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# At risk: The environmental and social impact assessment. The need for action

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**Abstract:** The introduction of the environmental and social impact assessment (ESIA) into public environmental protection schemes and corporate performance standards has been an important development, especially as compared to the situation prevailing before the 1970s, when only technical and economic aspects were considered in decisions about project implementation. Some believe that the ESIA supports the integration of environmental and social considerations, from project design to implementation, and takes public concerns into account in decision-making. However, shortcomings in current practices and pressure to relax ESIA schemes could lead to their marginalization. It is important to respond to the many criticisms made by observers and review committees over the years about the relevance of the information contained in impact studies and about transparency in the analysis process. A solution to this problem is to find innovative ESIA methods. Using a structured stake-by-stake approach and applying multicriteria decision aid (MCDA) methods are promising ways of improving the situation. The proposals made in this paper are consistent with the characteristics of the collaborative approach used in the ESIA of projects. These proposals are designed to respond to the issues raised and to meet the challenge posed by a pressing social demand for increased citizen participation in decisions affecting the environment and society.

**Keywords:** Environmental assessment, impact assessment, methodology, multicriteria decision aid, PROMETHEE, public participation, stakeholder, social acceptability

**Résumé :** L'implantation de l'évaluation d'impact environnemental et social (ÉIES) dans les régimes publics de protection de l'environnement et dans les standards de performance des entreprises constitue une évolution importante par rapport à la situation qui prévalait avant les années '70 où seules comptaient les considérations techniques et économiques pour décider de la réalisation des projets. D'aucuns considèrent que l'ÉIES favorise l'intégration des considérations environnementales et sociales, de la conception à la réalisation des projets, et la prise en compte des préoccupations du public dans la prise de décision. Toutefois, les lacunes de la pratique actuelle, combinées aux pressions exercées en faveur de l'assouplissement des dispositifs d'ÉIES, pourraient conduire à leur marginalisation. Il importe d'apporter des réponses aux nombreuses critiques formulées par les observateurs et divers comités d'étude au fil des années concernant la pertinence de l'information contenue dans les études d'impact et la transparence de la démarche d'analyse. Une amorce de solution réside dans l'innovation sur le plan des méthodes d'ÉIES. La structuration de la démarche d'évaluation par enjeu et l'application de méthodes d'aide multicritère à la décision (AMCD) constitueraient autant de mesures susceptibles d'améliorer la situation. Les propositions faites dans cet article sont cohérentes avec les caractéristiques de l'approche concertée de l'ÉIES des projets. Elles visent à répondre aux problématiques évoquées et à relever le défi posé par une demande sociale pressante en faveur d'une participation citoyenne accrue aux décisions ayant une incidence sur l'environnement et la société.

**Mots clés :** Évaluation environnementale, évaluation d'impact, méthodologie, aide multicritère à la décision, PROMETHEE, participation du public, partie prenante, acceptabilité sociale

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# 1 Introduction

The environmental and social impact assessment (ESIA) is certainly the most widespread form of environmental assessment (EA) process.[1] More than 250 countries and organizations worldwide currently use ESIA mechanisms (Morgan 2012). These mechanisms are also an important component of public environmental protection plans that require project proponents to obtain prior authorization for any activities that may affect the environment or society. ESIA is also included in the regulations or performance standards of corporations, multilateral donors (e.g. the World Bank) and private financial institutions (e.g. the International Finance Corporation).

Though the ways of applying ESIA mechanisms vary widely, most mechanisms involve an obligation to carry out an impact study in addition to public participation strategies.[2] The use of such measures has been a significant development compared to the situation prevailing before the 1970s, when only technical and economic aspects were considered in decisions about project implementation. It is now recognized that ESIA helps to integrate environmental and social considerations, from project design to implementation, and takes public concerns into account in decision-making.

Over the years however, observers and review committees have criticized impact studies, particularly with regard to information relevance. A frequent reproach is that impact studies do not identify the project's major stakes, which then hinders the ability of the authorities concerned to make well-informed decisions about implementing the projects. Lacking relevant information about what's at stake, public and private decision-makers are sometimes forced to synthesize the content of impact studies for themselves. This can result in additional delays in delivering administrative authorization or in granting the funding needed for project implementation.

The ESIA is also criticized for a lack of transparency. The approach used by analysts when assessing impacts is not always clear, suggesting an arbitrariness that can undermine the trust of those using the study reports, and may even lead them to dispute the validity of the findings. It is increasingly common to see people and organizations impacted by a project turning to alternate sources of information to develop a counter-analysis contradicting an impact study's findings.

These shortcomings could ultimately lead to the marginalization of the ESIA as a decision-support tool and weaken its role in the implementation of projects that are environmentally and socially acceptable. The emergence of new practices at the fringe of the formal ESIA processes, namely, the negotiation of private agreements between project promoters and interest groups on project impacts and benefits, may be symptomatic of such phenomena. Nor can we ignore pressures to relax ESIA mechanisms in order to promote economic growth and employment.

The proposals made in this paper are consistent with the features of a collaborative ESIA approach to projects. These proposals are meant to respond to the problems described above and to face the challenge of a pressing social need for increased citizen participation in decisions that have an environmental and social impact. Indeed, the conventional approach that has been applied to date and that gives decision-makers and experts a central position in the ESIA process is highly contested. Some feel that even though the ESIA is based on a rational approach, namely, on identifying and systematically analyzing a project's repercussions on the biophysical and social environment, the evaluation of the significance of those repercussions in terms

[1] André et al. (2010) use the terms "environmental impact assessment" (EIA) or "environmental impact study" (EIS) to describe a procedure looking at a project's anticipated outcomes—both positive and negative—on the environment. We use the term "environmental and social impact assessment" (ESIA) because it is more commonly used. Note that "impact" here is taken as singular, to take into account analysis methods that aggregate the criteria-based results to obtain an overall impact for the project and its potential variations. The addition of the term "social" signals that the methods used to analyze the impact on the biophysical environment differ from those used for the social impact. Furthermore, according to André et al. (2010), the EIA (or EIS) is only one of the processes that make up an "integrated system of environmental assessment" [translation], which also includes 1) environmental studies and strategies; 2) strategic environmental assessments; 3) lifecycle analyses; and 4) environmental management systems (pp.55 ff).

[2] We use the generic term "public participation" but should instead talk about the participation of various publics to take into account the variety of stakeholders involved in the ESIA process. In the participatory ESIA we propose here (see the section on "The application of MCDA as a participation tool"), we distinguish between the notions of "public" and "stakeholders." We also distinguish between nuances in the notion of "public participation".

of impacts is subject to interpretation and should be subject to public review. This applies to the whole of the ESIA process in general, but more specifically to how the stakes are identified and structured into impact assessment criteria, since these play a determining role on the overall evaluation of a project and its potential variations.

A first step toward a solution is to innovate at the level of the ESIA methods. The overall situation would likely be improved by using a stake-by-stake structure for the evaluation process, developing multicriteria analysis grids comprising impact descriptors and specific variability thresholds, and aggregating results through multicriteria decision aid (MCDA) methods in a multi-stakeholder context.

We first identify the conceptual and methodological justifications for reviewing current practices. This includes identifying the key shortcomings of the ESIA as currently used, along with their tangible outcomes. We then propose two improvements to current practices, with the aim of breaking the inertia of established practices, which, as suggested by Cashmore et al. (2010), may be a reflection of a "rational" model perpetuating the existing social order.

## 2 Justifications for a review of ESIA practices

Many have drawn a parallel between the use of the ESIA as a planning approach and the evolution of theoretical planning models (Gauthier et al., 2011; Morgan, 2012). Within the range of planning theories, we focus on rational planning and collaborative planning. We then look at the epistemological foundations of ESIA and the concepts of stake, impact, change, and the impact of change. We then analyze one of the most common methods used in conducting impact studies, namely, the "descriptive method focusing on individual setting components" and identify its limitations.

For the following in this paper, we clarify here the concepts of actors and stakeholders involved in decision-making processes for planning and environmental assessment.

Roy and Bouyssou (1993) have the following definition for the notion of an "actor in a decision-making process":

> "An individual or a group of individuals is an **actor** in a decision-making process if, through their value system—be it directly, because of that individual's or that group's intentions, or indirectly, through the way in which they involve others—that individual or group directly or indirectly influences the decision" [translation] (Roy and Bouyssou, 1993, p.64).

The authors (1993, p.20) distinguish between two categories of actors: *interveners* and the *acted-upon. Interveners* are people who, by their intervention, directly affect the decision based on the value system they represent. The *acted-upon* are people (citizens, taxpayers, etc.) who, normally passively, are subjected to the outcomes of the decision, which is only supposed to take into account their preferences.

Within the more specific framework of ESIA schemes, actors refer to the decision-makers, the project proponents, and all the people or organizations directly influencing the course of actions during the impact study process or its review during the public participation mechanisms, acting as experts representing a consulting firm, a ministry, or a civil society organization, or as members of the public. In the definition cited above, the *acted-upon* refer to citizens, taxpayers, or simply the public, who remain passive throughout the process. These notions will be defined further in our proposed participatory approach to multicriteria decision aid applied to ESIA.

Inspired by Quebec's environmental impact evaluation and review procedure (PEEIE), Côté and Waaub (2012) identify seven actor categories in the ESIA process (all are interveners according to the definition given above since they are involved in the process):

- (D) the decision-maker
- (PR) the promoter
- (RA) the responsible authority

- (C) the Cabinet
- (S) the stakeholders
- (P) the public
- (EX) the experts in various fields, such as
  - (sa) strategic environmental assessments
  - (da) decision aids
  - (pa) participation

## 2.1 Planning theory and the ESIA

The rational planning model has had (and continues to have) a significant influence on how the ESIA is conducted. In accordance with the principle of "positivism," the model aims to construct a "rational" approach, that is, one based on an analysis and knowledge of facts verified by scientific experiment. The model is founded on the postulate that the quality and effectiveness of political management are improved through the "apolitical" tool of scientific knowledge.

The rational model has had a decisive impact on the role played by actors (Côté and Waaub, 2012) in the planning process, by placing decision-makers and experts (bearers of technical and scientific knowledge) on one side, and the public on the other: on the one hand, the rationality of well-informed players, and on the other, the public's irrationality and ignorance. From this perspective, public consultations are unidirectional: their purpose is to inform and educate the public.

The rational model has been strongly contested. The postulate that planning is based on a "rational process" and on an analysis of facts is not in question. However, we feel that even where the planning approach draws on rigorous fact analysis, these facts are subject to sometimes diverging interpretations by experts and decision-makers. As highlighted by Limoges et al. (1993), questions submitted to experts for a verdict seldom receive simple, unequivocal answers. In the current state of scientific knowledge, there are areas of intractable uncertainty whose meaning remains open to debate. Thus,

> "...there is no rupture between rationality and irrationality, between knowledge and ignorance, but rather different, and even divergent, interpretations of what rational behaviour calls for in uncertain situations. There is no single cleavage that puts decision-makers and experts on one side and the public on the other, but multiple cleavages also fragmenting the decision-maker and expert groups" [translation] (Limoges et al., 1993, p.57).

There are also areas of ambiguity arising out of the "subjectivity" of people expressing themselves in terms of perceptions and preferences (Roche and Waaub, 2006).[3] Such cleavages manifest not only at the time of decision but also at several levels of the process itself (Richardson, 2005):

- Problem set-up: Defining the problem and creating a list of conceivable solutions;
- Identification and analysis of the stakes, against which the conceivable solution(s) will be studied; and,
- The decision: Choosing one solution in light of the outcome of the analysis and then making a decision.

In this regard, Limoges et al. (1993) note that "we frequently observe value reversals: what appears to some to be part of the problem [...] is for others part of the solution, or again, completely fails to appear in the discussion" [translation] (Limoges et al., 1993, p.10).

In their study of four environmental controversies, these same authors highlight significant differences in the ways in which stakeholders constructed the problem and the solutions. In the reviewed cases, these differences could be seen for instance between the regional departments of one same public health agency.

[3] Roche and Waaub (2006) make a distinction between the notions of "uncertainty" and "ambiguity." The former is defined as resulting from a cleavage between required information and existing information, while the latter is the result of a hesitation between legitimately relevant choices.

Limoges et al. (1993) also suggest moving away from the conventional representation of public controversies as opposing decision-makers and experts to the public. According to these authors, every controversy is polycentric. The value systems and interests represented by the participants in a public controversy are multiple and complex. This is why it is delusive to believe that there is a pre-existing "real issue" that just needs to be revealed or clarified.

> "Controversies are not defined *a priori* and then afterward submitted for public debate. Rather, controversies are constructed by the participants who progressively define the content by participating in a process of debate and discussion. That's why public controversies never seem well defined, and why those involved in discussions don't seem to be talking about the same thing: public controversies are not a discussion between two parties, they are always polycentric. Unlike in a scientific controversy, the participants in a public controversy do not agree on an identification of the relevant issues or on what's at stake" [translation] (Limoges et al., 1993, p.420).

This reframing of the notion of controversy proposed by Limoges et al. (1993) has been confirmed by observations from numerous recent sociological studies that bring out the high level of social differentiation of modern societies, which translates into the construction of multiple systems of meaning. According to Offe and Preu$\beta$ (1997), no single hierarchy of values or specific viewpoint can now claim objectivity or innate validity, rendering obsolete the construction of a global view of the collective interest. For instance, it is now common to consider that faith in the ability of science and technology to solve problems is no longer the only value, nor even a value shared by all (Limoges et al., 1993).

The high level of social differentiation that characterizes modern societies goes hand in hand with the (social) demand for increased citizen participation in decision-making, especially in those decisions that impact the environment and quality of life. Unidirectional public consultation, consisting of informing and educating the public, or of going through a validation exercise at the end of the process (Gariépy, 1986), is no longer sufficient. Citizens are claiming the right to intervene at every level of the decision-making process (Côté and Waaub, 2012).

The response to such demand in the area of planning has been to implement interactive participation mechanisms inspired for instance from conflict prevention and resolution methods: negotiation, conciliation, mediation, and arbitration. These methods foster the expression and questioning of the value systems and interests of the actors involved in the decision-making process, in order to identify the points of agreement that unite them and the points of disagreement keeping them from reaching an acceptable solution. This is the logic behind the collaborative planning approach.

Additionally, planning no longer strives to find the optimal, as it did under the rational model, but rather to find the acceptable. And the search for the acceptable no longer applies solely selecting a solution but to every level of the decision-making process, including problem setting and identifying and analyzing the stakes.

The orientation of this study falls within the continuity of the ESIA's theoretical foundations (Lyhne and Kornov, 2013; Morgan, 2012; Poder and Lukki, 2011; Pinho et al., 2010; Cashmore et al., 2010; Wood, 2008; Richardson, 2005) and the application of the collaborative planning approach to ESIA. Also, like Cashmore et al. (2010), we consider that current practices may reflect a "rational" model that considerably limits the role the ESIA can play as a decision-support tool and as a vehicle for citizen engagement.

In the next section, we demonstrate this by revisiting the concepts that underlie ESIA practice and the most widespread methodological approach to conducting impact studies.

## 2.2 Review of the ESIA's epistemological foundations

Most formal ESIA schemes (be they state controlled or not) comprise a technical component and a sociopolitical one. The former, which consists of conducting the impact study, is carried out by decision-makers and experts. The latter refers to the implementation of "public participation" mechanisms via various methods including consultation, negotiation, conciliation, mediation, and arbitration.

This segmentation of the ESIA process illustrates an application of the rational model to the stakeholders' roles. As we shall see, this approach significantly compromises the ESIA's ability to achieve its full potential as a decision aid tool, as a process contributing to the implementation of environmentally and socially acceptable projects, and as a vehicle for the expression of public concerns in the decision-making process. An issue here is the interpretation of the notions of "stakes," "impact," "change" (in a component of the environment or society), and "impact of that change." Here's how.

### 2.2.1 Distinction between "impact analysis" and "stakes analysis"

Some distinguish between an analysis of impacts and of stakes. André et al. (2010) associate impact analysis to an expert technical-rational action whose primary goal is to identify prevention or mitigation measures for negative repercussions, to increase positive impacts, or to compensate for residual impacts. According to these authors (André et al., 2010, p.53), a stakes analysis goes beyond a simple analysis of the impacts: "It involves asking questions about the project as a whole, and scrutinizing it in light of concerns that may bring it into question" [translation]. They call this a "socio-political" process, one that must be carried out with participation from all the stakeholders.[4]

This interpretation of the notions of "stakes" and "impacts" can be critiqued on several levels. First, conceptually, the term "stake"[5] when taken literally is defined as something that can be gained or lost in a competition or enterprise. This is exactly what ESIA offers: an analysis process whose purpose is precisely to shed light on a given project's environmental and social stakes by producing precise and structured information about the project's outcomes.

What's more, this interpretation of the notions of stakes and impacts reproduces the rational planning model, which distinguishes between a technical-rational process that's identified with decision-makers and experts involved in conducting the impact study, and a sociopolitical process identified with the public. The environmental impact evaluation and review procedure (known by its French initials PEEIE) used by the province of Quebec (Canada) is an example of an application of this model.

The PEEIE involves a sequential process comprising a technical portion (impact study), undertaken by the project proponent under the supervision of the provincial Ministry of Sustainable Development, the Environment and the Fight against Climate Change (French initials MDDELCC), and a sociopolitical portion (public enquiry and hearing) undertaken by an independent public organization called the Public Environmental Hearing Bureau (French initials BAPE). The process results in three separate reports: The technical portion includes, first, the impact study report produced under the responsibility of the project proponent, and second, the MDDELCC's environmental analysis report based on the results of the impact study. And, third, for the political portion, there is the BAPE's public enquiry and hearing report. Together, these three reports make up the main sources of information drawn upon by the minister responsible for the MDDELCC when making recommendations to the Cabinet, which is ultimately responsible to authorize the project and set conditions for it.

To meet the social demand for increased citizen participation in the PEEIE, the MDDELCC recommends that project proponents consult the "public" during the "scoping"[6] stage of the impact study. However, in practice, the consultation held at the start of the process is not necessarily used to structure the contents of the impact study, but rather to answer concerns raised by participants and then negotiate solutions that are likely to increase a project's chances of being accepted. In other words, the information coming from participants in the consultations held early in the process are not used to identify the stakes to be thoroughly analyzed through an impact assessment (Côté, 2004).

Normally, impact studies will include a report of these preliminary consultations in the form of a list of the major topics covered, questions raised by participants, answers provided by the project proponent, and

[4] See also Hydro-Québec (2003).

[5] In this paper, we use "stake" as a translation for the French word "enjeu."

[6] "Scoping" is the stage of the process whereby the competent authority and the contracting authority, once they have established the need for an impact assessment, identify the main environmental problems raised by the project and determine the timing and scope of the analyses to be carried out; the sources of specialized knowledge to be used; and the mitigation, amplification, or compensation measures to be considered (OECD, 1992a: 14)" [translation] (André et al., 2010, p.66).

where applicable, measures taken to correct certain problems. However, no indication is given of how the concerns raised by participants are handled at the analysis level.

It is important to recall here the distinction made by Freudenberg and Olsen (1983) between the notions of "participation in a political process" and "participation in an analysis" using impact assessment processes. The former refers to the debating of opinions and arguments aimed at solving problems of a political nature. The latter refers to the integration of value systems and interests of stakeholders in an analysis process aimed at evaluating an action's impacts.

> "... Information about opinions isn't necessarily the same as information about social outcomes. Data relating to opinions prior to the implementation of a project or a policy change [...] are important in of themselves. But data on attitudes is simply not the same thing as information on potential outcomes" (Freudenberg and Olsen, 1983, p.72).

Ceasing to make a distinction between the technical and the sociopolitical aspects would open up new possibilities for the role played by stakeholders in the decision-making process. This is a real challenge in view of the existing practice, but it is surmountable, given the advances made in operational research in recent years and the application of multicriteria decision aid (MCDA) methods in multi-stakeholder, participatory, and contributory context.

But first, it is important to provide clarifications on two notions underlying environmental assessments: "change" and "impact of change." Confusion around the interpretation of these two notions leads to errors and inaccuracies that can considerably decrease the ESIA's capacity to produce relevant information for the purposes of identifying and analyzing project stakes.

### 2.2.2 Confusion between the notions of "change" and "impact of change"

One of the methods most often used in impact studies is the "descriptive method focusing on individual setting components,"[7] which consists of creating an impact study case that includes a description of the project, a description of the modifications (or changes) to components of the (biophysical and human) setting resulting from actions related to the project, and an assessment of the significance of these modifications in terms of impact. Results are presented in an evaluation grid showing the significance of these impacts by setting component and accompanied by explanations from the analyst. This type of evaluation uses a qualitative approach to classification (minor, moderate, major). Generally, three major variables are taken into account, namely, impact intensity, scope, and duration.

A significant shortcoming of this approach is that it allocates a value (significance of the impact) to the changes affecting biophysical and human components as a result of a given action, without explicitly referring to any specific issues formulated in terms of stakes. The impact evaluation is often based solely on the general postulate that any modification to a biophysical or human component constitutes an impact.

For example, the mere fact that one variation of a hydroelectric project calls for the clearing of 100 $km^2$ of forest, as compared to another where the cleared surface is only 60 $km^2$, would, according to this logic, lead to the conclusion that the former has a more significant impact than the latter. In our opinion, this conclusion is false, because it confuses two basic notions: that of "changes to components of the environment," which refers to the material or direct outcomes of an activity, and that of "impact," which refers to their significance with regard to the stakes. In fact, clearing 100 $km^2$ of forest signifies nothing in of itself, except as it refers to something that's at stake.

One same change to a biophysical component (decrease in forest cover over a given area) resulting from an activity (clearing of 100 $km^2$ of forest) will have a different significance (impact) according to the stake in the light of which it is analyzed. In fact, the change to the component "forest" can be analyzed in light of biodiversity (environmental stake), the maintenance or development of sport hunting in a given territory (social stake), or the viability of forestry activities (economic stake).

[7] As termed by Hamel (1986).

The criteria used to evaluate the impact differ depending on what stake is being analyzed. The same applies to the threshold (minimum or maximum) beyond which the change to a biophysical or human component becomes significant or not. This is why allocating a value to the material or direct outcomes of an activity, without referring to a stake, to impact descriptors, and to specific thresholds, becomes completely arbitrary.

This confusion between the notions of "change to biophysical and social components" and "impact" decrease the capacity of ESIA mechanisms to produce relevant information for use in identifying and analyzing project stakes. For example, in a research program on modelling the monitoring of social impacts, Gagnon (2002) performed a detailed analysis of the impact study conducted for the Rio Tinto Alcan industrial complex construction project in Alma, Quebec. This study brings to light the same deficiencies that were identified in the previous case. For instance, the researcher points out that the impact study describes an increase in noise resulting from construction activities around the site, and an increase in heavy vehicle traffic on the local road network, but it fails to discuss the human/social impacts arising from these changes for residents living near the construction site's access roads, namely, changes to their living habits, loss of sleep, and increased stress. As Gagnon (2002) shows, even though the average noise level standards are respected, this doesn't mean that there are no impacts.

The deficiencies identified during the impact assessment stage have repercussions on those in the monitoring and environmental follow-up. As Gagnon (2002) observes, since the impact study report deals only with material changes caused by the project, that is, with the increased noise level, the only planned follow-up measure is ensuring that regulatory noise standards are complied with. When a controversy broke out regarding the increase in heavy vehicle traffic in a site-adjacent residential neighbourhood, no additional analysis was conducted during the follow-up stage regarding the social/individual impacts of the declining sound environment quality.[8]

Furthermore, the approach that consists of describing impacts by setting component has other shortcomings that affect how effective the ESIA can be as a decision aid tool and as vector of civic participation in the decision-making process.

## 2.3 Methodology: Observed deficiencies and consequences for the ESIA's effectiveness

An impact analysis involves mobilizing knowledge from several fields. The challenge at the methodological level is to make links within this knowledge and to synthesize it in a way that sheds light on the major stakes involved in a project.

The first deficiency of the descriptive method focusing on individual setting components is its lack of more efficient mechanisms to synthesize impact information at the decision-making stage. Its second shortcoming is the impossibility of integrating the value systems of the actors involved the ESIA process, which are often expressed as disagreements about, e.g., the assessment of an impact; the relative significance of environmental, social, and economic considerations; and even the initial identification of the stakes involved in a given project.

### 2.3.1 The ESIA as a decision aid tool

The "descriptive method focusing on individual setting components" does not include any mechanisms for aggregating assessments by impact criterion. As previously mentioned, results are presented in a grid assessing the significance of the impacts for each setting component.

Also, the information available to the decision-maker comes from an impact summary table similar to Table 1. It contains eight main headings: 1) the activity at the source of the impact; 2) affected setting components; 3) impact description and evaluation; 4) indicators (variables) of the impact's intensity (I), duration (D), and scope (S); 5) the impact's significance, expressed through qualitative coding: major,

[8] For more on this topic, see the analysis by Rossouw and Malan (2007) of the social impact monitoring for the Berg River Dam project in South Africa.

moderate, minor; 6) mitigation measures; 7) significance of the residual impact; 8) follow-up and monitoring measures.

This way of presenting results relating to impacts by setting component is certainly useful for managerial purposes: each impact is associated with mitigation measures, thereby facilitating the development and application of an environmental and social management plan. However, without a more sophisticated analysis tools to synthesize the impact information, it is extremely difficult to arbitrate between the many environmental, social, and economic considerations raised by a project and between the interests of the parties involved.

At that stage, decision-makers are more or less left to their own devices in answering two major questions that come up consistently from one case to another:

1. Up to what point must we accept a certain amount of environmental and quality-of-life degradation to allow for economic development?
2. Up to what point can we require a minority, made up of the people affected by a project and who must bear its risks and disadvantages, to make a sacrifice for the well being of the majority?

Without more accurate information available to answer these questions, the decision-making process becomes more susceptible to arbitrariness, especially at the stage where a decision is made by decision-makers who are accountable in the context of a representative democracy.

In cases where ESIA is used in a state context, the final decision (of whether or not to authorize a project) is influenced by the political balance of power within the decision-making body, here, the Cabinet. In a report published by the Law Reform Commission of Canada, Schrecker (1984) points out the following on environmental protection as a political objective:

> "As a general policy priority, controlling environmental hazards may be at a distinct disadvantage in intra-governmental conflicts. At best, the ministers or officials of other departments may view this as an unwelcome competitor for legislative time and limited administrative resources. And departments with responsibilities for promoting industry, regional development, or natural resource exploitation may find concerns with hazard reduction irrelevant, or even antithetical to their principal objectives and those of their major client groups." (Schrecker, 1984, p.14).

The problems put forward by the author would remain the same in cases where the decision rested with the environment ministry.

The other great shortcoming of the "descriptive method focusing on individual setting components" is its lack of transparency and the impossibility of integrating the value systems of the actors involved the ESIA process.

### 2.3.2 The ESIA as a vector of participation for stakeholders

The assessment of an impact through qualitative coding is based on "expert judgement". Outside the analyst's comments, the impact study report rarely describes what assessment criteria are applied, or how upper and lower value thresholds are allocated to variables: those relating to impact intensity, duration, or scope, or those relating to the final assessment of an impact's significance.

Furthermore, the descriptive method relies on a matrix-based approach applying standardized variable weighting that account for the specific characteristics of each type of impact. For example, the choice (relevance) of variables and their relative value (weight) would not be the same when describing the impacts on, for instance, biodiversity and employment in a given area.

And finally, since the descriptive approach does not include a means of aggregating assessments by impact criterion, it is impossible for the analysis to integrate a weighting of criteria corresponding to the value systems of the stakeholders involved in the participation process. For example, not everyone would give the same value to environmental and social criteria as compared to economic criteria, and vice versa.

In this context, it becomes extremely difficult to find a compromise when a disagreement arises between stakeholders about the assessment of impacts or the weighting of impact criteria. Such disagreements may arise between experts and the "public," or among experts. It is also relevant to wonder what consequences such disagreements have on the final decision. Stakeholders may disagree on how to evaluate the impact for one criterion or on how much weight to give the impact criterion, but without the means of aggregating results, how is it possible to measure a modification of values on the overall impact assessment?

In other words, the shortcomings of the "descriptive method focusing on individual setting components," and more broadly of ESIA's underlying concepts, considerably limit its scope as a decision aid tool integrating value systems in a multi-stakeholder context. The above analysis tends to confirm the view expressed by several observers that the current ESIA practice reflects a "rational" model that pits decision-makers and experts (bearers of technical and scientific knowledge) against the public.

What's more, the deficiencies observed in the ESIA process decrease its ability to produce information that is useful for understanding a project's significant stakes, including in the follow-up stage, and to resolve the disagreements that arise. As tends to be demonstrated in the analyzed cases, it is difficult in reading an impact study report to follow exactly how the analyst arrived at "informed predictions" by making links between the project (source of impacts), the modifications it causes in the natural and human settings, and the significance of those modifications with regard to the issues formulated as stakes.

For several years, it has been suggested that impact studies be structured in a stake-by-stake manner rather than by component of the setting. Multicriteria decision aid methods, which recognize the existence of multiple rational perspectives and accept diverse logical approaches in the stakeholders, have been successfully applied in a collaborative ESIA approach. These methods enable the aggregation of results by criteria to facilitate comparisons between several variations of a given project or between various action scenarios (at the strategic planning level).

# 3 Proposed improvements

Two modifications are proposed to help the ESIA reach its full potential as a decision aid tool and as a means of building social acceptability: 1) using a stake-based structure for the impact identification stage of the ESIA process; and 2) applying multicriteria decision aid methods at the impact assessment stage for the planned activities.

## 3.1 Using a stake-based structure in the ESIA process

The proposed approach consists of identifying the activities[9] within a project that can be a source of impact, measuring the changes caused by these activities to biophysical and human components, and analyzing them with regard to specific issues formulated as stakes, to determine their impacts. It should be noted that impact assessment involves not only the scope of the change in the affected biophysical or human component, but also its significance in terms of given stakes.

In the case of the previously cited hydroelectric development project the impact assessment concerns at once the change to the forest component (measured in square kilometres of cleared forest) and to the stake (biodiversity, maintenance of existing forestry activities, etc.) in light of which this change is being analyzed, each aspect referring back to its own specific analysis criteria. By a circularity effect, the choice of the stake determines the threshold below or beyond which this modification is significant or not by applying variables of intensity, spatial extent, and duration. Circularly, the selection of a stake determines the threshold beyond which this change is either significant or not in applying the variables of intensity, spatial scope, and duration.

According to the approach described above, assessing the impact requires that a model be designed to link the components of the outcome chain of a given activity to a given stake. It also assumes a specific

[9] A project involves several activities that should be defined at the outset. For instance, in a power line project, there is a pre-construction stage, which involves deforestation work and constructing access routes, and a construction stage, which involves excavation and earthmoving work. At the operational stage, the presence, operation, and maintenance of equipment can constitute sources of impact.

application (while not limiting itself to it) of the variables of intensity, spatial scope, and duration to each type of impact. However, this is not the case for the setting-component-based evaluation method, which relies on a generic application of the said variables, notwithstanding the type of impact being considered.

The following example deals with hydrocarbon exploration and exploitation in a maritime environment. The stake-based evaluation grid was developed from documentary research on this type of activity in general and more specifically from Canadian strategic environmental assessment (SEA) reports.

Table 2 provides an excerpt of this grid, relating to the maintenance of fisheries exploitation activities, that is, fishing. The grid identifies the source of the impact (in italics), the affected components in the biophysical and human settings (*in italics*), and the impacts of these changes. The purpose of this approach to structuring information is to establish the "chain of consequences for the planned activities by identifying its components with regard to each stake.

Table 2 is a simplified representation of a systemic approach being applied to identifying impacts. Its advantage is that it gives a clear picture of the chain of consequences for each stake, based on an ad hoc definition of the affected biophysical and/or human components and/or of the relationships among them.

There are several advantages to structuring information about impacts on a stake-by-stake basis. First, it allows users of the information to quickly see a project's major environmental and social stakes and how they have been handled in the analysis.

Second, it facilitates the scoping of the impact study, particularly as it relates to determining the scope of the analyses to be performed and the specialized sources of knowledge to be used. Structuring information about impacts on a stake-by-stake basis better targets information needs, and from there, the studies required. Applying this approach can result in economies of time and cost for the impact study.

Third, a stake-based analysis grid of the impacts makes the ESIA process more transparent by clearly identifying its constituent parts. In accordance with the points enumerated above, it is important to name the descriptors used and the variability thresholds used to measure changes in the affected biophysical and human components, and then assess their impact.

What's more, this type of grid facilitates a follow-up of the process at every stage. Several of the impacts identified early on, during the scoping stage, maybe removed from the grid because, after assessment, they are seen to be minor (low impact) or because recognized and effective measures exist to mitigate them. Also, impacts may be removed from (or added to) the grid in light of the results of the follow-up because the anticipated impacts are greater (or lesser) than the prediction or because impacts not foreseen at the evaluation stage are now being identified.

In short, structuring information about impacts on a stake-by-stake basis is a significant improvement over the current practice, particularly with regard to the transparency of the ESIA process. However, achieving such a structure also involves thinking about ways to improve impact assessment methods.

## 3.2 Applying multicriteria decision aid methods (MCDA) to the ESIA in a multi-stakeholder context

As mentioned previously, the "descriptive method focusing on individual setting components" does not offer a means of aggregating the results by impact to find out the overall impact of each project variation. What's more, as currently presented, the information is largely unusable for the purposes of arbitrating between the environmental and social considerations raised by a project and between the interests of the parties concerned or affected by the project's implementation. Multicriteria decision aid (MCDA) methods offer solutions to these shortcomings.

### 3.2.1 Applying MCDA methods to make trade-offs

There are two broad classes of MCDA methods available: 1) so-called *unique-criterion of synthesis* methods and 2) so-called *outranking synthesis methods*. This first class of methods is inspired by utilitarian logic,

which consists of evaluating an action's consequences and applying a logic of compensation by testing the proportionality between the advantages (e.g. economic spin-offs) and disadvantages (e.g. impacts on an ecosystem). Between two actions, the action selected is the one that obtains the best overall score.

Operationally, such methods involve performing a complete aggregation of the results of the evaluations carried out for each of the criteria (environmental, social, economic) using numerical coding that enables a summation of various measurement units (of length, time, temperature, etc.). Between two actions, the action selected is the one that obtains the best overall score.

The main advantage of such methods, commonly used in the economic sciences, is that they give a simple, unambiguous answer to a complex problem. They do however have several weaknesses. First, they rely on the postulate that all assessment criteria are comparable, when in fact, the criteria used to assess a project's impacts on a community's economic situation are simply not the same as those assessing the impacts on maintaining the balance between an ecosystem and a human population in a given area.

Furthermore, the compensatory logic underlying the utility calculation and its operational translation, consisting of using an average index, can lead to paradoxical results from the point of view of environmental protection. One project variation that has both significant benefits (economic spin-offs) and drawbacks (local environmental impacts) may be preferred over another variation with less significant but better-distributed benefits and drawbacks.

The second class, the outranking methods, instead applies a rationalist logic. Inspired by Kantian morality, these methods are based on the premise that every free and reasonable human being is capable of producing absolute moral rules, that is, that are universally applicable. Their application to solving social problems can translate to an a priori expression of the principles and standards, against which the planned actions will be assessed. Consequently, the project must be viable in light of the previously stated principles and standards.

Operationally, these methods enable the development of a complete or partial ranking of the actions based on an outranking relationship. The methods draw on the principle of the (environmental and social) criteria's *incommensurability,* which is reflected concretely in the fact that an action's good economic performance cannot compensate for a poor environmental or social one. This is done by performing a complete aggregation of the results by impact assessment criterion.

Brans and Mareschal (2002) with the PROMETHEE methods and Roy and Bouyssou (1993) with the ELECTRE methods adopt an approach consisting of inter-comparing potential actions, that is, of comparing them one pair at a time and establishing an *outranking relation* between them.

> "An **outranking relation** is a *binary* [or valued] *relation* defined on the set A of actions whose meaning is the following: an action *ai* outranks an action *ak* if it is possible to state with convincing arguments that, for the decision-maker, *ai* is at least as good (or no worse) than *ak*" [translation] (Maystre et al., 1994, p.21).

The basic idea behind these methods

> "is that when action *ai* is at least as good as another (*ak)* according to most criteria and when there is no criterion according to which *ai* is much worse than *ak*, than *ai* outranks *ak*. It is a principle of the majority—tempered by a principle of respect for a potential large minority—of the different points of view [translation] (Maystre et al., 1994, p.21).

Outranking methods are not strictly speaking methods of assessing an impact's significance. Rather, they are methods of comparing several actions and allowing those actions to be placed in decreasing order of preference (classification or ranking procedure) (Brans and Marechal, 2002; Roy and Bouyssou, 1993).

An important feature of these methods is their ability to use various units of measure (units of length, time, temperature, etc.) without requiring additional coding. They do however make it possible to integrate the stakeholders' preferences at two levels: 1) intra-criterion information (preference functions and threshold definitions) that specifies the stakeholders' relative preference with respect to pairwise action comparisons;

and 2) inter-criteria information (weighting of the impact criteria) that specifies the stakeholders' priorities relative to the stakes. Leveraging an operational approach based on the partial aggregation of results by impact criterion rather than on their complete aggregation, these methods prevent the need for a further, prior coding of qualitative assessments through the use of a numerical index, which amounts to adopting a single-criterion approach. A complete aggregation of performances

> "is equivalent to assuming that the judgments collected in light of the various criteria are *commensurable* (can be said of two magnitudes that share a common [comparable] measurement), whereas one of the justifications for using the multicriteria approach is precisely that these judgements lack commensurability. We thus take steps toward the multicriteria and then return to something that very strongly resembles the single criterion" [translation] (Schärlig, 1988, p.63).

In short, the decision of whether or not to authorize a project is largely influenced by the logical framework to which the decision-maker refers when arbitrating. The same is true for the point of view adopted by the protagonists when the decision becomes the subject of a public debate. However, it is rare for the protagonists in a public debate to explain the logical framework to which they are referring, which leads to inextricable conflicts.

As far as we are concerned, the decision aid models developed for instance by Brans and Mareschal (2002) using the PROMETHEE methods and Roy and Bouyssou (1993) using the ELECTRE methods provide solutions to the problems inherent to the methodological approaches we have discussed, namely, the descriptive approach and the methods based on a complete aggregation of performances. These appear to us to offer new potential for effectively integrating the stakeholders' concerns and values into the assessment of projects' social and natural impacts.

### 3.2.2 The application of MCDA as a participation tool

Applying MCDA methods makes the ESIA approach more transparent by letting it explicitly take into account a unique evaluation model for each impact through the use of a variable adapted to its inherent characteristics. Experts must then, on the one hand, take a stand on the weighting of the variables being taken into account, and on the other, establish, for each impact, a degree of preference for one action over another based on a gap observed for that impact (Brans and Mareschal, 2002). The goal is to integrate knowledge according to sector-based expertise.

What's more, MCDA also allows the various stakeholders to assign a relative weight to an impact criteria being compared to another, based on their own preferences and values. This is a real challenge compared to the existing practice, where experts make such judgments implicitly, without having to really be aware of what they are doing by applying crosscutting grids.

However, the MCDA methods described above are flexible enough to allow an integration of the impact assessment corresponding to the descriptive approach, which is based on a qualitative codification of the impacts' significance, according to an approach determined by the experts a priori (e.g. the matrix approach described above). The evaluation of the variables can be carried out according to a qualitative codification or a numerical index applying a multiplicative logic (e.g. significance = effect X intensity of action X sensitivity of setting) or any other model.

The search for solutions (e.g. ranking project variants in terms of impact criteria) in a multicriteria framework consists of nine (9) steps:

1. Actively searching for stakeholders;
2. Developing possible or feasible solutions (e.g. project variants);
3. Identifying and structuring the stakes, formatted as impact criteria;
4. Identifying methods for assessing impact criteria using performance indicators, measurement scales, and specific variability thresholds;
5. Weighting impact criteria according to the stakeholders' various value systems;

6. Developing a table of project variant performances according to the various impact criteria by conducting sectoral studies on the impacts;
7. Aggregating the project variant performances for all the impact criteria (for each stakeholder and for the group);
8. Searching for solutions, discussing, collaborating, negotiating;
9. Making a decision for implementation and follow-up.

The linkages between the multicriteria approach and the ESIA process are presented in Figure 1, which is an adaptation of the proposal on the strategic environmental assessment process presented by Côté and Waaub (2012). The nine steps therein identified become opportunities for stakeholder participation in the ESIA process, and more specifically, in the impact study process traditionally reserved only for government and project proponent experts (other actors involved). Insofar as one supports the principle of collaborative planning discussed in the introduction, the following questions then arise: Who participates? At what step(s) in the process? According to what term(s)?

Consistent with Côté and Waub (2012), in the diagram presented in Figure 1, the use of "+" indicates that the participating actors have a joint involvement, while "⇔" indicates that the first category of participating actors has a greater degree of involvement while the second plays a supporting role.

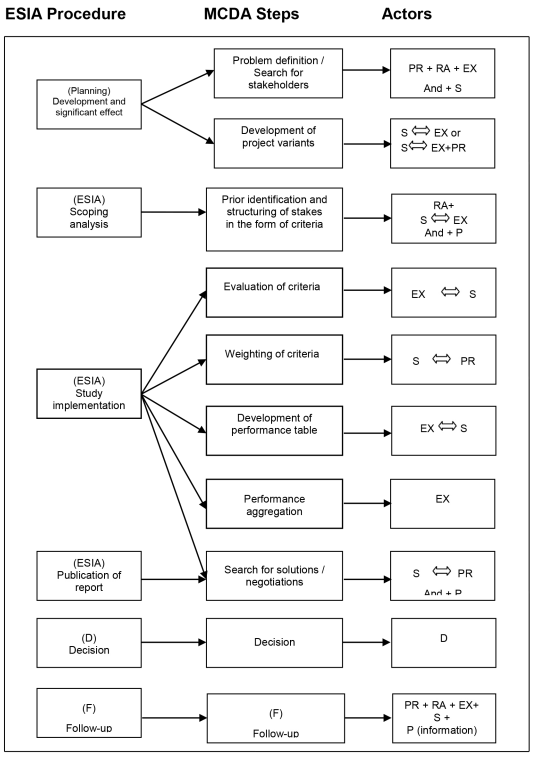


**Figure 1: Application of multicriteria decision aid to ESIA**

The Cabinet (C) is made up of ministries or government agencies concerned with the impacts of the proposition under review because of their involvement in specific areas (the environment, health, the economy, etc.). The diagram also includes the notions of stakeholders (S) and the public (P). While Martel and Rousseau (1993, p.20) consider the term "stakeholder" (S) to mean individuals or groups of individuals who share a common interest in a goal, problem, or decision, we associate this term with organized groups and reserve the term "public" (P) for individuals. Martel and Rousseau (1993, p. 20) also make a distinction between two categories of stakeholders: people who are involved and those who are affected. Stakeholders are involved when they participate in any way in the process of formulating and resolving a problem. They are therefore interested parties, because they are able to directly influence the course of events. This category is

an integral part of what we have termed "interveners." But other stakeholders or members of the public are not in a position to directly influence the problem's formulation or resolution because they do not participate in those activities. However, they will be affected by the decision: this category is what we earlier termed the "acted-upon."

The decision-maker (D) is the Cabinet, which has the responsibility of making decisions about whether or not a project will be carried out and under what conditions. Elected officials make the decision and are accountable for it.

As previously mentioned, the first step in the search for solutions in a multicriteria framework is an active search for stakeholders. As Martel and Rousseau (1993) point out,

> "... while it is necessary to have some idea of the problem to be able to begin identifying all the stakeholders, it should not be forgotten that, circularly, the process of identifying stakeholders serves in turn to clarify the problem. Indeed, a problem is not an autonomous reality to be discovered but rather a construction: the result of a relationship between one or more subjects and a reality that the subject(s) want to act upon in order to change it for their own benefit (Landry, 1988). Seen in this light, a problem cannot be discussed independently of the subject(s) who "own" that problem, and the process of identifying them serves to clarify the problem itself. Thus, the process of stakeholder identification is an invaluable aid in formulating the problem" [translation] (Rousseau, 1993, p.21).

The problem setup step and the subsequent steps leading up to the decision are all part of the "decision construction" process. Thus the criterion to be applied to the search for stakeholders should be relevance relative to the identified stakes rather than political representativeness. Thus, specific individuals or organizations should be chosen on the basis of their representativeness of a "stakeholder logic" (elected representatives, environmental interest and economic groups, affected persons, etc.). The sociopolitical weight of the stakeholders is important only at the decision-making stage, i.e., when trade-offs must be made between the project's various aspects (economic, environmental and social) and between the varied interests of the people who are affected by the project and will have to bear its risks and disadvantages (the smallest number possible) and those who will benefit from the project (the largest number possible).

The role given to the stakeholders and public involved in the ESIA project can be more or less significant depending on whether these resources are to be mobilized on an ad hoc basis to obtain specific information (vernacular knowledge on the characteristics of the study area and certain social practices) or to measure the level of social acceptability (opinions of those concerned or affected by a decision) or even broadened to include the partners directly participating and contributing to the trade-offs being made throughout the analysis process.

Following an earlier proposal (Côté and Waaub, 2012), we select three levels of participation: information, consultation, and engagement. Information aims to describe and explain previously made directions, choices, and decisions. Consultation includes the possibility of reacting and formulating arguments and opinions at various stages of the process. The consulting party may or may not take these into account, and may or may not change its directions, choices, and decisions accordingly. Finally, engagement comprises a process of discussing and formulating arguments according to various terms. Unlike consultation, the consulting party here invites participants to directly involve themselves in developing the directions, choices, and decisions. This therefore implies that participants must be able to be present at all stages of the decision-making process.

## 3.3 Advantages of a combined application of the stake-based approach and MCDA methods

Regardless of the participation level being adopted, the systematization of the analysis approach using a stake-by-stake multicriteria structure, along with an application of MCDA methods, improves the ESIA's transparency and makes it easier to include the preferences of the parties involved in the process, including the stakeholders. Indeed, apart from two exceptions (decision and performance aggregation), the participation scheme presented in Figure 1 calls for stakeholder participation at every step of the process: project

planning, scoping analysis, study implementation, and the search for solutions at the time of publication of the preliminary study report. It is also strongly recommended that the public be involved at key steps of the process in a broadened consultation format. Aside from the conventional benefits of a consultation process, such consultations provide the public with, on the one hand, an opportunity to contribute, and on the other, an opportunity for greater involvement and ownership.

MCDA methods facilitate the search for solutions in a context involving diverse stakeholders by shedding light on areas of convergence and divergence in their preferences, which can be expressed for instance in the selection of criteria and in determining their relative significance. The main benefit of developing a multicriteria grid is its concise identification of the parameters used in analyzing the stakes, which facilitates discussion among stakeholders in the event of disagreement on that subject. Disagreements may also arise regarding the assessment of impacts, more specifically as regards the setting of (minimum and maximum) thresholds beyond which changes to a biophysical or human component becomes significant or not, and regarding the relative weighting of evaluation criteria for actions. Integrating preferences into the analysis process makes it possible to verify their influence on the ranking of project variants, e.g. by facilitating negotiations and compromises between participants to arrive at a final selection.

Figure 2 illustrates a sample application of PROMETHEE to a siting problem for industrial infrastructure. Five potential sites were evaluated using a series of criteria (including economic, environmental, and social ones), according to the viewpoints and priorities of stakeholders from four areas: industrial, political, environmental, and social. For each stakeholder, PROMETHEE enables the association of a multicriteria score between -1 and +1 to each site. The sites are then ranked in decreasing order of their score.

In Figure 2, the vertical bars show the scores obtained for each stakeholder. For each site, a line connects each stakeholder's scores to make it easier to compare each set of rankings. For instance, we can see that site 3 (shown in blue) is the best solution for the industrial and political stakeholders, but not for the other two.

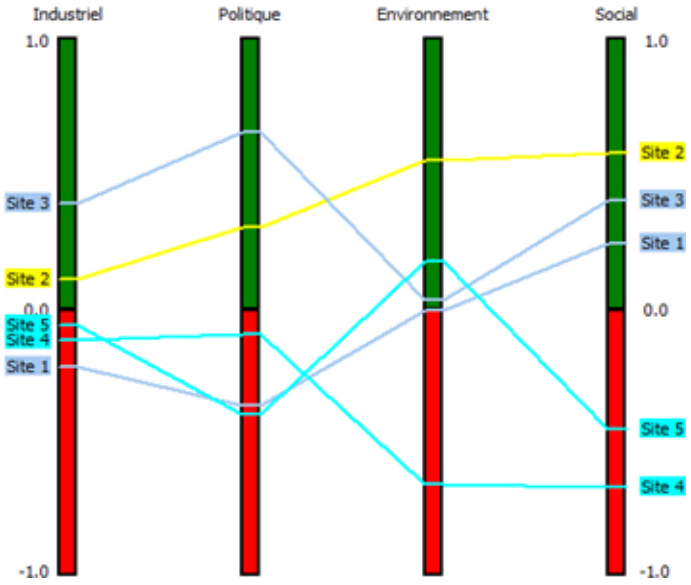


**Figure 2: Multicriteria, multi-stakeholder analysis through PROMETHEE**

From this analysis, PROMETHEE also makes it possible to construct a ranking that takes all the stakeholders' viewpoints into account, to explain the observed sources of conflict between stakeholders, and to analyze the robustness of the rankings relative to the criteria weighting and each stakeholder's respective influence. A complete description of the PROMETHEE method falls outside the scope of this paper, but interested readers can consult Brans and Mareschal (2005) for more information.

The application of MCDA methods however entails significant resources. It requires participation from several experts, for instance, from varied fields of knowledge related to the impacts or specialized in decision aid or participation. Furthermore, the search for solutions in a multi-stakeholder, participatory context

involves a certain number of prerequisites. Collectively, the stakeholders involved must be willing to negotiate, recognize the relevance of performing an evaluation using multiple criteria, make the necessary efforts to ensure the representativeness of viewpoints, and agree to work with a support team. This team must, in turn, remain behind the scenes and ensure the discussions' legitimacy, particularly through the intervention of a facilitator. Individually, each person representing a stakeholder must commit to the process to the end, have access to the resources (time) required to do so, be open to revisiting positions in light of the analysis results, and accept that the results of the process might be different from those anticipated in terms of the selected project variant.

# 4 Conclusion

This paper presents arguments in favour of revitalizing the environmental and social impact assessment (ESIA) approach and practices. These arguments are based primarily on the observation that ESIA reports are underutilized in decision-making and more broadly in constructing a shared understanding of the stakes for stakeholders in the decision-making process, which must be a prerequisite in any search for socially acceptable solutions.

Several conceptual deficiencies in the ESIA were identified to explain this state of affairs, and two improvements to ESIA's effectiveness as a decision aid tool and as a process facilitating the search for socially acceptable solutions were proposed: 1) structuring the ESIA process on a stakes basis during the impact identification stage; and 2) applying multicriteria decision aid methods at the impact assessment stage for the planned actions. As such, these solutions meet the requirements of a collaborative ESIA approach that focuses on the participation of decision-makers and mobilizes the people concerned by the project, while also taking into account those affected but not participating in the process.

These proposals make up the basis for revitalizing the ESIA approach and practices. This renewal is needed to counter the marginalization of ESIA schemes that we are currently seeing, under the pressure of emerging sociopolitical negotiation practices such as agreements on impacts and benefits. The aim of these proposals is to ensure that decisions are made on the basis of informed consent and a direct engagement with the issues at stake.

The benefits of the proposed approach can be summarized as follows:

- Development of a feeling of legitimacy about decisions;
- Strengthening of stakeholders' capacities and social learning with a view to continuous improvement;
- Social construction of acceptable solutions;
- Possible follow-up of decisions relative to the stakes raised.

Finally, the two proposals discussed in this paper open up new possibilities of application and research. Impact models in relation to the consequence chain and according to a systemic approach still largely remain to be defined. In addition, feedback on the implementation of these new forms of participation will have to be evaluated, taking into account also the aspect of social learning as it applies to all actors, including stakeholders.

**Table 1: Summary of impacts and mitigation measures**

| Source of Impact | | Affected Components | | Impact Description and Evaluation | Indicators | | | Significance of Impact | Mitigation Measures | Significance of Residual Impact | Follow-up and Monitoring |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stage** | **Activity** | **Setting** | **Component** | | **I** | **D** | **S** | | | | |
| Pre-construction and construction | Drainage work | Natural | Surface water | Increased concentration suspended materials and turbidity due to contributions from work areas and building of ditches and pipelines for rainwater | H | S | L | Moderate | 57. Measures to prevent sediment intake to water<br>58. Not obstructing ditches and removing obstructions (debris) to surface water flow. See design measures for runoff management | Non-significant | |
| | | | Wildlife | Fish habitat affected by modification of physico-chemical qualities of water and sediments linked to decrease in surface water quality | H | S | L | Moderate | | Non-significant | |
| | | Human | Lachine Canal | Water levels in Lachine Canal and sluice gate management modified by additional runoff / visual degradation due to change in water appearance (clarity, colour) | H | S | L | Moderate | See design measures for runoff management | Non-significant | |
| | | | Sound environment | Disturbance from pumps used to evacuate surface water | L | S | I | Minor | See measures 77 to 83 on construction of new infrastructures: sound environment | Non-significant | Intermittent acoustic follow-up |
| | Construction of new infrastructures | Natural | Soil | Physical and chemical disturbance of underlying and adjacent soils from building road foundations and surfaces | L | M | L | Moderate | See measures 20 to 28 on heavy machinery and worksite vehicle traffic: soil and surface water | Non-significant | |
| | | | | Contamination from fill and residual materials from the construction | H | M | L | Major | See measures 35 to 37 on excavation and earthmoving: soil, surface water and ground water<br>See design measures for management of contaminated fill | Non-significant | Risk monitoring and analysis relative to reuse of contaminated soil in fill |
| | | | Surface water | Contamination from increased runoff from adding ground-covering surfaces | M | M | L | Moderate | 59. If necessary, control runoff and drainage water by building ditches to prevent intake of sediment from the worksite to water<br>60. When possible preserve a 15 m–wide protective cordon around waterways | Non-significant | |

Adapted from: Transport Québec 2008, p.34.

**Table 2: Stake-based impact grid**

| **Stake** | **Action**<br>*Source of impact* | **Affected component in the biophysical setting** | **Affected component in the human setting**<br>*Modification* | **Social impact of change**<br>*Descriptor* |
|---|---|---|---|---|
| **Economic development (maintenance of existing activities)** | | | | |
| Maintenance of economic activities relating to the exploitation of fishery resources | Exploration via seismic surveys<br>*Noise* | Commercially exploited or likely-to-be exploited fishery resources in the area under study<br>*Displacement of fish populations* | Commercial fishing<br>*Interim decline in catches in affected areas* | Profitability of businesses in the fisheries sector<br>*Economic losses for businesses due to decline in catches, increase in costs, or decrease in market value* |
| | Exploration via seismic surveys or drilling<br>*Restrictions on physical access to fishing sites* | | Commercial fishing<br>*Decline in catches resulting from restricted access to some fishing areas in exclusion areas around exploration sites (seismic or drilling)* | Unemployment in fisheries sector<br>*Employment losses resulting from financial difficulties or closure of businesses* |
| | | | Commercial fishing<br>*Decrease in demand for fishing products stemming from a perception that extraction activities in the area decreases resource quality* | Territorial financial situation<br>*Losses in revenue at the territory level stemming from taxes, property tax, or activity-related fees* |
| | Exploration or production activities via drilling<br>*Dispersion of mud in the area of activity* | Commercially exploited or likely-to-be exploited fishery resources<br>*Displacement of fish populations in the affected area* | Commercial fishing<br>*Decline in catches in affected area* | |
| | | Commercially exploited or likely-to-be exploited fishery resources<br>*Contamination of fish populations in the affected area* | Commercial fishing<br>*Decline in resource quality* | |
| **Economic development (maintenance of existing activities)** | | | | |
| Maintenance of economic activities relating to the exploitation of fishery resources in the St. Lawrence Estuary | Production activities<br>*Liquid discharges and air emissions* | Commercially exploited or likely-to-be exploited fishery resources<br>*Contamination of fish populations in the affected area* | Commercial fishing<br>*Decline in resource quality* | Profitability of businesses in the fisheries sector<br>*Economic losses for businesses due to decline in catches, increase in costs, or decrease in market value* |
| | Production, transhipment and transport activities<br>*Accidental hydrocarbon spill* | Commercially exploited or likely-to-be exploited fishery resources<br>*Contamination of fish populations in the affected area* | Commercial fishing<br>*Decline in resource quality Decline in catches* | |
| | | | Commercial fishing<br>*Damage to fishing equipment* | |

**Table 2: Stake-based impact grid**

| **Stake** | **Action** *Source of impact* | **Affected component in the biophysical setting** | **Affected component in the human setting** *Modification* | **Social impact of change** *Descriptor* |
|---|---|---|---|---|
| | | | Commercial fishing *Decrease in demand for or price of fishing products stemming from a perception that extraction activities in the area decreases resource quality* | |
| | | | Commercial fishing *Increase in operating expenses due to move of fishing activities to other areas* | |
| | Production, transhipment and transport activities *Restriction of physical access to are affected by accident* | | Commercial fishing *Decline in catches due to decreased access to the resource* | |

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