 2012; Vanclay et al., 2015), becomes an important strategic tool because it can aid decision-makers in evaluating the social consequences of anthropogenic activities. Analysis often extends to an assessment of real effects arising from the positive or negative perception of project impacts. SIA, in principle, is intended to be a proactive approach to assist communities in assessing impacts and developing strategies to manage and minimize negative outcomes, while maximizing benefits (Vanclay, 2003). This is not always the case; indeed, SIA is more often a reactive approach to comply with legal requirements.

Many nations, such as Australia, Brazil, Canada, the United States, Sweden, and Russia (Central Intelligence Agency, n.d.; Migiro, 2018), are highly dependent on cumulative natural resources exploitation (e.g., oil and gas, forestry, mining, hydro, etc.). The experience in many countries, however, is that while the economy thrives and industries benefit from resource extraction, many developments are located in regions inhabited by Indigenous people, whose livelihoods, culture, self-identification, social structure, recreation, and spirituality are deeply affected by these extractive activities. In addition, the expansion of resource development industries moves at a speed that outstrips the capacity of Indigenous communities to keep up with the best practices and methods for assessing cumulative social effects (Baker and Westman, 2018). Indigenous (Aboriginal or First Nations) groups are key rights holders and stakeholders in

resource processing developments. It is known that Indigenous worldviews can differ in a number of ways from Western scientific-based knowledge. Indigenous people in Canada often have an intrinsic relationship with the land and hold a different perception of site significance (Sutton et al., 2013); similar results have been found for Sami communities in Russia (Kumpula et al., 2006) and Indigenous communities in Australia (Voyer et al., 2014). Therefore, Social Impact Assessment methods need to pay special attention to these differences when reporting the direct, indirect, induced, and cumulative effects that developments have on Indigenous people.

A substantial amount of literature exists pertaining to SIA practices. There are multiple qualitative and quantitative SIA methods to predict or verify cumulative social outcomes of projects in the context of Indigenous people. Qualitative researchers, who go directly to communities and conduct interviews about their perceptions of impacts, offer important primary sources of information. SIA can use secondary sources as well, such as EIA (Environmental Impact Assessment), SIA monitoring and follow-up studies, population censuses, government statistics, previous surveys/interviews, media reports, maps, photos, and videos, among some of the types of information collected by others. There are quantitative and physical science approaches using software that merges qualitative and quantitative information to provide a multidisciplinary view of local impacts. Early practitioners were often trained in applied scientific disciplines, but they lacked knowledge about social methodologies and concepts covered by scientists who conduct SIA with primary data sources. As a result, SIA methods tended to use only natural science approaches to study social changes (Becker, 2003). For example, in a review on the evolution of SIA in Canada, Parkins and Mitchell (2015) illustrate technical approaches, often including quantitative methods, focusing on the selection of indicators that measure biophysical components, and conducting cost-benefit and statistical analysis to represent the social effects of projects. Criticisms of the SIA process and the involvement of social scientists led to the introduction of social-based approaches comprising both qualitative and quantitative methods (Burdge and Vanclay, 1996). Under the banner of qualitative approaches, other methods such as comparative case studies predicted impacts based on previous experiences with similar types of projects (Burdge et al., 2003), and political approaches that used SIA methods to advocate more directly for better outcomes for local communities (Parkins and Mitchell, 2016).

Even though SIA aims to be an inclusive tool, the prevailing practice tends to reflect the predominance of Western culture, methods, and contexts. McGregor et al., (2003) and O'Faircheallaigh (2009, 1998) claim that Indigenous groups, who have historically suffered discrimination, marginalization, and injustices, had important aspects related to their community wellbeing ignored in past assessments. In light of these identified shortcomings, there has been an evolution in the debate in favour of more inclusive and participatory SIA, whereby Indigenous people are the central influencers in decision making (O'Faircheallaigh, 1999). In Canada, for instance, the Impact Assessment Agency of Canada (2019) published tailored EIA guidelines that include a separate section for the assessment including Indigenous contexts. There is still a pressing need for a literature review to identify, synthesize, and summarize SIA methods that cover the cumulative effects of extractive industries in the context of Indigenous people, not only because of the different worldview of Indigenous people, but also because of climate-related changes, and the current and continuing pressure to develop activities on lands used by Indigenous nations. Decision-makers, scientists, practitioners, and society constantly require updated information on SIA and EIA practices. This issue falls within the discussion of how to achieve sustainable, inclusive, informed, and acceptable developments in the twenty-first century (Szablowski, 2010) and how to implement effective SIA practice with regard to Indigenous people (O'Faircheallaigh, 2009).

In light of these challenges, this report offers a systematic review, based on both scholarly and grey literature of cumulative social effects related to natural resources extraction and Indigenous groups. This literature review aims to develop a better understanding of how the social dimension of cumulative effects has been documented using SIA methods in an Indigenous context. In other words, this report bridges a knowledge gap concerning the integration of social dimensions in the assessment of cumulative effects from multiple resource developments. To do so, our analysis focuses on the way in which scholars, governments, and non-government organizations have addressed cumulative social impacts using both conceptual frameworks and empirical methods.

2. Methodological procedures

We adopted a systematic approach to search, identify, select, and analyze relevant literature (Siddaway et al., 2019) addressing SIA methods that involved the context of extractive industries and their cumulative effects on Indigenous people's livelihoods and spirituality. The first step was to define the type of systematic review; we chose to focus on a narrative review, as the main objective of this study is to synthesize findings about methods and theories where different SIA tools have been implemented and discussed to tackle cumulative effects of projects.

Due to the multiplicity of methods, industries, and social aspects involved in SIA, the keywords list for searching encompassed different concepts that captured the essence of SIA applied to cumulative impacts of projects on Indigenous groups. The list of keywords is provided in Table 1. The words were often interspersed with synonyms to vary the search and find studies using different terminologies. Only online literature written in English was evaluated. We used Google Scholars, Science Direct, and NovaNet (available at the Dalhousie University Library) to find papers.

A first round of screening was necessary to rule out papers that did not fit with certain criteria for this study. More than 120 papers emerged from this systematic method of selecting literature. The title, abstract, introduction, method (when existent) and conclusion sections of each paper were read and analyzed. Materials that did not have the words "cumulative," "Indigenous" (or synonyms), and "social impact/effect" were excluded from our list. These words were selected to identify whether papers addressed cumulative effects under the social dimension and from a First Nations (Indigenous) perspective. Moreover, when a methodology section existed, we scanned it to verify the SIA method used. Two distinct categories of studies were analyzed: empirical and theoretical papers.

A second round of screening was performed to rule out papers that did not present a method to assess cumulative social impacts specifically in the context of Indigenous people. During the screening process, many comparative diachronic case studies, a very popular method in academia (Parkins and Mitchell, 2016), were also removed from the final list. As noted by Asselin and Parkins, (2009) this approach is a case study-based method that focuses on the

prediction of social impacts from one particular development using a similar case. However, cumulative social effects are derived from the interaction of multiple developments on a specific region, which makes comparative diachronic studies inadequate for the purpose of cumulative assessment.

Table 1. List of keywords* used to search, identify and select the literature conveying the cumulative effects of extractive industries on Indigenous people

Concept	Keywords
Analysis, monitoring and management of social alterations due to project development	Social Impact/Effect Assessment Social-ecological assessment Social-cultural assessment
Analysis of cumulative positive and negative social changes due to multiple activities	Cumulative impact assessment Cumulative social impact/effect Cumulative cultural impact/effect
Social impacts experienced during the development of large-scale projects	Livelihood Social impacts Hunting ground Fishing Heritage
Natural resources industries and activities	Extractive industry Mining Forestry Oil and Gas Energy industry Natural resources exploration Natural ecosystem exploration
Indigenous people affected by extractive industries exploration	Indigenous First Nations Aboriginal
The inclusion of specific words to narrow the focus on methods for Social Impact Assessment	Method/Analysis/Assessment Survey Interviews GIS (Geographical Information System) OR Spatial Mapping Demographic/census Ethnographic

* Example: social-ecological impact assessment AND “cumulative” social effect AND Indigenous AND extractive AND natural resources AND livelihood

We focused on empirical studies that used SIA methods, e.g., case studies that demonstrate how cumulative social effects have been addressed in the context of Indigenous perspectives. We also included theoretical works that address SIA and cumulative assessment from conceptual frameworks used to guide cumulative social effects assessment of extractive industries. The papers needed to emphasize the cumulative effects on Indigenous people; otherwise, they were removed from my list. The main reason for exercising great rigour in

selecting these studies is related to the worldview of Indigenous groups, which varies from the Western worldview. In describing Social Impact Assessment, Lockhart (1982) states that SIA needs to involve "insider's" knowledge and the perception of impacts, rather than only scientific knowledge that does not fully capture the social-ecological link present in the Indigenous worldview. Therefore, special attention was given to studies that demonstrated such a link rather than only recognizing the need for it.

3. What does the literature say about cumulative impact assessment in practice?

The necessity of cumulative effects assessment (CEA) has appeared in the literature and in environmental regulations since the early decades of the 1970s and 1980s (IAIA, 2020; Smit and Spaling, 1995). In the following decade, the 1990s, the USA and Canada started to incorporate concepts and a definition for CEA in their regulations. In addition, the International Association for Impact Assessment (IAIA) promoted several forums for practitioners and academics to discuss lessons learned from previous developments, new methods and frameworks to guide CEA, and further concepts to facilitate the implementation of this tool (IAIA, 2020). After 50 years of discussion and practice, the literature still discusses the fact that there are gaps in the procedural engagement with Indigenous people, and discusses the timeline for assessing and integrating of First Nations' opinion on the process and methods used to conduct SIA from Indigenous perspectives (Booth and Skelton, 2011). Here, we selected documents that conducted content analysis relating to EIA, SIA, regulation, policies, as well as from other studies, in order to understand common practices, trends, lessons, improvements, and weaknesses reported in relation to cumulative social assessment.

3.1. Consultation and policy making

With regard to Indigenous communities, the first perspective that is clearly evident in the literature is the lack of consultation and Indigenous voices in decision making (Booth and Skelton, 2011a). Indigenous communities feel powerless before big industries and governments that want to develop extractive projects in their territories (McGuigan, 2006). These circumstances are the result of the following: conflicts, limited meaningful engagement and participation, disrespect towards Indigenous concerns and spirituality, manipulation of data and

the EIA process, discrimination over Indigenous culture and worldview, unfairness with respect to Indigenous rights, and a lack of neutrality on the debate about whether to build the project or leave the resources on the ground without exploitation (Booth and Skelton, 2011). A comparison analysis of two cases, one in Canada and the other in Ghana, shows developed and developing nations share the following similarities: the exclusion of Indigenous concerns from the process, lack of involvement of Indigenous communities in the assessment of impacts, and poor consultation mechanisms employed to inform the community about the project and its effects (Olagunju and Dara, 2014). Studies carried out in Sweden, Finland, Russia (Larsen et al., 2017), Australia and New Zealand (Larsen, 2018) all point to the same conclusion. The historical and accumulated lack of trust in government officials and EIA procedures can potentially hinder meaningful and inclusive SIA that captures direct, indirect, and cumulative effects, and generates adequate material for policy making.

Issues associated with lack of voice in decision making are clearer when analyzing the methods used. Given the overarching concern for meaningful participation in decision making, Larsen (2018) developed a framework for analyzing the degree to which Indigenous people are integrated into SIA process. Four scales of involvement are presented: corporate-owned SIA, consultation, co-management, and community-owned SIA, with the degree of involvement increasing in that order. Indigenous people have no influence under corporate-owned processes: the community is only notified—and not consulted—about the development and the studies are conducted on the basis of Western knowledge without including cumulative social effects. Consultation regimes tend to have a somewhat limited influence on decision making; there is the inclusion of traditional knowledge and voluntary corporate practices, but the process remains centralized in committees or parties involved. Under a co-management SIA regime, all stakeholders are involved and asked to submit materials (comments, photos, testimonies, etc.), and to identify specific social contexts such as language hurdles, cultural differences, and site significance (Burdge et al., 2003), in addition to participating appropriately with community leaders (or Indigenous Elders). The last stage of involvement is the community-owned SIA regime, whereby Indigenous groups would have total influence on the project development, including conducting environmental, social and cumulative assessments, and hiring consultants.

Larsen (2018) identified examples of the four regimes in different countries (Norway, Canada, Australia, and New Zealand). However, the examples are not meant to reflect the sovereign reality in impact assessment practice for Indigenous groups, as EIA practice and legislation may vary considerably based on the local context. When we analyzed other studies carried out in Canada, such as the one by Booth and Skelton (2011b), Indigenous elders recalled that, in many resource sectors (e.g., wind farms, coal mining, and landfills), some corporations adopted a community-owned approach giving full support to the community and guaranteeing influence on decision-making, while for other developments, corporations tried to establish the activity based on corporate-owned SIA regimes. Considering the 2019 Impact Assessment Act promoted in Canada, Eckert et al. (2020) reported that there are still many procedural and resource obstacles for consultation during EIA, as well as political, historical, epistemological, and legal unresolved issues. Lawrence and Larsen (2017) report a situation where an oil and gas company applied for a licence to develop activities in an area used by the Sami communities of Sweden. The SIA that was carried out reflected a corporate-owned view, which did not integrate Indigenous knowledge and opinion in the assessment. Subsequently, public scrutiny led to the preparation of a second SIA in which Sami Indigenous groups became the central focus of attention and changed how the assessment was conducted, thus changing the results and conclusions for direct, indirect and cumulative impacts. The political regimes associated with SIA consultation will influence how Indigenous communities are integrated into the cumulative social assessment process. The following sections provide more information on the methods used to do so.

3.2. What is missing in the methods?

When dealing with cumulative impacts, EIA/SIA is focused on the likely physical effects that some aspects of development will cause on the environment when there is a lack of integration of Indigenous culture and political dynamics (De Rijke, 2013). Even the physical components are limited to certain identified valued ecosystem components (VEC), such as aquatic and terrestrial species, recreational areas, air, soil, and water quality, health, land use and heritage, among others (Bérubé, 2007). A link is often missing between these components and the social-ecological, human health, and cultural value of the ecosystem, as well as Indigenous livelihoods (Booth and Skelton, 2011; Hackett et al., 2018).

Liu (2015) analyzed how human health issues were addressed in EIAs for hydropower developments in Manitoba, Canada. The author argues that cumulative health effects were not properly assessed in the EIAs. The methods focused on physical human health and did not capture the complex and cumulative social effects on human health that were experienced during and after the installation of projects (Hackett et al., 2018; Liu, 2015). For instance, the cumulative social and health effects of multiple projects bidding to explore an area can start during proposal phase, before development begins (Vanclay et al., 2015). In the case of Indigenous communities, it is known that these communities have limited capacity in terms of human and financial resources, data, and other resources to analyze the large volume of proposals, pre-consultation, consultation, monitoring, and other materials informing them about the environmental effects of natural resource developments. Each project presents a high volume of highly technical information covering thousands of pages that need to be reviewed in a couple of months (Baker and Westman, 2018; Booth and Skelton, 2011; Udofia et al., 2017). The accumulation of materials to be analyzed, stress due to limited resources and expertise, and pressure to focus on what really matters for the community can physically and mentally overwhelm the few individuals who handle the process; this in turn can lead to further fatigue and psychological problems that are not captured during SIA.

In Booth and Skelton (2011), Chiefs from First Nations (Indigenous people of Canada) are critical of the Traditional Use Study (TUS) and Traditional Land Use (TLU) approaches used by consultants and governments to identify social and cumulative impacts of developments. These approaches have a restricted scope given multiple land uses, and they fail to reflect community culture with respect to land use during different seasons. Consultants claim that they have limited access to traditional land and knowledge use studies, and difficulties in obtaining participation in the study (Udofia et al., 2017). For their part, Indigenous communities in Canada complain that TLU only reflects a Western way of collecting and presenting data; thus, Indigenous people might refuse to provide information or to participate in the consultation (Joly et al., 2018). This is an example of a procedural obstacle as identified by Eckert et al. (2020). In this regard, Baker and Westman (2018) describe how the hiring firm might manipulate the assessment by stating facts based on information that is false or is not representative. Another complaint is that the TUS assessment is focused on the past and fails to predict future effects, especially when cumulative effects are at play (Westman, 2013). This in turn results in

inaccurate information and practices that will be used for licensing. When such studies present controversial results, companies might refute the science behind Traditional Land Use Studies or require analysts to change the report as the company is paying for the assessment, e.g., (Fisher, 2008). For instance, Baker and Westman (2018) reported on a project where Indigenous hunters and trappers perceived that noise was impacting moose and other animals. The company in charge of the project neglected the assessment and contested the study by comparing it with other reports pertaining to the impact of noise on domesticated sheep in the United Kingdom. Some SIA practitioners might prefer desktop mapping and modelling participatory approaches to describe complex social-ecological and cultural issues (Westman, 2013).

This scenario reflects the criticism of some scientists who oppose the kind of impartial and industry-driven social assessment methods used to license different extractive industries—i.e., how can features such as open-pit mines and lakes, which can be seen clearly from space images, cause no significant negative impact? (Baker and Westman, 2018). In this regard, community-based agreements are being introduced between industries and affected communities in order to offset negative impacts and provide means for local development (Le Meur et al., 2013). Nonetheless, Larsen et al. (2018) conclude that voluntary industry-led actions to assess cumulative effects and to use these assessments to license projects in Sami communities living in Sweden can be seen only as cosmetic improvements. The same conclusion can be drawn regarding community-based agreements (Le Meur et al., 2013) on mining policy and production in New Caledonia. They arrived at this conclusion based on inconsistencies in the methods used in community-based approaches, and based on the likely consequences when effective participation is lacking or poor. We have summarized the consultation and policy section as well as elements that are missing in Table 2. The information presented here is intended to facilitate understanding of the issues relating to the effectiveness of CEA and alternative approaches.

Table 2. Summary of issues pertaining to consultation and SIA methods in the context of Indigenous people

Element	Issues	Comment
Participation in the process	Existing corporate-owned assessments Indigenous members are not properly consulted Lack of Indigenous voices and influence in decision making	Corporations and governments still have great power in decision making and assessment relating to environmental and social effects. Even though progress has been made in involving and acknowledging the concerns of Indigenous groups, participation has been limited and hindered by differences in approaches, cultures, and interests.
Indicators	Selection of biophysical components Lack of measurable social indicators Health issues still not properly addressed	Prioritization in the selection and measurement of biophysical components, such as water quality, soil contamination, air quality, valued species (biodiversity in the area and influences on the ecosystem chain). Social indicators, or those that reflect the community's interaction with and dependence on biophysical components for culture and livelihoods, and the manner in which effects will accumulate over time and space, might be missing in many cases. Other impacts, such as health issues, are not properly addressed in the assessments. Impacts occurring before the development are not accounted for. The stress and pressure on elected community analysts, who lack time and resources to conduct evaluations, are also not explicitly addressed in the overall assessments and perspectives.
Common methods	Traditional Use Study (TUS) or Traditional Land Use (TLU)	TUS and TLU approaches are criticized by Indigenous leaders in Canada because the scope, reporting, and consultation methods reflect a Western way of conducting studies. Such approaches do not predict future impacts and are based on an earlier and incomplete picture of the community. Indigenous groups are demanding the inclusion of traditional knowledge in a participative manner that respects cultural differences and worldviews and gives a proper representation of the community.
Response to critiques	Critiques not accepted Controversial debates	When the knowledge acquired through participatory approaches challenges the industry's assessment, some companies might deny the results and claim that anthropological approaches "lack validity." Technical methods such as economic analysis and statistical approaches, are still "preferred."
Contested conclusions	Biased conclusions	Critiques arise from the fact that some EIA/SIA conclude that projects will have no major significant impacts even though there is physical evidence to the contrary.
Corporate actions	Palliative improvements	In the sense that SIA and corporate social responsibility are connected, some corporations have only developed actions to alleviate and improve public image, rather

	than engaging and promoting community-based approaches.

3.3. Viewing CEA strategically

EIA is a project-based (e.g., a particular gold mine) or even a sector-based (gold mine and access roads) tool, which means that the prediction of likely impacts covers a specific development. CEA might be included in the assessment, but content analysis studies often contest the effectiveness of CEA in different cases due to the project-centered nature of EIA. For instance, two studies analyzing the CEA of the Keeyask Hydroelectric Station and Bipole III transmission line, both in Manitoba, Canada, arrived at the conclusion that CEA failed to acknowledge the significance and cumulativeness of previous (hydro) developments in the area, with the result that the CEA performed was not effective (Gunn and Noble, 2002; Noble and Gunn, 2013). The new development might not be the only industry or infrastructure in the region. The environmental changes added to a region would accumulate with historical events, and all together, they impact terrestrial and aquatic ecosystems, social-ecological relationships, and community wellbeing. Authors such as (Larsen and Raitio, 2019) contend that the practice of licensing projects one at a time, without regional and strategic land use planning, makes it harder for government officials and communities to assess cumulative social impacts. In this regard, Booth and Skelton (2011b) and Gunn and Noble (2011) suggest a holistic and strategic approach, the strategic environmental assessment (SEA), which focuses on plans, programs, and policies (PPPs) for the entire region and takes into consideration knowledge accumulated from multiple developments. For instance, a framework proposed to manage the cumulative effects of shale gas exploitation in Australia suggests that independent projects perform their risk assessments and include data and results in the strategic assessment, such that impacts are considered in a cumulative manner (Witt et al., 2017). This view of strategic environmental thinking is connected to Indigenous participation in the assessment process and to cumulative social effects assessment (Lajoie and Bouchard, 2006). There are examples, such as the Sami community, where ethnographic methods (surveys and workshops) were put in place to collect data from communities to implement strategies for the region (**section 4.2**). However, even regional land use planning for Indigenous grounds might fail to predict and manage the cumulative effects of future developments because of the complexity in the dialogue of maintaining nature

conservation and cultural significance on an “industrialized” environment (Ehrlich, 2010). For example, the participation of the Indigenous people of Canada in developing the strategic plan for the James Bay area in Quebec is viewed as positive, but only partially effective for cumulative effect assessment of hydroelectric, forestry and mining projects in the region, as it addressed only half of the criteria suggested by the literature (Lajoie and Bouchard, 2006). For regional planning, Christensen and Krogman (2012) reported that some communities prefer small-scale developments rather than big oil and gas, mining, and forestry industries, despite the creation of fewer jobs. However, a challenge arises in that various small-scale projects might skip the assessment requirements due to the size of the development, which then leaves a gap in the participation of Indigenous groups and the consideration of cumulative social impacts under regional planning (Udofia et al., 2017), and may result in major effects on Indigenous livelihoods (Lockie et al., 2009b). Another issue with participation is presented in Gardner et al. (2015), pertaining to a development where one of the proponents was an Indigenous group, but the consultation process and regional planning did not represent other Indigenous groups in the area. Another example of the complexity of regional planning involved the Indigenous opposition to create marine parks in Northern Australia (Voyer et al., 2014). The impacts are not the only cause for opposition to marine parks; Indigenous leaders perceive conflicts between conservation policies and traditional knowledge about the area. In terms of cumulative effects, a planning process that includes many policies devaluing Indigenous knowledge about fishing in the area can create hurdles for livelihoods and traditional practices. Historical abuses, discrimination, and restrictions to the practice of cultural activities accumulate with the implementation of policies that do not take into consideration Indigenous perspectives. Interestingly, even parks designed to conserve the natural environment can harm the livelihood of traditional users, mostly because of the duty to provide fish for the community and to comply with park regulations (Voyer et al., 2014).

Thresholds for regional development limiting the expansion of natural resource industries on Indigenous lands can be difficult and subjective to implement; this also adds to the polarized political scenario in which governments and industries exert power over marginalized communities experiencing discrimination. Thus, there are no easy answers to these challenges by providing holistic approaches to cumulative effects assessment. Whether an assessment is project-based or regional-based, we believe that participation is the key to an effective SIA. The

discussion also returns to the lack of trust of political bodies that conduct regional planning and to different obstacles for integration of traditional knowledge in the assessment. The issues discussed on this section and previous ones set the stage for the presentation of SIA methods covered in the literature. Table 3 presents a summary of the limitations of the strategic view for CEA in the Indigenous context.

Table 3. Summary of issues pertaining to CEA and regional planning in the context of Indigenous people

Element	Issue	Comment
Project-based EIA	Impacts of a single development	Each development causes different environmental disturbances that cumulatively affect the biophysical and social environments.
Licensing	One at a time	Similarly to the assessment of impacts from a specific project, the licensing system does not (usually) consider the additional pressure of one more development on the region.
Baseline condition	Altered environment and accumulated conditions	In the example of Gunn and Noble (2012), the assessment is based on a deeply altered environment, even though the study concludes that there were no significant cumulative effects.
Plans, policies, and programs (PPP)	Political power	Indigenous groups have historically suffered the consequences of colonial policies and Western plans and programs to explore natural resources without Indigenous consent. Strategic assessment should include Indigenous communities in the process of formulating PPPs such that projects follow guidelines that already reflect the community's concerns.
Approach	Complexity	Current, there is no software or method with the capacity to separate the impacts of each development. The complexity of EIA is another factor in addition to the political scenario and interests behind the development of projects. Thus, the issue sums methods and interests.

4. Approaches to assessing cumulative social impacts on Indigenous livelihoods

In reviewing the literature, we find a wide range of approaches to CEA. These include the following: social science techniques such as interviews and questionnaires, checklists and matrices, network and system analysis, indicators and indices, ecological modelling, trend analysis, GIS analysis, risk-based approaches, habitat suitability modelling, scenario analysis, environmental management systems, carrying capacity analysis, and expert opinion (Roudgarmi,

2018; Smit and Spaling, 1995). The following sections present examples of frameworks, as well as field and desktop methods used to study CEA of resource developments in Indigenous areas.

4.1. Frameworks

4.1.1. Blishen-Lockhart model

The Blishen-Lockhart framework for cross-cultural contexts is an SIA community-response model designed to evaluate the social effects of developments on Indigenous groups living in Northern Canada. This model is particularly relevant for situations where communities are living in poverty and in close proximity to the development of natural resource extractive industries (Blishen et al., 1979). This framework incorporates three main indicators guiding the cross-cultural analysis, which are as follows: social viability (social behaviour that represents the community health); economic viability (the degree to which a community depends on the government for its survival); and political efficacy (the power of previous parameters in decision making) (Blishen et al., 1979; Ross and McGee, 2006).

There is a series of papers describing a modified version of the Blishen-Lockhart model used to evaluate social impacts of mining industries in Coronation Hill, Australia (Lane et al., 2003, 1997; Lane and Rickson, 1997). In these papers, the method used includes a three-step approach to SIA. First, ethnographic methods (interviews, workshops, consultations, etc) are applied to collect qualitative information about the interest of the different stakeholders in the region. The second, and concomitant, step is the acquisition of technical data (demographics, socioeconomic profiles, analogous studies, etc.) used to construct a social profile of the community and baseline analysis. Next, the Blishen-Lockhart framework provides guidance on verifying how communities perceive social impacts and on the community's resilience or susceptibility with respect to dealing with adverse impacts. The authors state that this method helps to integrate both technical and participatory data in one tool, and that it obtains qualitative and quantitative results, and aids decision making.

As for cumulative social assessment, the studies indicate that historial facts play a significant role in Indigenous responses to extractive industries. Common causes of impacts include an increase in foreign population, the displacement of communities and a lack of interest in traditional knowledge about the area. All of the above affected the capacity of Indigenous

communities to maintain their connection with the land and with sacred knowledge. This further impacts the community's social vitality and political efficacy. Conversely to models that characterize the community's capacity to adapt to historical changes, this model is not able to predict future social impacts, but only analyzes and describes the current situation derived from accumulated practices and policies (Ross and McGee, 2006).

4.1.2. Equity assessment framework

The literature is vast for Indigenous rights and Indigenous injustices. This section aimed to collect only frameworks or methods intended to capture cumulative changes due to extractive industries. We recognize that the topic requires an entire separate paper to discuss injustices and rights in further detail.

Gislason and Andersen (2016) point out that health in EIA should be understood to have two meanings: health of ecosystems and health of people. Thus, cumulative social effects can cause negative effects on the environment and the physical health of the communities that depend on and use natural resources for their livelihoods. Using the environmental justice lenses and concepts of ecosystem health, sociocultural health, natural resources quality, socioeconomic health, and human health, Harris and Harper (1999) propose the *equity assessment framework* to assess and compare the cumulative social effects of extractive natural resource industries on Indigenous and non-Indigenous people. This framework takes into consideration pre-existing historical stressors and new activities likely to affect the environment. It emphasizes three main components: discovering what the community thinks is relevant, establishing measurable indicators, and conducting risk assessment based on the indicators. For the former component, planners and stakeholders need to engage with communities, through appropriate survey methods to acquire data regarding the resources, intrinsic value to the community, services provided, and uses that are at risk in the event that the development of an industry degrades local resources. Community engagement can be difficult, especially if ethnic differences are not taken into account in the survey (Szablowski, 2010; Wilson et al., 2016). Regarding indicators, the inclusion or exclusion of metrics that are important for all stakeholders (Indigenous groups, industries, governments, etc.) might present an extra challenge, as the worldviews and interests of the various stakeholders differ in many cases. In other cases, adverse impacts not required by regulation or first identified as concerns might be included later in the assessment to evaluate

cumulative changes (Harris and Harper, 1999). The use of individual indicators that look at individual impacts camouflages the actual cumulative effects that Indigenous nations suffer every day due to intensive natural resource exploitation (Gislason and Andersen, 2016). Harris and Harper (1999) suggested using indicators that incorporate biophysical components covering ecosystem health, the functions of the various components in relation to the community, human health issues, the sociocultural infrastructure such as religion and recreation, and socioeconomic health. They argue that each characterization needs to be followed by a mathematical risk assessment analyzing "exposure versus sensitivity." Notwithstanding the quantitative approach, environmental risk assessment can face problems related to subjectivity in assigning magnitude values (Aven, 2016, 2011).

4.1.3. Gender-based analysis

Most of the literature, including methods reviewed in this report, fails to develop frameworks or methods differentiating gender inequities (O'Faircheallaigh, 1998). Decision-makers, researchers, and industry stakeholders should bear in mind that extractive industries affect the livelihoods of both men and women, and the ways in which they interact with the land. Men and women might have different roles in the community and be in charge of activities other than those directly associated with industrial developments (Lahiri-Dutt and Ahmad, 2013). In many cases, however, women are excluded from the social assessments (Koutouki et al., 2018; Lahiri-Dutt and Ahmad, 2013). Verloo and Roggeband (1996) view *gender-based SIA* as a helpful instrument for designing policies that shatter certain myths associated with gender neutrality during the EIA process. The authors highlight the fact that a *gender-based framework* should include issues related to the structure of society, processes, equity and autonomy. Mitchell and Parkins (2011) note that gender is an aspect of cumulative effects and can be discussed as one of the indicators representing gender equity, quality of life, locus of control (control over one's own life).

A *gender-based analysis* is presented in Lahiri-Dutt and Ahmad (2013) for scheduled castes and scheduled tribes (Indigenous) of India. A participatory approach was adopted, and thus both men and women of the community were interviewed and expressed their concerns and perceptions of impacts due to mining industries in the region. The authors selected areas of concern regarding a gendered SIA where there is evidence of cumulative pressure from mining

activities (land, household, food security, scarcity of water, health issues, culture, gendered conflicts, fear and mobility, children's education, and economic opportunities). The areas of concern are intertwined such that effects on one issue induce direct and indirect effects, or accumulate for the other issue. The local social structure also plays a role in the dynamics of the community and in how communities experience the effects. In general terms for that community, the loss of agricultural land seemed to be a major driver for changes in women's livelihoods (e.g., a decline in the collection of seeds and forest goods). The land is connected to food production, and therefore to food security and changes in diet, once connected to farmed products, to industrialized products bought in the market. There has been a dependence on men for household incomes as the industry compensatory policy focuses solely on families who have lost revenue land, and on the creation of jobs and opportunities for men. Not all families receive compensation from mine companies, and therefore access to food becomes harder for those who cannot afford market products. Women have the right to mine as well, but as Lahiri-Dutt (2012) noted, there has been an expressive decline in the number of Indian women in the mining industry. Reasons include policies, discrimination, technology use, and neglect of women's needs.

A *rights-based approach* was discussed in Koutouki et al. (2018) as encompassing the voice of minorities, challenge of discrimination of Indigenous women even among themselves, and perform a more equal gender-based analysis in Canada. The three key components of *a rights-based framework* are as follows: equity in the regulatory process; meaningful participation in community-based agreements; and the recognition and integration of Indigenous laws, treaties, and agreements. First, assessments should include the cumulative impacts on Indigenous women and girls, and improvements to community-based agreements should go beyond including people who are directly working on a given project. Secondly, assessments should ensure the participation of Indigenous women in the decision-making process pertaining to development. Indigenous women represent only 16% of members of management boards in Northern Canada (Koutouki et al., 2018). Thirdly, assessments should comprise recognition and integration of Indigenous laws, treaties, and agreements. There are economic benefits and improvements in aspects access to goods and infrastructure; however, the main point in the research is that SIA should differentiate impacts on women from those on men in the analysis of

PPPs in order to verify whether the rights of one gender are favoured more than those of the other gender.

4.1.4. Story telling-based frameworks

Preston and Long (1998), Canada, and Ross (1990), Australia, present an SIA framework model based on narrative (we have used the label *story telling frameworks*) to assess cumulative cultural changes in the context of historical facts that affected Indigenous livelihoods. In both Canada and Australia, Indigenous communities seem to use story telling as a way to pass on traditional knowledge to future generations; thus the authors agreed to use a familiar approach to assess cumulative social impacts and capture historical events.

Preston and Long's qualitative narrative framework covers stories about travelling for subsistence, the impact on means of transporation, extractive developments at different industrial scales, and government plans, programs, and policies (PPPs) that affected Indigenous culture in Ontario, Canada. For Preston and Long (1998), travel reflects histories of trading between Indigenous and non-Indigenous groups, travel for missions, and subsistence purposes. The first impact concerns the spread of diseases and the death of several Indigenous people. This impact was intensified when the government started to expand roads and railways to reach more northerly areas and Indigenous lands. The analysis also shows cumulative cultural changes from the creation of settlements, immigration and population increases, interference from outside cultures, the spread of more diseases, and the ability of industry to easily access other natural resource grounds. Hydroelectric developments were perceived as having the greatest impact on Indigenous culture, as large and long-lasting reservoirs alter the environment, resulting in changes to animal behaviour, access to hunting grounds, fish spawning, and areas of spiritual significance, and causing floods. The last component of the framework involves cumulative cultural changes derived from government policies. Policies that disregard Indigenous livelihoods and impose a colonial mindset tend to severely affect Indigenous culture. This can be observed by analyzing a series of measures that were intended to preserve the environment, but that interfered with the livelihoods of the Cree Nations (Canada),including beaver trapping, employment as game wardens, trapline mapping, and individual trapline licences.

Ross's framework aims to identify community control over the SIA process, including Indigenous values, perspectives, and aspirations, social and cultural contexts, and cumulative effects. The author describes three major periods (development, pastoral, and intensive development phases) in which the Australian government implemented settlement PPPs to occupy the Warmun region and caused permanent negative effects on the Indigenous people living in the area. The stories recall cumulative effects from regional PPPs that induced massacres, and the displacement, persecution, discrimination and oppression of Indigenous culture. The narratives demonstrate that Indigenous people resist cumulative social effects in spite of continuing and intensive disturbances. For example, Indigenous people kept returning to the region and practicing sacred and traditional rituals. In addition, during the third historical phase, covering intensive development, mining developments began to exploit sites of significant spiritual concern for the community. The Indigenous people expressed their interest in engaging with proponents and contributing to the management of the projects, but government policies and cultural factors still presented hurdles to prevent this from happening. As described in section 3.3, regional and strategic plans are not easy to implement, particularly when Indigenous people have been excluded from such PPPs while industries have a certain degree of power over decisions.

4.1.5. Resource community cycle and cumulative social impacts

SIA might be conducted using documentary analysis of reports and databases to analyze the way in which social effects are experienced over time as a result of political, economic and social changes. Lockie et al., (2009a) examined two SIA reports, one from 2002–2003, and the other from 2006–2007 preparing for a coal mining project in Australia. The authors then applied the *resource community cycle* framework to predict *ex-post* social impacts from other developments. SIA presented information on the following aspects: regional demographic changes; the historical demand for human and health services; the demand for housing and infrastructure; increase in crime rates; community participation and integration; traffic rates and work fatigue; community identity; job creation and business opportunities; the capacity of local institutions to plan and govern; opportunities for Indigenous people; and environmental impacts.

The *resource community cycle* framework analyzed the changes and interactions between economic aspects (growth and decline), employment policies for workforce hiring (with attention

given to Indigenous workforces here), social capital, and population dynamics over the lifecycle of the development. The results identified the fact that, in spite of population increases and a rise in crime rates, job creation was dependent on mining industries, and a possible collapse in the economy would cause serious damages for the local social structure. When cumulative social effects are generally addressed, the negative effects of mining and extractive industries on Indigenous people tend to be emphasized. Funds from mining projects can be used to offset negative social effects and to aid cultural practices consistent with corporate social responsibility (CSR) literature. But according to the authors, the social benefits might also change when other developments are brought together and intensifying negative social effects. Changes in the economic situation in addition to the accumulation of mining industries affected the relationship with Indigenous groups living near the area. Marginalization, discrimination, and other problems were experienced with the influx of developments in the region.

A summary of this section is expressed in Table 4. We highlight the frameworks, bibliographic information, location, as well as the main strengths and weaknesses of the different frameworks.

Table 4. Summary of frameworks to analyze cumulative effects assessment of extractive industries on Indigenous people

Approach	Ref.	Location	Key aspects	Strengths	Weaknesses
Blishen-Lockhart	(Blishen et al., 1979)	Canada	Community viability Economic viability Political efficacy	Good description of the community situation; well-documented historical impacts capture cumulative effects	No prediction of impacts
Adapted Blishen-Lockhart	(Lane et al., 2003, 1997; Lane and Rickson, 1997)	Australia	Ethnographic methods Technical data Community viability Economic viability Political efficacy		
Story telling	(Ross, 1990)	Australia	Community control over SIA; community values and perspectives Social and cultural contexts embedded; Cumulative effects view; Indigenous aspirations and strategies	Good description of the community situation; well-documented historical impacts Analysis of regional PPPs; Capture of cumulative effects	No "quantifiable" indicators Limited issues addressed
	(Preston and Long, 1998)	Canada	Travel Means of transportation Extractive developments Scale of industrial activities PPPs		

Equity Assessment	(Harris and Harper, 1999)	USA	Community participation Establishment of measurable indicators Conduct of risk assessment based on the indicators	Qualitative and quantitative approach	Difficult to select indicators Subjectivity in risk assessment
Resource community cycle	(Lockie et al., 2009a)	Australia	Document analysis focusing on indicators presented in SIA	Analysis of the project lifecycle may predict impacts on similar conditions	Difficult to find projects reflecting the same conditions Cumulative effects might be hard to measure from different developments
Rights-based approach	(Koutouki et al., 2018)	Canada	Equity in regulatory process Participation in community-based agreements Recognition and integration of Indigenous laws, treaties, and agreements.	Guidance to improve assessment	No "quantifiable" indicators No prediction of impacts
Gender-based analysis	(Lahiri-Dutt and Ahmad, 2013)	India	Community participation to differentiate effects based on gender. Framework covers land use changes, social and structural changes, effects on livelihood, and economic opportunities focusing on men.	Guidance to improve assessment	No "quantifiable" indicators No prediction of impacts

4.2. Participatory spatial methods (case studies)

Spatial assessment via remote sensing or Geographic Information System (GIS) tools have been a common practice among professionals carrying out EIA and cumulative assessments (Smit and Spaling, 1995). This can be a highly technical approach to create maps locating environmental features, pointing their proximity to important infrastructure, visualizing the landscape, and to apply overlay techniques for assessing impacts (Rodriguez-Bachiller and Wood, 2001).

For SIA in the context of Indigenous communities, we identified a trend of studies that merge traditional ecological knowledge with scientific GIS approaches; we have labelled them *participatory spatial methods or GIS-SIA*. In fact, Indigenous communities from Canada and Sweden have been using GIS tools (GeoPortal in Canada and RenGIS in Sweden) to collect information on caribou/reindeer migration, behaviour, and habitat changes due to cumulative anthropic pressures (Driedger, 2014; Herrmann et al., 2014). Proverbs (2019) and Lawrence and Larsen (2017) argue that this integration represents a novel step enabling the methods used to assess the cumulative effects of extractive developments. The main difference between Indigenous nations in the study is that the First Nations (Indigenous people of Canada) make use of wild caribou while the communities in Scandinavian countries (specifically, the Sami and Nenets communities) have domesticated reindeer (Kumpula et al., 2006). Nevertheless, the underpinning argument is the same: these methods acknowledge the intrinsic relationship that caribou/reindeer, moose, and other animals have, and that land use has with respect to Indigenous livelihood, subsistence, and spirituality in Northern Canada, or in Northern Europe, including the Scandinavian countries (such as Sweden), Russia, and Finland. Therefore, measuring how these animals are affected by human activities can facilitate understanding of cumulative effects of multiple projects on Indigenous livelihoods (Wolfe et al., 2000).

In the *participatory spatial assessment or GIS-SIA*, interviews were used to obtain insights about the views of Indigenous people in Canada (Proverbs, 2019), as well as reindeer herders in Sweden (Lawrence and Larsen, 2017) and Russia (Kumpula et al., 2011). This ethnographic approach was aimed at understanding the groups' connection to the land, and their spirituality, livelihood, and perceptions about the impacts of natural resource industries. The studies on Russia collected satellite images in addition to photos taken during field trips, helicopter flights, and other visits to compare the impacts perceived through satellite and field images (Kumpula et al., 2006). A GIS tool is used to process and integrate the images and results from the interviews onto a single platform. Figures processed using GIS tools have the advantage of presenting visual and statistical data that shows cumulative environmental changes caused by multiple industries in a given area. Depending on each case, adaptations had to be made in order to include traditional ecological knowledge of Indigenous people and their perception of impacts. At this phase, different indicators can be incorporated into the process to investigate the cumulative disturbances in the region (Driedger, 2014).

Surveys of Indigenous communities might reveal a historical knowledge of the land and the ways in which industrial activities have changed the landscape. Data from these surveys with GIS could be used to construct a historical map showing the cumulative changes and the impacts of the activity on the region (Kumpula et al., 2010). It is a general understanding that infrastructure used for transportation (roads, railways, aircraft), recreational activities (tourism), forestry, petroleum and mineral exploitation, hydropower plants, and other activities might affect the behaviour of caribou/reindeer populations differently (Driedger, 2014; Wolfe et al., 2000). Mines and associated infrastructure (roads, railways), as well as other developments (hydroelectric, population, hunting), create barriers that directly impact caribou/reindeer/moose habitat and migration (Herrmann et al., 2014). Thus, scholars on GIS-SIA strongly agree that caribou/reindeer tend to migrate away from an area that has developed an extractive activity or suffered any environmental disturbance (e.g., roads). Animals might not attempt or might hesitate to cross linear structures; as a result, there is a likely risk of them being killed by direct interaction with components of the activity (vehicles or increased hunting) (Wolfe et al., 2000). Even when the infrastructure does not occupy a large area in terms of hectares (such as a pipeline), the greater impact is the associated functional loss of the area, linked to traditional and ecological practices. The participatory mapping studies conducted with Sami reindeer herders only reinforce the fact that impacts exceed the entire zone of influence of one project. This means that multiple projects have the cumulative effect of restricting areas for reindeer/caribou migration and habitat. These effects were identified through project-based EIA/SIA separating the impacts by each project individually (Booth and Skelton, 2011a). Issues imposed by climate change, coastal erosion and landslides are not addressed, which neglects the cumulative social challenges faced by northern Indigenous communities (Kumpula et al., 2011).

The SIA-GIS results might challenge and contradict company-based assessments stating that there is no correlation between noise and changes in animal behaviour (Baker and Westman, 2018). Lawrence and Larsen (2017) report that the non-recognition of participatory approaches to SIA is still evidenced as the authors state that the proponent (mining industry) considered the authors' approach to be overly subjective and therefore invalid for assessing and predicting social impacts on Sami Indigenous communities. Even though some of the results conflict with the industry's interests, Herrmann et al., (2014) argue that participatory GIS tools help to improve dialogue between private sectors and communities (the knowledge holders) and to

create an understanding of how both practices affect one another, so that a decision can be made based on the interests of both groups. In discussing this tool covering a range of Indigenous rights, Lawrence and Larsen (2017) claim that participatory GIS can give voice to the affected communities and contribute to an informed decision about the project. For instance, a mining project was rejected in Sweden due to the SIA showing cumulative effects that would go beyond interests associated with Sami reindeer (Herrmann et al., 2014; Lawrence and Larsen, 2017).

The method also has limitations. First, the perception of impacts changes according to whether Indigenous or non-Indigenous participants are interviewed. In Kumpula et al., (2006), Sami communities described cumulative and historical changes related to migration routes, camping sites, fishing grounds, and surface resources, while oil and gas workers tended to describe the historical perspective of petroleum drilling and expansion of the activity in the area. In this way, complementary field surveys are often required to understand people's perception of the benefits and constraints associated with human developments, but integration of traditional and ecological knowledge is still a challenge as it is sometimes divergent from Western approaches (Kumpula et al., 2011, 2010). Secondly, cumulative effects can be identified all together, but no method exists to separate the effects derived from each development operating in the region (Wolfe et al., 2000). Thirdly, spatial approaches do not provide sufficient data to evaluate socioeconomic and social-ecological separately, as it is difficult to capture positive socioeconomic effects and livelihood changes using GIS approaches. For instance, in spite of negative effects, interviewees in Kumpula et al. (2006) acknowledged positive effects of industries on the area, such as settlements as a source of staple food for herders and other benefits for the community. These impacts were not incorporated into the production of maps showing cumulative social effects. Moreover, satellite and aerial imagery can identify major landscape changes, e.g., deforestation and fires, and social activities such as gatherings of reindeer herders. Other indirect impacts (contamination and spills) and the impacts of small-scale infrastructure (such as off-track roads) are barely detectable using spatial images (Kumpula et al., 2010, 2006). Finally, we provide a summary of the literature in *Table 5*, with the main points being addressed in the section.

Table 5. Participatory geographic information system SIA (GIS-SIA) linking the monitoring of animal migration and Indigenous livelihoods

Ref.	Location	Key aspects	Strengths	Weakness
(Kumpula et al., 2011, 2010, 2006)	Russia	Ethnographic data, remote sensing images, aerial imaging are integrated to analyze and predict cumulative effects of Oil and Gas industries on reindeer herder communities	Spatial and temporal visualization of impacts Capture social movements and link animals' migration to livelihoods Overlay impacts and identify cumulative industries	Difficult to integrate economic and positive impacts Effects assessed all together Difficult to integrate different perceptions Limited detection of small-scale components
(Driedger, 2014)	Sweden and Canada	Documentary analysis on the Canadian Caribou Planning Program and reflections on the Swedish Program		
(Herrmann et al., 2014)	Sweden and Canada	Three cases showing how Indigenous people of Canada and Sweden are using GIS to monitor caribou migration changes resulting from human activities		
(Lawrence and Larsen, 2017)	Sweden	GIS tools are used to integrate the technical data and qualitative data from interviews with reindeer herders. Bridge traditional and scientific knowledge to predict cumulative social impacts.		
(Proverbs, 2019)	Canada	GIS-SIA combines spatial environmental physical changes and Indigenous perceptions of impacts. Coastal community highly dependent on aquatic environment for subsistence and cultural practices.		

4.3. Community-based ethnographic methods and frameworks for CEA

Community-based ethnographic approaches are the primary source of knowledge about the community's perception of impacts. This section describes studies that performed interviews, workshops, observations, and other forms of contact with Indigenous communities and developed community-based methodologies or frameworks capable of assessing cumulative effects considering the local reality. Parlee et al. (2012) and Booth and Skelton (2011a) claim that traditional knowledge about ecological conditions of the region might be used to predict impacts of extractive developments from the perspective of those who suffer the effects and live with it daily. In this context, power is associated with knowledge, and traditional and ecological knowledge becomes an important tool to understand the cultural local context and to improve the

relationship with the community (Rozak, 2011). Even on different Indigenous contexts, it is agreed that truthful collaborative approaches that equally reflect and value the interests of both governments and Indigenous groups are seen as the ideal solution for cumulative assessment (Larsen et al., 2017).

The locations of the studies included the Yukon, (Christensen et al., 2010; Christensen and Krogman, 2012), British Columbia (Booth and Skelton, 2011a; Hutchison, 2017; McGuigan, 2006) and Alberta (Parlee et al., 2012) in Canada, as well as Guatemala (Rozak, 2011). A method to assess cumulative effects was proposed by Parlee et al. (2012), based on the cause-effect relationship between extractive developments and social-ecological changes in the context of thresholds for Indigenous livelihoods. Christensen and Krogman (2012) address the community's resilience in the face of social-ecological changes and whether thresholds can be used to measure the degree to which communities are able to adapt to cumulative impacts. The model proposed by Mantyka-Pringle et al. (2017) addresses the difficult challenge of bridging traditional and scientific knowledge in a single tool to assess cumulative social and environmental effects. The authors construct their approach based on interviews to capture traditional knowledge and the adapted Bayesian Belief Network that uses probabilistic models (such as multi-criteria analysis) to deliver a visual representation of the major indicators. According to the authors, scientific knowledge focused on spatial indicators to compare locations, while traditional knowledge emphasized temporal aspects (how features changed over time).

Indigenous people have an intrinsic relationship with the landscape and depend on it for their subsistence, spirituality, and livelihood. Thus, biophysical components are included in the methods as well as indicators for measurement. The major components selected by Mantyka-Pringle et al. (2017), Parlee et al. (2012) and Rozak (2011) incorporate water quantity, water quality, ice regime, the health and population of fish and other animals, access to forest resources, moose health (for Canada specifically) (McGuigan, 2006), air quality, and climate change. The biophysical changes are mainly associated with forestry, oil and gas, farming and agriculture, and waste treatment centre facilities. The consideration of cumulative effects on biophysical components, drawing attention to historical and regional contexts, is a key component of community-based SIA. All of these parameters are important, but they need to be

considered in the context of traditional knowledge and land use, and their connection to Indigenous livelihoods. Otherwise, the analysis is no different from current practices that focus solely on biophysical changes. Thus, Mantyka-Pringle et al. (2017) also include 22 traditional knowledge components reflecting social indicators (story telling, cultural changes, animal ethics), and livelihood indicators (ecotourism, harvesting, travel, adaptation). With respect to qualitative indicators, Mcguigan (2006) interviewed four Indigenous communities in British Columbia, Canada, and mapped six areas that need to be considered when addressing cumulative effects. These areas are as follows: land-based activities; human health; sense of place, identity and culture; obtaining financial benefits; Indigenous rights and power; and the intrinsic value of nature. These areas should provide indicators to be considered during SIA. Community members might recall ecological changes in conditions over the past years, indicating the nature of cumulative effects that play a role in the transformation of the region's ecological conditions, such as contaminants, forest fires, floods, etc. (Christensen et al., 2010). These delicate changes, which are cumulative over time, are not commonly detected by scientists, but are perceived by local knowledge holders living in the community (Mantyka-Pringle et al., 2017). Turner et al., (2008) describe subtle changes as "invisible losses" that tend to accumulate, impact Indigenous livelihoods, and decrease the community's resilience to changes. The authors associated losses in the area of local culture (identify, self-determination, lifestyle, knowledge, seasonal practices), physical and psychological losses, and losses associated with emotional health, and economic losses (indirect losses and the loss of opportunities resulting from businesses coming to the area).

Changing the perspective from biophysical-based effects to social effects, Christensen et al. (2010) and Christensen and Krogman (2012) present indicators for regional planning concerning social healing and healthy relationships with the land. Social healing includes participation in programs that allow First Nations to recover from cumulative historical abuses, discriminations, and marginalization. This topic fits well with the social viability component addressed by Blishen et al. (1979). A healthy community needs to have people free from addictions, past traumas, and abuses suffered. The community in the case concerned expressed the importance of healing circles for overcoming past traumas and abuses. They also would like to have more activities to engage in cultural practices and residential school healing, and would also like community support systems, and drug and alcohol programs. The component of a healthy relationship with the land focuses on the perception of keeping the environment clean

from pollution; this component is also associated with animal and human heath, intrinsic respect for the land, education and recreation activities, stewardship, and shared governance. Christensen and Krogman (2012) drew attention to social healing and healthy relationships with the landscape, and connected these with the concept of social-ecological resilience of Indigenous nations (absorbing changes and reorganizing the system to function as closely as possible to the initial state). In the same study and in Foote (2012), there is a discussion of the existence of social-ecological thresholds for temporal and spatial cumulative effects that will affect the capacity of the community to recover from changes in the same way. In another paper, Christensen et al. (2010) compared the same indicators with the government's regional planning framework; they found similarities among the indicators, but the ones used by the government did not include interactive and accumulative aspects of change.

Another study (Hutchison, 2017) focused on cumulative effects on the culture of Indigenous nations. The authors make recommendations to improve the current government's regional program. The indicators reflect an intent to avoid exploration at sites of cultural significance to Indigenous livelihoods, and to secure traditional harvests and maintain subsistence practices such as hunting and fishing; in this regard, environmental stewardship is crucial for ensuring that communities continue to have access to resources in the future. Minimizing negative cumulative cultural effects also means investing in traditional language learning and increasing fluency among new generations. Finally, the program should pay attention to participation in social activities (feasts, arts, dancing, etc.) that express Indigenous culture and livelihood. Common areas addressed in the studies include the need for effective participation in decision making, Indigenous governance and sovereignty, and policy making (Christensen and Krogman, 2012; Lawe et al., 2005; Rozak, 2011).

Indigenous communities might criticize the outcome of interviews done during the assessment of social effects because they are usually reported using a Western-style mechanism that is not accessible to communities. Accordingly, to address these shortcomings, researchers can integrate an adaptive management approach that emerges from constant interaction with the affected communities (Lawe et al., 2005). As an example, the Indigenous people interviewed by Booth and Skelton (2011a) were critical of the government pushing developments to expand into these areas, as was done in the era of high modernization and construction of large developments

without taking into account the social implications for Indigenous people. They report feeling undervalued and left out of any significant decision making. Their culture, ways of life, and beliefs are not considered because of differences compared with to Western culture. Booth (2017) even states that governments and inhabitants seem to be indifferent about the changes and social impacts of resource development on Indigenous groups living in remote areas.

McGuigan (2006) sets out future steps for cumulative effect assessment and regional planning. Political and legal issues are among the highest priorities, given the lack of trust, high grievance rates and injustices that have culminated as a result of political legacies and that still persist. Measurable indicators are also suggested, but these pose a challenge and might be limited to the scope and nature of the project. A summary of the results of this section is presented in Table 6.

Table 6. Summary of Indigenous community-based SIA methods to conduct CEAs of extractive industries

Ref.	Location	Key aspects	Strengths	Weaknesses
(McGuigan, 2006)	Canada	Interviews with the Indigenous community to select indicators Areas of concerns include hunting, trapping and snaring, fishing, food gathering, medicine gathering, teaching and cultural sharing, camping, human health, identifying Indigenous culture, financial benefits, Indigenous rights, value of nature,	Co-management SIA Selected themes address common areas of concern for more than one community Focus on predicting effects based on past experiences	No indicators for threshold of change Qualitative indicators might not be easily quantifiable Contradictions might arise from qualitative indicators Need to assess economic benefits and cultural values trade-off No case study of the application of this method
(Christensen et al., 2010)	Canada	Interviews with Indigenous people of Canada to select indicators for CEA in the context of forest and land management. Two themes for cumulative effects (social healing and healthy relationship to the land) and twelve indicators are identified. Indicators for social healing: justice, culture, mission school healing, community support, drugs and alcohol. For healthy relationship to the land: pollution,	Co-management SIA Guidance to improve assessment Includes historical context	Qualitative indicators might not be easily quantifiable Limited understanding of cumulative social effects due to short time frame Limited number of indicators

		healthy animals, teaching and Indigenous education, land use, recreation, protection, and government.		
(Booth and Skelton, 2011b; Booth and Skelton, 2011a)	Canada	Interviews with Indigenous Elders of British Columbia. Research explores the way that Indigenous communities view the cumulative impacts of many extractive industries carrying out resource exploration on their lands	Co-management SIA Historical cumulative effects Guidance to improve the process and management	No clear prediction of cumulative effects, but description of past and current state No actual indicators, but themes of concern
(Rozak, 2011)	Guatemala	Combined traditional knowledge and scientific approach to assess cumulative environmental effects and improve CSR strategies. Indicators include sphere of governance, socioeconomic aspects, natural resources, and socio-cultural aspects.	Involvement of the community Guidance to improve the process Calls for gendered analysis	Some indicators are not easy to quantify Areas of concern are broad and somewhat similar to current practices (which have guidance, but do not perform appropriately)
(Christensen and Krogman, 2012)	Canada	Collaboration with the Indigenous people of the Yukon, Canada, to link social-ecological resilience, temporal and spatial cumulative effects, and the existence of social-ecological thresholds. Social thresholds will affect the capacity of the community to recuperate from changes.	Co-management SIA Discussion of resilience and ecological thresholds	Qualitative indicators might not be easily quantifiable Complexity for defining social thresholds Need to include values of youth and other groups
(Parlee et al., 2012)	Canada	Interviews with Cree community members are conducted. Resource developments changes on the environment and social-ecological interactions, livelihood and wellbeing of Indigenous people. Indicators reflect community concern for water quality and quantity. Fishing. Forest resource and management. Moose. And air quality.	Co-management SIA Cumulative effects discussed from a historical perspective Traditional knowledge is incorporated into the discussion	Limited number of indicators No indicator for socioeconomic development Complexity of defining quantifiable social thresholds Prediction relies on qualitative approaches

(Mantyka-Pringle et al., 2017)	Canada	Combined traditional ecological knowledge and scientific approach to assess cumulative environmental effects. Creation of 41 indicators, 22 qualitative and 19 quantitative indicators, to represent Indigenous and non-Indigenous worldviews.	Co-management SIA Includes traditional knowledge and scientific knowledge	Model might be too complex to apply Subjectivity and biases in assigning weight to and including traditional perspectives The authors claim a limited number of parameters
(Hutchison, 2017)	Canada	Topics of importance for cumulative effect assessment: Changes at sites of cultural significance. Traditional harvest and maintenance of subsistence practices. Stewardship of resources. Traditional language and participation in social activities (feasts, arts, dancing, etc.).	Co-management SIA Implications for regional management Focus on Indigenous culture Cumulative effects perceived on historical events	Limited areas of concern Qualitative indicators might not be easily quantifiable No clear prediction of impacts, but description of past and current states No indicator for socioeconomic development

4.4. Modelling and other approaches

Spyce et al. (2012) apply an economic model, the *choice experiment*, in the context of cumulative effects, to evaluate a community's willingness to accept environmental externalities over instant economic benefits. As with previous participatory approaches, the authors interviewed community members (34% were Indigenous people and the remaining were of non-Indigenous origin) to understand the degree to which the community maintained its wellbeing and resilience to changes brought about by cumulative social and environmental effects of multiple developments. Mathematical weight preference approaches (based on multi-criteria decision making) are added to decrease the subjectivity of the process of selecting preferences (arguments can still be made to the contrary). The indicators selected by community members reflect common aspects of Indigenous concerns, such as the moose population, fish catches, but, as this is an economic model, the focus was given to the creation of employment and population growth. Although the number of participant and scenarios is limited, the results indicate a preference for conservation, and small developments, rather than large-scale developments.

Along this line of thinking for regional planning, Francis and Hamm (2011) use ALCES@ *landscape cumulative effects simulation model*, which is scenario modelling software

that makes it possible to look at different outcomes from oil and gas expansion in a region of the Yukon, in Canada. Scenarios offer useful guidance tools for decision-makers examining the social and economic implications of development and wondering whether the desired goals are achievable under a particular set of circustances. This model separates changes in geographically selected areas based on the user's input (landscape types, land use footprint, trajectories, reclamation rates for each land use, etc.). Isolated instances of pressure from other human activities (forest fires, tourism, insects, climate, etc.) might be examined together or separately. Although this study was conducted in a region populated by Indigenous people, there was no direct participation in the model's inputs or in the interpretation of outputs from a community perspective. Socioeconomic parameters reflect Western governance concerns, such as commodity production (oil and gas), revenue, employment, wages, royalties, and regional human populations. Land use and infrastructure encompass surface disturbance, linear density, the habitat suitability index, and the habitat effectiveness index. The model did not consider spiritual and livelihood parameters associated with landscape disturbances when simulating the acceptance of change for the region (apart from the density of caribou in the region); the socioeconomic parameters are more economic than social per se. Although challenging, regional planning and software modelling needs to integrate Indigenous worldviews and concerns to go beyond the interests of the dominant group. When Indigenous rights are violated, their knowledge is contested, and their voices are silenced in the management of the region, grievances are likely to occur.

From the perspective of impact assessment and governance, Lockie et al. (2009b) adapts the *Pressure-State-Impact-Response (PSIR) model,* a framework used by the World Bank and OECD (Organization for Economic Co-operation and Development) countries, to present an integrated framework and methodology for assessing the social effects of natural resource developments. The "Pressure" component comprises human developments causing changes to the environment (type, magnitude, timeframe). "State" stands for the key environmental indicators, such as VECs and impact magnitude, used by State environmental agencies. "Impact" relates to the effects on key human welfare and social environment aspects. Finally, "Response" refers to the policies, regulations, community actions and economic instruments, etc., used as a response to pressures, state procedures, and impacts.

The authors contextualize the strong connection between Indigenous groups, the land as the provider for spiritual and cultural practices and subsistence, and how knowledge (how to fish, where to go, when to fish certain species, etc.) is passed through story telling, such as in the models of Preston and Long (1998) and Ross (1990). However, human activities change the waterways and the land cover, thereby altering the environmental equilibrium and animal behaviour. This devalues the traditional knowledge and livelihoods of the Indigenous communities. The accumulation of changes caused by additional projects moving to an area tends to increase social effects by marginalizing and creating difficulties for the communities. Social impacts might seem minor, but the effects can be concentrated in vulnerable groups such as Indigenous communities. This demonstrates that regional planning is more complex when including Indigenous worldviews in the decision making. Table 7 summarizes the results of this section.

Table 7. Summary of modelling and other SIA methods used for regional planning

Approach	Ref.	Location	Key aspects	Strengths	Weaknesses
Pressure-State-Impact-Response	(Lockie et al., 2009b)	Australia	Pressure: human developments causing changes in the environment (type, magnitude, timeframe). State: key environmental indicators (environmental changes and magnitudes). Impact: effects on key human welfare and social environment aspects. Response: policies, regulations, community actions, economic instruments, etc.	Good description of current situation Cumulative social effects from a historical perspective Identification of numerous impacts Application for Indigenous and non-Indigenous people	Not exclusively focused on Indigenous people More for government management than for community application
Alces@ landscape CEA simulation	(Francis and Hamm, 2011)	Canada	Study applied scenario modelling method to predict cumulative effects of oil and gas industry Model can include spatial dimension of effects Socioeconomic parameters include production, revenue, employment, wages,	Ability to assess spatial changes Presents insights for regional planning Model can evaluate pressure from more than one development	Study limited to one sector Focuses more on economic aspects and does not consider spiritual and livelihood aspects No participation by Indigenous people

			royalties, and regional human populations.		
Choice experiment	(Spyce et al., 2012)	Canada	Interviews with residents of the Southwest Yukon region. Mathematical modelling is applied to understand trade-offs between economic development and nature conservation.	Provides scenarios for development Includes questionnaires and a mathematics-based approach (industries seem to prefer this kind of method)	Limited number of parameters Focused on economic aspects Subjectivity in assigning weights Limited Indigenous participation in the interviews No gender-based analysis

5. Concluding thoughts

This report offers a systematic review to identify frameworks and empirical methods used to assess cumulative social effects of extractive developments in the context of Indigenous groups who have their livelihoods and spirituality affected by these developments. When conducting SIA, the science behind the assessment is an issue that emerges from the literature. Practitioners with a deep physical background might rely on the assessment of biophysical changes without connecting them to human livelihoods, while social scientists criticize such an approach and seek alternative methods, e.g., (Baker and Westman, 2018; De Rijke, 2013; Westman, 2013).

This review showed that the adoption of one approach does not exclude or jeopardize another approach. In fact, multiple methods can be concurrently applied. Whereas qualitative methods are used to gather information for understanding the social situation—*sections 4.1.2 and 4.3*—, quantitative methods might "translate" the data into statistical results that express a social phenomenon, e.g., GIS-SIA discussed in *section 4.2 or* other models covered in *section 4.4*. In this context, it is not accurate to say that socioeconomic indicators are quantitative and that social/cultural indicators are qualitative. Notwithstanding the subjective elements of social and cultural experience, subjectivity does not preclude quantitative assessment. In fact, social science has developed robust methods for measuring subjective phenomena (e.g., attitudes, norms, emotional states). Therefore, when addressing Indigenous groups, practitioners, industries, and governments, it is necessary to seek clarity regarding differences in the way that Indigenous people view the land, their traditional knowledge about the environment, the manner in which

they report this relationship, and expectations for economic benefits. A statement given in Booth and Skelton (2011) affirms that Indigenous people in British Columbia are not against extractive development. The results presented by Spyce et al. (2012) support the statement by showing that communities in Southwest Yukon, Canada (including Indigenous and non-Indigenous communities), appreciate job and business opportunities created with the arrival of projects in a given area. The problem, as pointed out in numerous studies, is the excessive focus on socioeconomic aspects, such as discussed in *section 4.4 and in* Booth and Skelton (2011), or an excessive focus on biophysical and socioeconomic aspects (Noble et al., 2017), and the lack of attention to the social and cultural aspects of local livelihoods and how they are impacted by resource development.

A historical analysis of cumulative effects indicates that Indigenous nations have suffered (and continue to suffer) due to the consequences associated with the planning and location of extractive developments. We argue that Indigenous views often differ from non-Indigenous views because of this history and because of a desire to see future development that will directly benefit Indigenous people in multiple ways (e.g., O'Faircheallaigh, 2009, 1999). Researchers and community practitioners working in Indigenous communities can have a positive impact on SIA practice. However, some papers continue to report a lack of recognition of participatory methods for assessing impacts; industry leaders allege that SIA methods remain *too subjective* (Parsons and Moffat, 2014; Stevenson, 1996; Witt et al., 2017). Pushing against this allegation, we argue that methods involving surveys, consultations, and interviews with communities/affected groups are the foundation of SIA methods. Participation is the key component of social assessment, and there is no software or applied science method that can replace these elements of SIA. When the livelihoods of Indigenous communities are at stake, the literature points to the need for meaningful engagement with the community during the process of conducting EIAs/SIAs and CEAs.

Bridging traditional ecological knowledge and cumulative effects assessment, the frameworks reported here focused on story telling to capture cumulative social changes that have built up over many years and for different industrial activities. Other SIA-GIS approaches merged traditional knowledge about caribou/reindeer migration, grazing, on one hand, and response to noise and disturbances caused by extractive industries, on the other hand. This

research identified many methods based on the selection of indicators that represent social-ecological relationships of Indigenous groups. The major similarity among the methods reviewed is the participatory approach to assess cumulative, direct and indirect changes caused by natural resource exploitation. This similarity confirms the advances made in SIA practice among academics, researchers, and practitioners. However, as Roudgarmi (2018) states, CEA continues to be conducted at minimal costs and on a limited timeframe.

Due to the restrictions placed on systematic research and on the objectives of this work, we identified relevant methods that attempted to bridge cumulative social assessment methods for extractive industries operating in lands occupied by Indigenous people. Further studies comparing SIA methods for both Indigenous and non-Indigenous are required, specifically to determine how methods vary and to identify possible specificities for each case. Another limitation involves the identification of documents during our research; the material selected reflects SIA methods that are usually implemented by academics and generally in a research-based context. A content analysis of practitioner and project-based assessments might point out different approaches that reflect the practices of industries and consultants. Such an analysis could reveal other insights into the current practices and SIA and CEA. However, given time and resource constraints, this study is limited to the published literature on this topic.

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