Confidence, Uncertainty, and Risk in Environmental Assessment

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Abstract

The level of confidence in residual effect predictions in environmental assessment (EA) depends on the degree of uncertainty associated with the basis for the determination, including the adequacy of available data, knowledge, and understanding about the environmental component being assessed, the proposed technology, the nature of the project-environment interaction, and the efficacy of proposed mitigation. In most cases, uncertainty (particularly low to moderate uncertainty) is addressed through monitoring or other follow-up programs. However, if there is a high degree of uncertainty associated with the residual effect prediction, it may be appropriate to undertake additional analysis to more fully characterize the potential risk associated with uncertain outcomes. This paper describes how risk is considered in standard EA methods, suggests criteria to determine when additional risk analysis may be warranted, and outlines key issues to consider when undertaking additional risk analysis in the context of an EA.

Introduction

In recent years, there has been growing concern among regulators and environmental assessment (EA) process administrators (at least in some jurisdictions in Canada) about the adequacy of consideration of risk in EA. This is likely being driven by several factors, including high employment turnover in government, resulting in EA process administrators with less experience in and familiarity with EA methods, growing stakeholder engagement and activism in relation to proposed development projects, increasing risk aversion on the part of regulators and technical reviewers in government departments (itself driven by increasing litigation, among other factors), and increasing pressure from statutory decision-makers to demonstrate explicit risk management to their constituents.

EA integrates consideration of risk, as it considers the likelihood and consequence – evaluated in terms of significance – of potential residual adverse effects arising from a proposed project or activity. However, standard EA methods may not be adequate to fully characterize the potential risk associated with highly uncertain residual effect predictions. This paper describes how risk is considered in standard EA methods, suggests criteria to determine when additional risk analysis may be warranted, and outlines key issues to consider when undertaking additional risk analysis in the context of an EA, drawing primarily on the author's 20-plus years of EA experience, as well as recent work developing methodological guidance for the British Columbia Environmental Assessment Office.

How EA integrates consideration of risk

The EA process is inherently a risk management process, as shown below. The typical steps involved in identifying and assessing potential effects of a project in an EA (left column in the table below) are similar to the steps used in standard risk assessment practice (right column).

Comparison of Environmental Assessment and Risk Management Steps	
EA Paradigm	**Risk Management Paradigm[1]**
Describe the Project	Establish Context
Describe the Existing Conditions	
Identify Project-Valued Component Interactions	Identify Risks (Causes, Events, Impacts)
Identify Potential Effects	
Develop Suite of Mitigation	Consider Existing Mitigation
Residual Effect Characterization	Analyze Risk
Significance Determination	Evaluate Risk
(*Done in an iterative manner prior to residual effect characterization and significance determination.*)	Treat Risk (Additional Mitigation)
Follow-up and Monitoring	Monitor and Review

A key difference between these processes is that a risk assessment evaluates a range of possible outcomes, and evaluates the level of risk of those outcomes based on likelihood and consequence. An EA, in contrast, focuses primarily on *likely* outcomes – the practitioner's best prediction of what *will* occur if a specific project is developed in a specific place in a specific way – and evaluates those outcomes (referred to as residual effects) in terms of likelihood and significance.

Figure 1[2] illustrates a typical 'heat map' used in risk assessment to determine the level of risk associated with outcomes of varying levels (ranging from 1 for lowest to 5 for highest) of likelihood and consequence.

Figure 1. Typical 'heat map' used in risk assessment

LIKELIHOOD						
	5	LOW	MEDIUM	HIGH	EXTREME	EXTREME
	4	LOW	MEDIUM	HIGH	HIGH	EXTREME
	3	LOW	MEDIUM	MEDIUM	HIGH	HIGH
	2	LOW	LOW	MEDIUM	MEDIUM	MEDIUM
	1	LOW	LOW	LOW	LOW	LOW
		1	2	3	4	5
		CONSEQUENCE				

Figure 2 illustrates how the typical conclusions of an EA might appear using a similar 'heat map' model. In this case, the outcome – the residual effect – is usually what is considered *likely* to

[1] Risk management procedural steps taken from *Risk Management Guideline for the BC Public Sector* (Province of British Columbia Risk Management Branch and Government Security Office 2012).

[2] 'Heat map' adapted from *Risk Management Guideline for the BC Public Sector* (Province of British Columbia Risk Management Branch and Government Security Office 2012).

occur, and the consequence is described as “not significant” or “significant”. The determination of significance is typically made initially by the practitioner and reviewed and accepted (or modified) by the regulator or administrator of the EA process. The determination of whether or not a predicted significant residual effect is justified (or “acceptable” in some jurisdictions) is typically made by the statutory decision-maker. In Canada, the binary nature of the significance determination can be traced to the Federal Court of Canada decision in *Canadian Wildlife Federation Inc. v. Canada (Minister of the Environment)* ([1989] 3 F.C. 309 (T.D.), aff'd (1989), 99 N.R. 72 (F.C.A.)), which clarified that a residual effect can be either significant or not significant. ‘Significance’ has since been entrenched as the critical EA decision criterion in both federal and provincial legislation.

Figure 2. Comparable “heat map” for environmental assessment

<table>
<tr><td rowspan="3">LIKELIHOOD</td><td rowspan="3">Likely</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Not Significant</td><td>Justifiable</td><td>Not Justifiable</td></tr>
<tr><td colspan="2">Significant</td></tr>
<tr><td colspan="3">CONSEQUENCE</td></tr>
</table>

As shown by this comparison, the conduct of an EA effectively constitutes risk management. The residual effect predictions documented in an EA by and large describe the risk associated with the project (albeit with fewer gradients of risk), articulated in terms of the likelihood of significant adverse residual effects occurring. For most project-Valued Component interactions, the analysis conducted for the EA will suffice to understand the potential risk associated with the proposed project or activity and to facilitate the effective management of risk.

When might additional risk analysis be warranted?

To illustrate when additional risk analysis of residual effect predictions may be warranted, it is useful to review key methodological aspects of current EA practice relevant to confidence and uncertainty. [A comprehensive description of the typical methodological steps involved in identifying and evaluating potential effects is beyond the scope of this paper. The reader is referred to the relevant literature, such as guidance documents provided by the Canadian Environmental Assessment Agency (CEAA) (*e.g.*, FEARO 1994).]

Key methodological aspects of current EA practice

In recommended EA practice (*e.g.*, FEARO 1994, EAO 2013), the practitioner will articulate the level of confidence he or she has in the residual effect prediction, taking into account key characteristics of the residual effect (*i.e.*, magnitude, extent, reversibility, duration, and frequency) and the significance determination. This statement of confidence depends on the degree of uncertainty associated with the residual effect prediction.

The practitioner should always make their best possible residual effect prediction based on the available information. However, in some cases, limitations in the available information may make characterization of residual effects and determination of significance difficult. For example, information about the conditions or sensitivity of the Valued Component or about the nature of the interaction between the project and the Valued Component may be incomplete. Also or alternatively, the project may involve new technology, the effects of which are not fully understood, or mitigation measures that have not yet been proven to be effective. Where such data gaps exist, the residual effect prediction may be *less certain*. That is, there is a greater possibility that the outcome – the residual effect – may be different from what is predicted. This

difference might manifest as a change in the characteristics of the residual effect (*i.e.*, magnitude, extent, reversibility, duration, or frequency) but have no effect on the likelihood or significance of the residual effect, or this difference might be sufficient to change the practitioner's determination of likelihood and/or significance (*e.g.*, from 'not significant' to 'significant' or vice versa). Generally speaking, as the uncertainty associated with the residual effect prediction increases, the level of confidence in the prediction becomes lower.

When is more analysis necessary?

In most cases, uncertainty (particularly low to moderate uncertainty) is addressed through monitoring or other follow-up programs. Such programs may include:

- monitoring to confirm actual residual effects are as predicted;
- monitoring to confirm mitigation measures are effective; and
- adaptive management programs to facilitate action when unforeseen effects occur or when ongoing monitoring identifies a need for new or modified mitigation.

However, in certain situations, particularly if there is a high degree of uncertainty associated with the residual effect prediction, it may be appropriate to undertake additional analysis to more fully characterize the potential risk associated with uncertain outcomes. As the statutory decision following EA usually hinges on the significance of the residual effects, the consideration of whether additional analysis is warranted should focus on the robustness of the significance determination.

For example, if the uncertainty associated with the characterization of a residual effect is of sufficient degree that the significance of the residual effect could change if the characterization is wrong, additional analysis may be needed to ensure the likelihood of a significant adverse residual effect is understood. Similarly, if the consequence of an unintentional project-related event, such as an accident or malfunction (including mitigation failure), could be a significant adverse effect, more detailed consideration of the range of possible outcomes in terms of likelihood and significance may be warranted. The goal of this additional analysis should be to facilitate understanding of the likelihood of a significant adverse residual effect arising from a particular project component, activity, or project-environment interaction, whether expected or unintentional.

Circumstances that may trigger the need for more detailed analysis of the likelihood and potential significance of a range of possible outcomes include a moderate to high degree of uncertainty coupled with:

- potential residual effects on a highly sensitive Valued Component (*e.g.*, a rare species);
- potential residual effects on Valued Components that are of serious concern to the regulator, Aboriginal people, the public, or other stakeholders;
- absence of prior relevant experience to shed light on uncertain residual effect characteristics; or
- potential for significant adverse effect arising from a plausible unintentional project-related event.

Such factors contributed to the need for additional risk analysis in relation to the Vancouver Airport Fuel Delivery Project in British Columbia, for example.

Additional risk analysis

If more detailed risk analysis is deemed to be necessary in relation to uncertain residual effect predictions, the practitioner should describe the range of probable, plausible, and possible outcomes in terms of likelihood and potential significance. This information will assist the

statutory decision-maker to understand both the likely outcome – that is, the predicted residual effect – and the risk particularly of more serious outcomes.

The additional analysis should also inform the need for and scope of additional mitigation and/or monitoring and follow-up programs to better manage risk by reducing the likelihood and/or significance of any potential adverse residual effect. To the extent such additional mitigation and/or monitoring and follow-up programs are directly related to the project being assessed, the practitioner should document those additional measures in the analysis. However, additional mitigation and/or monitoring and follow-up may be required to address the residual effects of other projects and activities on the landscape. While the practitioner may identify additional measures required in relation to other projects and activities, the responsibility for confirming the need for and scope of such additional measures, and for assigning responsibility for those measures, will rest with the regulator, EA process administrator, and/or statutory decision-maker.

The need for additional mitigation and/or monitoring and follow-up programs in relation to uncertain residual effect predictions will depend in part on the likelihood of significant adverse residual effects if the residual effect prediction turns out to be incorrect, and in part on the level of risk tolerance of the statutory decision-maker. Consultation between the practitioner/proponent and the regulator, EA process administrator, or other party designated by the statutory decision-maker may be helpful to characterize the latter factor.

It is beyond the scope of this paper to propose specific methods to conduct additional analysis to evaluate risk. There are many existing guidance documents pertaining to risk assessment that provide tools that may be useful in this type of application. Some jurisdictions have established risk management guidelines (*e.g.*, Risk Management Guideline for the BC Public Sector (Province of British Columbia Risk Management Branch and Government Security Office 2012)), the use of which may facilitate acceptance of analysis outcomes by decision-makers. However, when selecting and applying risk assessment tools, care must be taken to ensure the selected tools provide results that are compatible with a values-based EA paradigm and enable the statutory decision-maker to make the decision required by the prevailing EA legislation.

In particular, risk analysis tools may require modification to avoid duplicating relevant analysis already completed in the context of the EA, and creating confusion for the reader, such as may arise from inconsistent terminology. In addition, risk assessment tools and methods vary by discipline, and the practitioner must select an approach that is appropriate to the Valued Component being assessed.

Conclusions

In most cases, the analysis and findings in an EA, presented in terms of the likelihood and significance of potential residual adverse effects, will suffice to characterize the potential risk associated with a proposed project or activity. However, where there is a high degree of uncertainty associated with a residual effect prediction, the practitioner should consult with the EA process administrator or statutory decision-maker to determine the need for and scope/methods of more detailed risk analysis. If additional risk analysis is warranted, the practitioner should apply appropriate tools and methods to enable the statutory decision-maker and other users to understand the expected significance of the *likely* outcome – that is, the predicted residual effect – and the risk particularly of more serious outcomes, as well as document additional mitigation and/or monitoring that may be required to manage the risk.

References

EAO (British Columbia Environmental Assessment Office). 2013. Guideline for the Selection of Valued Components and Assessment of Potential Effects. Victoria. Will be issued Summer 2013.

FEARO (Federal Environmental Assessment Review Office). 1994. Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects: A Reference Guide for the Canadian Environmental Assessment Act. Ottawa. November 1994. 196pp.

Province of British Columbia Risk Management Branch and Government Security Office. 2012. Risk Management Guideline for the BC Public Sector. Government of BC. March 2012. Accessible on-line at: http://www.fin.gov.bc.ca/pt/rmb/ref/RMB_ERM_Guideline.pdf