



ECOLOGICAL RISK ASSESSMENT AS A FRAMEWORK FOR ENVIRONMENTAL IMPACT ASSESSMENTS

M. Claassen

Division of Water, Environment and Forestry Technology, CSIR, P.O. Box 395, Pretoria, 0001, South Africa

ABSTRACT

Environmental impact assessments in South Africa are usually conducted according to the integrated environmental management (IEM) procedure. The preliminary investigation reported here, indicates that most of the ecological requirements specified in the IEM procedure are supported in the ecological risk assessment (ERA) framework. The main concern about the ERA process is that it might not allow for sufficient feedback and consultation during impact quantification. A lack of appropriate techniques and expertise has also been identified in the collation and integration of the various disciplines involved in an environmental impact assessment. The outcome of this preliminary investigation suggests the need for a more detailed evaluation of the applicability of the ERA framework in the IEM procedure. © 1999 Published by Elsevier Science Ltd on behalf of the IAWQ. All rights reserved

KEYWORDS

Ecological risk assessment; effects assessment; environmental impact assessment; exposure assessment.

INTRODUCTION

The impacts of pollutants on the environment are often assessed. These assessments are frequently conducted as part of integrated environmental management (IEM) procedures for new developments (DEA, 1992a; Figure 2), either under current legislation or as a tool in pro-active environmental management. The ecological aspects of the assessments are usually conducted through applying specific measurement tools such as toxicity tests or field surveys and comparing the measured data with guideline or literature values. The problem requiring impact assessments, however, often extends beyond the impact of single chemical contaminants on single species, but rather to assess the impact of multiple stressors on entire ecosystems over long periods. The use of the ecological risk assessment (ERA) framework has been proposed for such assessments (Figure 1; EPA, 1996). ERA provides a framework for the application of the various environmental assessment tools and serves as a common currency to integrate and communicate results between scientists, risk assessors and managers and thereby promotes mutual understanding and collaboration.

METHODS

Similar to a human health risk assessment, an ecological risk assessment identifies pathways and mechanisms of exposure to physical, chemical or biological factors of concern. Unlike human health risk assessments that focus on the most sensitive, maximally exposed individuals, ecological risk assessments

rely on professional knowledge for the assessment of ecological risks to relevant individuals, populations, communities or ecosystems. The purpose of an ecological risk assessment is to contribute to the sustainable utilisation and management of the environment through scientifically credible evaluations of the ecological effects of environmental changes. This is done through a process of selecting endpoints (problem formulation), assessing exposures and effects, and characterizing and managing risks (Figure 1).

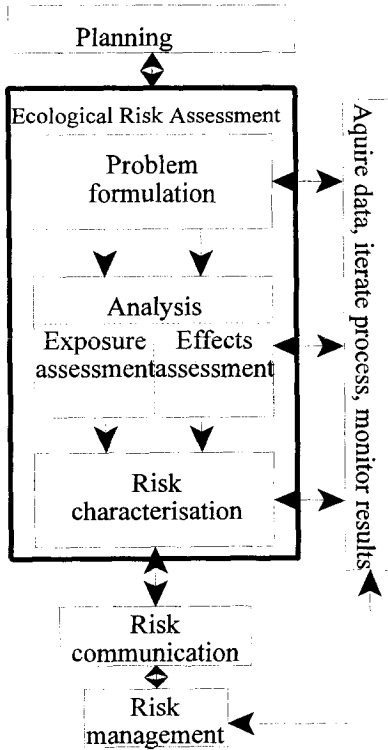


Figure 1. The ERA framework (redrawn from EPA, 1996).

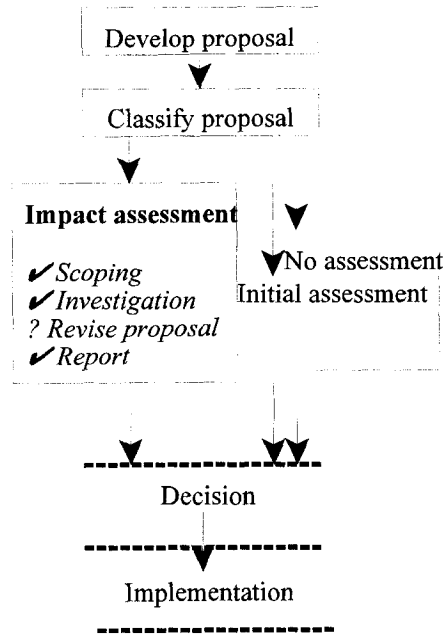


Figure 2. The IEM procedure (summarised from DEA, 1992).

Endpoints are measurable characteristics (indicators) of valued components of the ecosystem that are considered to be at risk. In traditional terms these endpoints could typically be attributes of standard laboratory organisms (toxicity evaluations), distinctive biotic components (field observations) or biota that has been well-researched (literature comparisons). In the ERA process the selection criteria require ecological relevance of endpoints as well as representing management goals for an ecosystem.

Exposure scenarios are spatial and temporal patterns of the physical, chemical or biological factors of concern. The determination of the endpoint organisms' contact with these factors is the exposure assessment. The exposure scenarios are determined through empirical calculations (design conditions), modelled estimates (probable conditions) or projections (possible conditions). These assessments do not always provide probabilities and uncertainties of their measures, but even when they do, these measures are rarely considered in the expression of effects. The ERA framework (Figure 1) provides for, and requires, the determination and expression of probabilities of occurrence and related uncertainties. These properties are considered during the statistical determination of effects.

The effects assessment describes the impacts of predicted exposures on the endpoint organisms. These assessments are mostly based on standard laboratory organisms in laboratory simulations of natural conditions. Extrapolation of these assessments to field applications often requires the incorporation of safety factors or more extensive field experiments. The ERA framework suggests the use of relevant biotic components and the evaluations under more natural conditions. This approach supports scientifically

credible evaluations of the ecological effects rather than depending on conservative estimations that are likely to be overprotective of the ecosystem, but as a result be overly restrictive to development.

The results from the exposure and effects assessments are integrated to obtain a probabilistic expression of the effects that will result from environmental changes. In practical applications, conservative estimates of exposures (with models or projections) and effects (with extrapolations) are compounded in this calculation to yield gross overestimates of impact. The ERA framework proposes the integration of probabilities and uncertainties from all sources into a realistic determination of the ecological impact of environmental changes.

DISCUSSION

The ERA framework (Figure 1) has been successfully applied to the assessment of ecological impacts in the USA and Canada (EPA, 1993; SETAC, 1996). This preliminary evaluation of its relevance to environmental impact assessments (EIAs) in South Africa is based on the criteria established for conducting impact assessments in the IEM procedure (Figure 2; DEA, 1993a).

The logical structure of the ERA framework and the integration of probabilities and uncertainties in the ERA evaluation presents a procedure that can be easily and comprehensively understood, documented and communicated. This addresses some of the key principles underpinning IEM such as; supporting informed decision-making, enabling consultation with interested and affected parties, permitting mitigation of negative effects and enhancement of positive effects, and providing opportunity for public and specialist input in the decision-making process (DEA, 1993a). The problem formulation stage of the ERA framework addresses all the issues required for the scoping phase of the EIA, although there is probably insufficient provision for a full consultative process and for revising the outcome of the scoping phase.

The description of the approach to the study as outlined in the IEM guideline documents (DEA, 1992b) is comprehensively addressed in the ERA framework, as are the requirements for assumptions and limitations (by definition of an ERA). The administrative, legal and policy requirements specified in the IEM procedure are not explicit components of the ERA framework, but provide the conditions for problem formulation and determine the framework for risk management. The advantage of this is that the ERA process remains objective and independent, but more feedback from these aspects to the assessment might be required for the local implementation of ERA. The exposure assessment step of ERA addresses all the relevant issues specified in the proposed outline of the IEM project proposal and the ecological components of the affected environment are also adequately covered.

One of the greatest perceived advantages of using the ERA framework in an impact assessment is that it quantifies very explicitly all the requirements of the assessment in the IEM procedure (DEA, 1993b). Some of these requirements are; the description of impacts or effects, an account of criteria for determining significance (by design supported in ERA), suggested mitigation options, impacts with mitigation measures (as a scenario-based tool ERA supports these evaluations) and the degree of confidence in the prediction (explicitly determined). The predictive capabilities of the ERA framework, furthermore, strongly support the documentation of the evaluation method, comparisons between alternatives, and the recommendation requirements of the evaluation phase of the IEM procedure. The statement of incomplete and unavailable information called for in the IEM procedure is also required in the ERA process.

The physical, ecological and pollution components of the environmental characteristics check listed in the IEM procedure (DEA, 1993c) are covered by the issues addressed in the ERA framework. A concern in this regard is that there may not be adequate provision for the integration of physical, ecological and pollution aspects with the land use, socio-economic, infrastructure and cultural resource issues.

CONCLUSIONS

It is evident that many of the ecological requirements specified in the IEM procedure are dealt within the ERA framework. A more comprehensive evaluation based on case studies should be conducted to test this hypothesis. An area of concern in the current ERA framework is the limited provision for consultation and

feedback during the quantification of effects. Mechanisms for the coordination and integration of social, economical, political, ecological and other aspects in the impact evaluation stage also need to be developed and refined.

ACKNOWLEDGEMENTS

The author would like to express sincere thanks to Dr. P.J. Ashton, Mr. D.J. Roux and Mr S Jooste for valuable contributions to the investigation and Dr. Ashton and Mr. Roux their constructive reviews. Furthermore, the CSIR and the Department of Water Affairs and Forestry are acknowledged for their foresight in supporting this investigation.

REFERENCES

- DEA (1992a). Integrated Environmental Management guideline series: The integrated environmental management procedure. Department of Environment Affairs, Pretoria.
- DEA (1992b). Integrated Environmental Management guideline series: Guidelines for report requirements. Department of Environment Affairs, Pretoria.
- DEA (1992c). Integrated Environmental Management guideline series: Checklist for environmental characteristics. Department of Environment Affairs, Pretoria.
- EPA (1993). *A review of ecological assessment case studies from a risk assessment perspective*. EPA/630/R-92/005, Risk Assessment Forum, US-EPA, Washington DC.
- EPA (1996). *Proposed guidelines for ecological risk assessment*. EPA/630/R-95/002B. Risk Assessment Forum, US-EPA, Washington DC.
- SETAC (1996). SETAC 17th annual meeting. Partnerships for the environment: Science, education and policy. SETAC Press. Pensacola FL.
- Suter, G.W., II (1992). *Ecological Risk Assessment*. Lewis. Boca Raton, FL.