ASSESSMENT OF INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS

Volume 1: Background to the study

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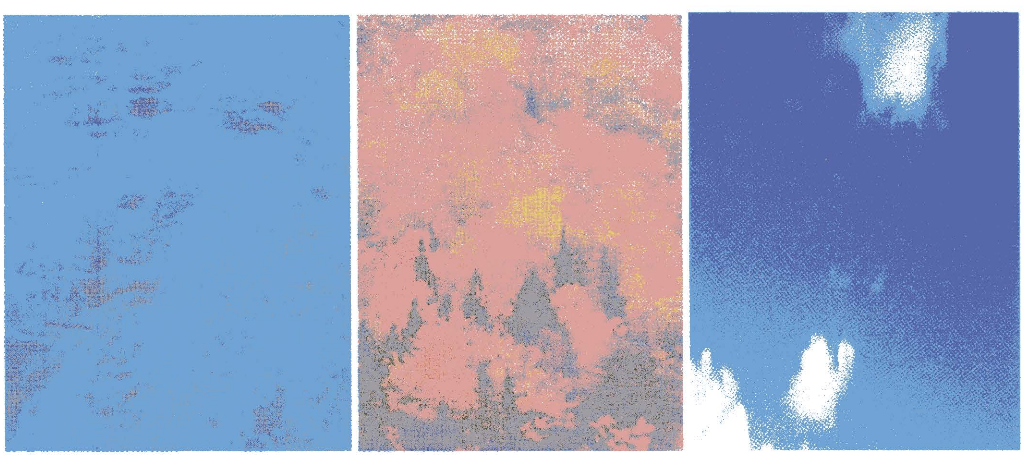

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MAY 1999

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Hyder

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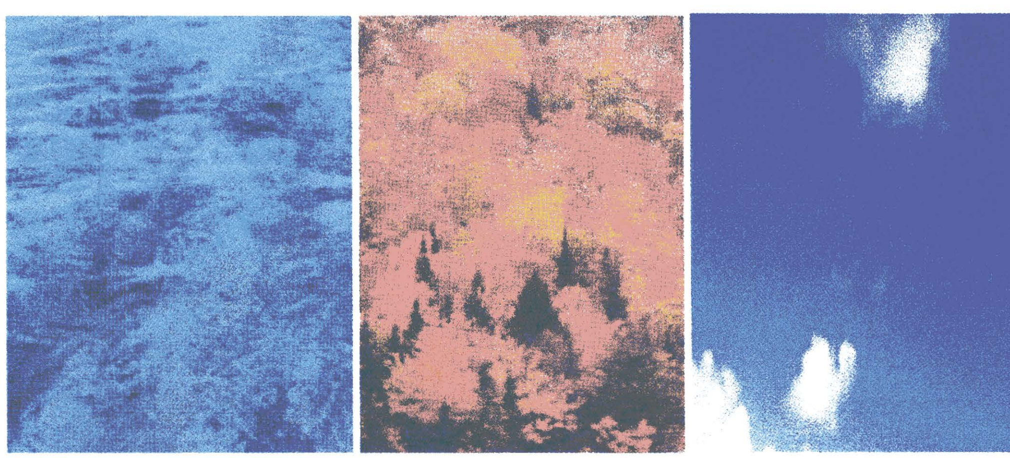

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NE80328/D2/3

Volume 1: Background to the Study

May 1999

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EXECUTIVE SUMMARY

Introduction

The study has been commissioned by the European Commission, Directorate General XI (Environment, Nuclear Safety and Civil Protection), in order to investigate the assessment of indirect and cumulative impacts, and interactions between impacts within the Environmental Impact Assessment (EIA) framework of the European Union (EU). The aim of the study is to determine how the assessment of these impact types is undertaken by Member States within the EU, and to identify what methods are used elsewhere in the world. The result of this research is the preparation of practical guidelines to assess indirect and cumulative impacts and impact interactions, which would assist EIA practitioners and those involved in training activities.

Volume 1 introduces the concepts of EIA and indirect and cumulative impacts and impact interactions; and also examines the extent to which the assessment of such impacts is already included in Environmental Statements.

A review of the EIA legislation currently in usage throughout the fifteen member states of the EU was conducted. The review paid special attention to the legal requirements for the assessment of indirect and cumulative impacts and impact interactions. The study also considered how the relevant requirements of the EIA Directive (85/337/EEC) have been translated into national law throughout the EU.

Finally, this volume describes known methodologies for undertaking the assessment of indirect and cumulative impacts and impact interactions, and discusses the problems currently experienced within the EU.

Evolution of Environmental Impact Assessment (EIA)

Background to EIA and the Emergence of the Assessment of Indirect and Cumulative Impacts and Impact Interactions

The origins of EIA lie in the USA with the passage of the *National Environment Policy Act* (NEPA), in 1969. Since then the EIA system has spread throughout the world, and was formally brought to Europe in 1985, when the European Community introduced its *Directive on the assessment of the effects of certain public and private projects on the environment (85/337/EEC).*

It was recognised from the inception of EIA that many of the most detrimental environmental effects may not result from direct impacts from individual projects, but from a combination of impacts from one development, or from minor impacts generated by a number of developments. Such impacts, over time can cause a significant impact. Directive 85/337/EEC, and the subsequent amendment (11/97/EC) requires that an EIA should include:

"A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climate factors, material assets, including the architectural and archaeological heritage, landscape and the *inter-relationship between the above factors.* [And] This description should cover the direct effects and any *indirect, secondary, cumulative, short, medium and long term, permanent and temporary, positive and negative effects of the project."*

The EIA Directive also requires that the "inter-relationships" and "interactions" between specified environmental effects be considered.

In practice few EIAs appear to consider the assessment of indirect effects, cumulative effects or impact interactions as this process is often thought to be too difficult due to technical and institutional barriers.

Approaches, Methods and Techniques

The review identified that there is still no single, universally accepted conceptual approach to the assessment of indirect and cumulative impacts and impact interactions. A number of approaches have been developed that broadly outline how to understand and more effectively address such impacts. The use of systematic approaches is reviewed in detail in Chapters 5 and 6 of Volume 1.

There are a wide range of techniques and methods for impact assessment which are available to undertake EIA. The same techniques can be applied to the assessment of indirect and cumulative impacts and impact interactions. They can be divided into those that are analytical or quantitative in nature and those that are planning orientated:

Analytical Methods	*Planning Methods*
Spatial Analysis	Multi-criteria evaluation
Network Analysis	Programming models
Biogeographic Analysis	Land suitability evaluation
Interactive Matrices	Process guidelines
Ecological Modelling	
Expert Opinion	

In practice, the application of these techniques for the identification and assessment of impacts is either limited or has not been developed to its full potential.

It is widely accepted that a single method would be unlikely to meet all the criteria required for the effective assessment of indirect and cumulative impacts and impact interactions. It would be expected that various methods and techniques in an adaptive approach would be combined to perform individual assessments. The most suitable combination of methods will depend on the nature of the problem, purpose of the analysis, access to and quality of data, and available resources.

Conceptual Framework

In many ways, the emergence of the assessment of indirect and cumulative impacts and impact interactions can, in fact, be seen as a response to the shortcomings of EIA, which have led to a shift in the scientific basis and institutional context of environmental assessment to incorporate consideration of indirect and cumulative impacts, as well as impact interactions (Spaling *et al*, 1993). These shifts in the emphasis of EIA can be considered in a number of different ways and this has resulted in the emergence of two approaches, which mirror the methodological slants introduced above.

The *scientific approach* emphasises analytical shifts. These include the expansion of spatial boundaries evident in regional approaches to Environmental Assessment, the extension of existing methodologies, and the monitoring of indirect and cumulative impacts as well as impact interactions. It is based on the view that these shifts represent the maturing of EIA into a more comprehensive form, which encompasses a wider assessment.

The *planning approach* considers the assessment of indirect and cumulative impacts and impact interactions as a form of planning, therefore differentiating it from EIA.

In effect, the two approaches represent different interpretations of the scope of the assessment of indirect and cumulative impacts and impact interactions, and are no means mutually exclusive.

This highlights an important issue. The difficulties encountered in the assessment of indirect and cumulative impacts and impact interactions are of two types, technical and institutional, both being of equal importance. While the technical, scientific, dimension is perhaps more obvious, it is clear that the institutional arrangements which currently exist in many countries, are often not consistent with effective assessment of indirect and cumulative impacts, as well as impact interactions.

Many of the same problems as are found with the traditional EIA processes also affect indirect and cumulative impacts, as well as impact interactions, including the issues of determining "acceptable limits" for environmental change and the establishment of the scope of the assessment. However, due to the complexity of the assessment of indirect and cumulative impacts and impact interactions there are additional problems; the most pertinent of which include:

Spatial Bounds: Selection of the most appropriate geographic scale and area to assess the significance of cumulative and indirect impacts as well as impact interactions. This invariably involves looking beyond site level effects and towards community, ecosystem, watershed and other levels, which are unlikely to match administrative boundaries.

Temporal Scale: How far into the future and how far into the past is it necessary to go to capture "past, present and reasonably foreseeable" effects?

Environmental Baseline Data: Assessment of indirect and cumulative impacts and impact interactions using existing data sources can be difficult as empirical evidence can be scarce, and quantitative analysis is hindered by insufficient data.

System Response Characteristics: The assumption that the environment will respond in a linear manner to human impact is not always valid, especially when considering indirect and cumulative impacts, as well as impact interactions. Complex ecological interactions give rise to non-linear responses in environmental systems including synergistic effects, threshold effects and compounding effects.

Institutional Arrangements: Different conceptual approaches, whether they be scientific or planning orientated, or based on the ecosystem approach, require different administrative considerations to effectively encompass indirect and cumulative impacts, as well as impact interactions.

EIA Legislative Framework in the EU Member States

Review of EU Legislation

This part of the study provides an overview of the legislative framework for EIA in the Member States of the EU, with a view to identifying for each country the relevant EIA legislation; the main steps in the EIA process; the transposition of the requirement to consider indirect impacts, impact interactions and cumulative impacts into national legislation and guidance; and the extent to which strategic environmental assessment (SEA) is covered by current EIA or other legislation.

Member State	Indirect Impacts	Impact Interactions	Cumulative Impacts	All three
Austria	✓	✓		No
Belgium	✓		✓	No
Denmark	✓	✓		No
Finland	✓	✓		No
France	✓			No
Germany	✓	✓	✓	Yes
Greece	✓	✓		No
Ireland	✓	✓	✓	Yes
Italy				No
Luxembourg				No
Netherlands	✓	✓	✓	Yes
Portugal	✓	✓	✓	Yes
Spain	✓	✓	✓	Yes
Sweden				No
United Kingdom	✓	✓	✓	Yes
Positive	12	10	7	6
Negative	3	5	8	9

Specific Environmental Assessment Regarding Indirect and Cumulative impacts, as well as Impact Interactions

The review of the legislative framework for EIA reveals that although most Member States have transposed the terms "indirect impacts" (12 out of 15) and "impact interactions" (10 out of 15) into national EIA legislation, the term "cumulative impacts" has only been transposed into national legislation by 7 out of 15 Member States. The national EIA legislation of only six Member States incorporates all three terms. In addition, this has not always been done in a way that reflects the intentions of Directive 85/337/EEC and the subsequent amendment.

Experience of the Assessment of Indirect and Cumulative Impacts and Impact Interactions outside the European Union

Difficulties with the assessment of indirect and cumulative impacts and impact interactions has been recognised as a major problem in the effectiveness of EIA throughout the world, but several countries outside the EU have begun to address the issues. For this purpose, the experience of Honk Kong, New Zealand and Australia are also reviewed.

Methodologies for Assessment

To date practitioners and researchers have published few methodologies for the assessment of indirect and cumulative impacts and impact interactions. Those that have been published have generally been designed for individual projects and have limited application. Davies (1992) has identified six themes as relevant to the development of a methodology. These themes often reoccur in the published methodologies and are as follows:

1. Defining Boundaries
2. Assessing interactions between the environmental impacts of the project.
3. Identifying past projects and activities and their environmental impacts.
4. Identifying future projects and activities and their potential environmental impacts.
5. Assessing interactions between the environmental impacts of past projects and future projects and activities.
6. Determining the likelihood and significance of the indirect and cumulative impacts and impact interactions.

An outline of some published methodologies is presented below. Methods were scored according to their adaptability to project type, to environmental conditions, to the European EIA framework, and to Annex I or II projects, and also according to cost effectiveness, international acceptability, complexity and utility to the practitioner.

SUMMARY OF PUBLISHED METHODOLOGIES

Methodology	*Description*	*Critique*	Score
Integrating cumulative impact assessment into the EIA Planning Process (Lawrence 1994)	It is essential to recognise that cumulative assessment is not a stage to be added to the EIA process, but that it is a dynamic EIA approach which facilitates systematic consideration of interactions among project characteristics, environmental components and other activities. It should therefore be incorporated into every stage of project-level EIA.	The approach is generally applicable to project types and environmental conditions. It is, however, highly theoretical, offering apparently little advice to the EIA practitioner as to how to undertake cumulative assessment, especially within Europe, where institutional arrangements are so different to that of the US.	0
Seven Steps to Cumulative Impacts Analysis (Clark 1994)	The seven steps can be summarised as follows: 1. Set goals 2. Establish spatial and temporal boundaries 3. Establish the environmental baseline 4. Define impact factors 5. Identify threshold values 6. Analyse the impacts of proposals and their alternatives 7. Establish monitoring	This appears to be the most useful in terms of implementing a methodology to assess indirect and cumulative impacts, as well as impact interactions at the project-EIA level. It is general enough to be applicable to any type of project and environmental condition. It is non-prescriptive and with its emphasis on utilisation during the scoping stage of EIA, is flexible and cost-effective enough to fit in with the European style of EIA. Cumulative impacts, indirect impacts and impact interactions are given early consideration. Its major drawback is its lack of detail in exactly how this consideration should be undertaken.	+11
Addressing cumulative impacts through Acts with Regulatory Powers (Bardecki 1990)	According to Bardecki (1990), the management of cumulative impacts is to some extent already being accomplished in a variety of situations in many jurisdictions, through the operation of regulatory frameworks. It is suggested that this vehicle for addressing cumulative impacts could be utilised more efficiently, by recognising the significance of cumulative impacts, identifying specific concerns and tailoring the regulatory powers accordingly.	This approach has several major disadvantages. Firstly the methodology is based firmly in the planning approach developed in Canada and which differs fundamentally from the European approach to EIA. Secondly, if the system were to be used in Europe, the institutional changes required may result in unacceptable complexity and consequent loss of cost-effectiveness.	-4

Summaries of Published Methodologies (Cont.)

Methodology	*Description*	*Critique*	Score
Assessment of cumulative impacts based on Monitoring and Modelling (Contant et al 1991)	A methodology based on the presumption that to be comprehensive it must include mechanisms that capture the two broad categories of cumulative impacts; impacts resulting from a project's relationship to another development's activities, and impacts produced by an activity's presence within a set of many natural systems. The suggested methodology responds to these contextual issues and furthermore, is focused upon the tasks of monitoring and modelling. It relies on establishing comprehensive levels of baseline environmental data.	Unfortunately the level of baseline environmental data available to be used in models is negligible and the costs of environmental monitoring required to provide the information for accurate modelling may be prohibitively expensive. However, the principles of the methodology provide a useful basis for assessing cumulative impacts where suitable data and models do exist.	+1
Questionnaire Checklist Approach (Canter et al 1995)	A questionnaire checklist for use in scoping indirect and cumulative impacts, as well as impact interactions, addressing detailed impact issues and summarising the results of indirect, and cumulative impact considerations and impact interactions. While all the items in the proposed questionnaire checklist will not be applicable to all projects and impact studies, it is argued that this methodology will provide a good basis for systematically addressing indirect and cumulative impacts, as well as impact interactions.	The questionnaire checklist approach does not set out to be a comprehensive methodology, but does provide a practical approach towards project level assessment of indirect and cumulative impacts, as well as impact interactions which can be implemented at the scoping stage.	+9
A Synoptic Approach to Cumulative Impact Assessment (US Environment Protection Agency, 1992).	In 1992 the US Environmental Protection Agency proposed a methodology to assist wetland regulators in assessing the cumulative effects of individual wetland impacts within the landscape. Although designed for this particular purpose, and with a focus on state or regional wide assessments rather than individual cases, it is suggested that the methodology has broader applications and that it could be applied to issues at different geographic scales.	Such a methodology would be very difficult to use in a European context due to its prescriptive and selective nature.	-1

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Summaries of Published Methodologies (Cont.)

Methodology	*Description*	*Critique*	Score
Seven Step Framework for Cumulative Effects Assessment (Damman et al 1995)	A methodology developed for the cumulative effects assessment of five uranium mine developments in Saskatchewan, Canada. A team of specialists was hired to undertake the assessment and specifically to identify significant impacts that could result from interactions between projects, interactions that might not be apparent from project specific environmental impact statements. The team's objective was to develop and apply a methodology that was consistent with prevailing theory and achievable within the limits of data, resources and time.	Damman's methodology provides a very thorough and transparent assessment process. It facilitates the setting of both spatial and temporal boundaries sufficiently broadly to be relevant for the assessment of indirect and cumulative impact as well as impact interactions. It takes into account wider interests of the community concerned and provides a very clear display of the thought process and results of the assessment. In addition, it is adaptable enough to provide a practical and beneficial guide to assessing cumulative and indirect impacts and impact interactions within the European EIA system.	+9
Impact Interaction Networks (Sporbeck 1997)	The methodology, which was developed to consider impact interactions in road projects and concentrates on ecosystem and landscape units and differentiates between three elements of impact interaction: ecosystematic interactions, impact-upon ecosystematic interactions and impact shifts. The methodology is expressed in the form of a cause-and-effect diagram, which is enables the identification of direct impacts on primary receptors but also follow-on impacts on other elements of the ecosystem resulting from impact interactions.	The complexity of this methodology is its main drawback, acting as a barrier for its use on small-scale project EIAs that are commonly conducted in Europe. It has also yet to be demonstrated that the methodology can be adapted to other project types.	+2
Cumulative impact assessment through Combining Individual Environmental Impact Assessments (ERM)	A methodology was specifically developed for the assessment of the cumulative impacts of two projects in the UK, the Channel Tunnel Rail Link and the widening of the M2 motorway. Combined impacts are identified as those that are additional to the impacts of the individual schemes or their simple additive impact.	This method was considered to be far too limited in its approach to be useful within the context of this study. It is possible the methodology could only be realistically employed where two very large scale, large budget projects have the potential to coincide.	+4

European Commission Directorate-General XI, Environment, Nuclear Safety and Civil Protection.

Study on the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

Volume 1: Background to the Study

NE80328/D2/3

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Section 1.0: Introduction

1.0 INTRODUCTION

This report is the first of three volumes issued as part of the Study on the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions within the Environmental Impact Assessment (EIA) Process. The study has been commissioned by the European Commission, Directorate-General XI (Environment, Nuclear Safety and Civil Protection) and is being undertaken by Hyder Environmental, an environmental consultancy, in association with EURONET, a pan-European research and consultancy network. Additional input was provided by European partners based in Germany, Greece, Portugal and Finland and an Expert Panel made up of leading members of the European EIA Community provided input to the study as well.

1.1 Study Objectives

Council Directive 85/337/EEC on *the assessment of the effects of certain public and private projects on the environment* and its 1997 Amendment (11/97) require that, along with consideration of the direct impacts of a project, an EIA should cover any indirect, secondary and cumulative effects of a project as well as the interactions between the environmental factors listed within the Directive. Experience has shown, however, that these issues often fail to be included in the impact assessment. A survey, conducted as part of this study (see Volume 2), has specified that most problems are related to the interpretation of interactions and to the lack of assessment criteria and methods to address these types of impacts.

The purpose of this study is therefore to investigate the assessment of indirect and cumulative impacts as well as interactions between impacts in EIA, within the European Union (EU). The study aims to determine how the assessment of these impact types is undertaken in the EU, with the overall aim to assist those involved in EIA practice or training activities to adequately address indirect impacts, cumulative impacts and impact interactions.

1.2 Report Structure

The Final Report is organised into three volumes. The first volume introduces the reader to the concept of Environmental Impact Assessment (EIA), its background, development and techniques. Following this introduction the concept of the assessment of indirect and cumulative impacts as well as impact interactions.

The first volume also includes an investigation into the EIA legislation currently in usage throughout the fifteen Member States of the European Union (EU). The legislative review pays special attention to the legal requirements for the assessment of indirect impacts, cumulative impacts as well as impact interactions and how the relevant requirements of the EIA Directive (85/337/EEC) have been translated into national law throughout the EU. This section also looks at how legal requirements for Strategic Environmental Assessment (SEA), if any, have been developed by Member States independently from the EU. This volume also includes a discussion into how three countries outside the EU have approached the introduction of the assessment of indirect and cumulative impacts as well as impact interactions into their EIA procedures.

Finally, this volume describes known methodologies for undertaking the assessment of indirect and cumulative impacts and impact interactions.

The second volume concentrates on the results generated by the questionnaire methodology developed for this study and the findings from the questionnaires. This volume discusses the problems currently experienced in the assessment of cumulative impacts, indirect impacts and impact interactions in the EU.

The third volume has been developed from this study and forms practical Guidelines intended for use by the Environmental Impact Assessment practitioner. The aim is to provide guidance on practical methods and approaches to assess indirect and cumulative impacts of a project as well as impact interactions.

Section 2.0: The Evolution of Environmental Impact Assessment

2.0 THE EVOLUTION OF ENVIRONMENTAL IMPACT ASSESSMENT

The origins of Environmental Impact Assessment (EIA) as a coherent system for assessing the potential environmental implications of a development, programme, plan or policy, lies in the United States of America (USA) with the passage of the National Environmental Policy Act (NEPA), in 1969. The Act gave structure and purpose to federal land-use planning which only existed in a rudimental format previously. The speed that the NEPA regulations were taken up and translated into state and regional legislation is testimony to the demand for and interest in a system that provided clear, accurate and stochastic, but scientific, information to decision makers.

As the NEPA regulations were refined during the 1970s, the system of EIA spread throughout the world; Canada, Australia, Japan, parts of Africa, China and South America all have experience of EIA (Wathern, 1988). It was not until 1985 when the European Community (EC) introduced its *Directive on the assessment of the effects of certain public and private projects on the environment (85/337/EEC)* (herein referred to as the EIA Directive), that EIA was brought to Western Europe. The spread of EIA, however, has not just been confined to national legislation, major international funding organisations such as the World Bank have also embraced the EIA system to add environmental probity to their investments. Moreover, multilateral organisations, such as the United Nations Environment Programme (UNEP) and World Health Organisation (WHO), have also integrated EIA into their decision-making procedures.

Since EIA came into being it has grown and developed into a viable environmental planning and decision making tool. It now not only provides scientific information about the physical environment of a development area to decision makers but acts as a public consultation document and an environmental management tool for the developer. In recent years, the field of EIA has expanded enormously with the evolution of EIA specialisms such as Social Impact Assessment (SIA), Environmental Health Impact Assessment (EHIA) and Strategic Environmental Assessment (SEA) which seeks to determine the effects of implementing policies, plans or programmes on the environment.

What links all these types of EIA and the systems in each country is a fundamental, iterative procedure that ensures that EIA is more science than art. A generic EIA system can be seen in Figure 2.1 below:

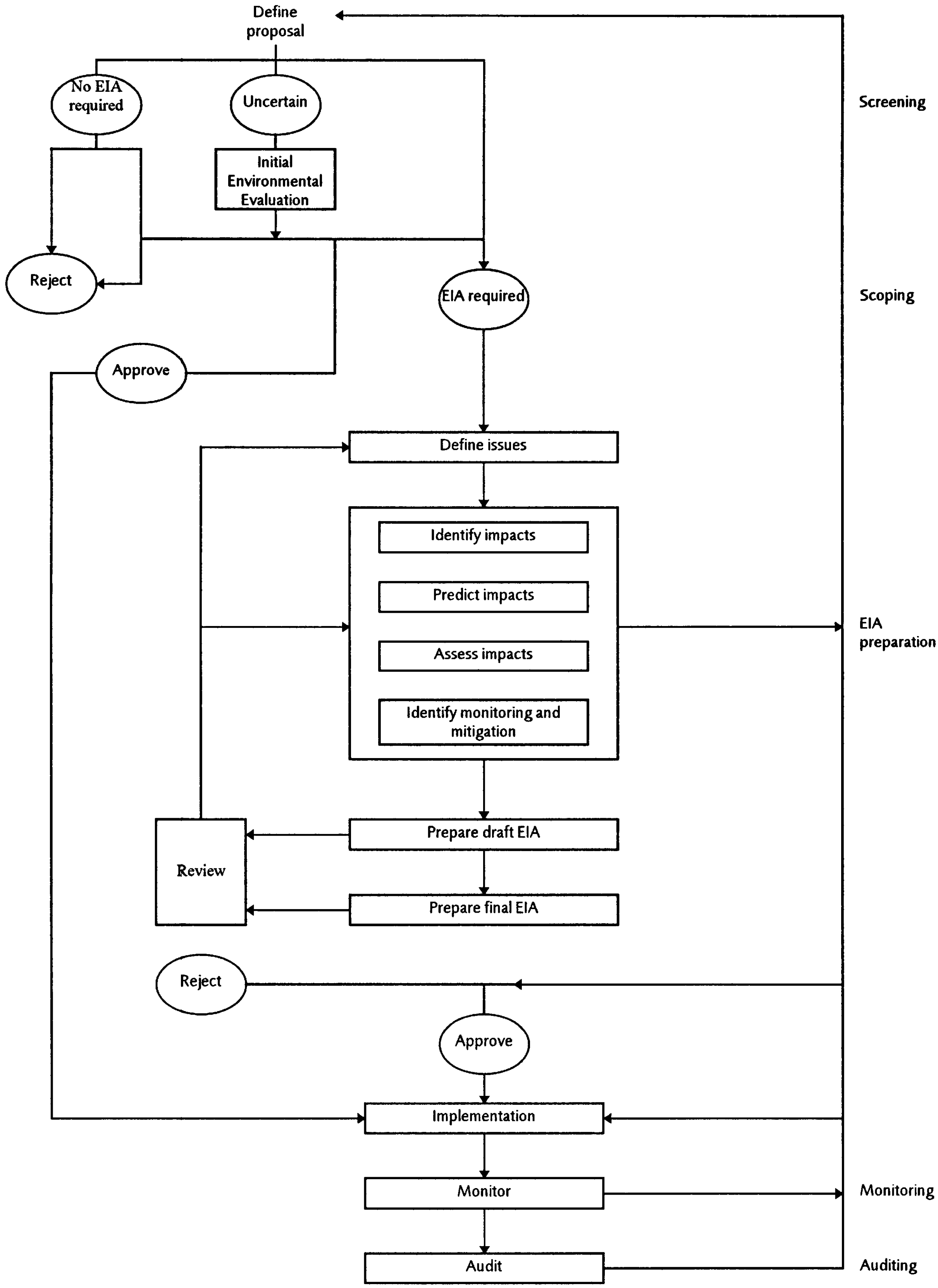

Figure 2.1 Flow diagram showing the main components of an EIA System (Wathern, 1988)

Once it has been identified that a development requires an EIA, through a process often termed *screening*, it can be seen from the above diagram that any EIA consists of three key stages. The first stage involves the identification and collection of relevant information. Exactly what constitutes relevant information is often determined through a *scoping* exercise in which the most pertinent impacts of the proposed development are identified and thereby the relevant information, often called the *baseline data*, determined. The baseline data must then be analysed and compared to the environmental situation with and without the development. This second phase of EIA consists of the *impact prediction* and the *impact assessment* stage. The results of all this data collection and analysis are usually reported to the relevant decision makers in an Environmental Impact Statement (EIS). The final stage is the *monitoring* and *auditing* of actual changes in the environmental baseline which must be recorded and analysed.

As can be seen from Figure 2.1, EIA is a cyclical process, theoretically, which forms a self-sustaining, positive feedback loop. Once the EIA process has been completed what has been learnt about that environment, the methods used in the EIA to identify, predict and evaluate impacts and the relationship between the predictions made and the actual impacts that occur post-development can all be used in future EIAs, refining and, hopefully, improving the whole process (Bisset & Tomlinson, 1988).

2.1 Emergence of Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

It was recognised from the inception of EIA that many of the most devastating environmental effects may not result from direct impacts from an individual projects, but from the combination of effects from existing developments and individually minor effects from multiple developments over time. Section 1508.7 of NEPA (1969) defines cumulative impact as:

"the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions...Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

This emphasis on ensuring that these types of effect are assessed has been reflected in the EC EIA Directive which requires that an EIA should include:

"a description of the likely significant effects of the proposed project on the environment [and] *this description should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project."* (Directive 85/337/EEC, Annex III)

The EIA Directive also requires that the "inter-relationships" and "inter-actions" between specified environmental factors are assessed. However, few EIAs throughout the world, appear to consider the assessment of indirect effects, cumulative effects or impact interactions as this process is often thought to be too difficult due to technical and institutional barriers. Even in the United States, where approximately 45,000 environmental assessments are prepared annually, there is little evidence for the comprehensive assessment of these types of impact (Burris & Canter, 1997).

Although this study is investigating the assessment of indirect impacts, cumulative impacts and impact interactions, much of the available literature classifies indirect impacts and impact interactions as cumulative impacts. Distinctions can be drawn between the three types of impact but their definitions do overlap (see Volume 3).

2.2 Overview of Environmental Impact Assessment Techniques

There are a wide range of techniques and methods for impact assessment available to undertake EIA. Most have been developed during the 1970s in response to NEPA (1969). Many of the more complex methods were initially developed by US Government Agencies that often dealt with large numbers of similar projects (Glasson, Therivel & Chadwick, 1994). Since their original design, many of these methods have been refined or altered and applied to other types of development. However, few methods have been demonstrably proven to accommodate the identification, prediction or assessment of indirect impacts, cumulative impacts or impact interactions.

Generally, methods used for environmental assessment can be divided into two distinct groups. The first group, which can be termed *predictive* methods, are used during the scoping and impact identification phase of an EIA. Predictive methods can be sub-divided into five distinct categories:

1. Checklists are the easiest of all methods to use consisting of a list of various factors that may be affected by the development; Annex III of the EIA Directive is an example of a checklist for inclusions within an EIS, requiring:

   "A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climate factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors."
   (Annex III, paragraph 3, 85/337/EC)

Checklists are useful in identifying impacts generally, ensuring that impacts are not overlooked. However, checklists do not identify relationships between impacts and are therefore very limited in their application to indirect and cumulative impacts as well as impact interactions.

2. Matrices are the most commonly used method in EIA. Matrices display in a two-dimensional format the relationship between project actions and environmental factors. Matrices have been modified to display not only direct relationships between development actions and the environment but also to give indications of impact magnitude through impact weighting systems. However, there are major problems with such weighted matrices, not least being the problem of subjectivity in attaching numerical values to different impact types. Additionally, conventional matrices deal only in direct impacts and are not, therefore, appropriate to the assessment of indirect and cumulative impacts as well as impact interactions (Glasson, Therivel & Chadwick, 1994).

3. Quantitative methods cover a broad spectrum of techniques, from mathematical and numerical models to sophisticated computer models. Fundamentally, quantitative techniques attempt to compare impacts by weighting, standardising and aggregating impacts and producing a relative, composite index. Despite the appeal of quantitative techniques through their ability to provide numerical evidence to support impact assessments they have many weaknesses such as their complexity and can be easily manipulated by changing assumptions underlying the model. In terms of assessing direct and cumulative aspects as well as impact interactions, quantitative techniques can be used to identify impact relationships but only if the relevant parameters are known and included in the model. Moreover, these techniques reduce environmental components to discrete units, often losing a great deal of information in the translation to numerical form.

4. Network methods are, theoretically, the most appropriate to the identification of indirect and cumulative impacts as well as impact interactions. Such methods recognise that environmental systems are composed of complicated, interrelated components and attempt to model these interactions. By following developmental impacts through the web of environmental relationships the effects of these impacts can be predicted though changes in the model. The drawbacks of using networks are that they are very time consuming in development and requiring highly specialised knowledge to accurately create a network for each environment under consideration.

5. Overlay maps have been in use for a considerably long time in environmental planning, before even EIA was a recognised technique. By using a series of annotated base maps each reflecting

a different environmental component of the development a composite picture of the developments impacts can be generated. The advance of computer graphics and Geographical Information Systems (GIS) has allowed weightings to be given to different types of information and more data to be analysed with this technique. These methods are not without their drawbacks, at their most complex they are very capital and skill intensive whereas at their most basic level they are limited to a small number of overlays by the cumulative opaqueness of the transparencies. Moreover, overlays will not identify secondary impacts and requires that the user has already identified the individual impacts before the techniques can be used.

The second group of EIA methods, described as *evaluation* methods, can be used to assess the significance of identified impacts. Although well documented (Barbier, Markandya & Pearce, 1990; Glasson, Therivel & Chadwick, 1994 for instance), few of the established evaluation methods have been seen in the European project EIA experience. This is not surprising due to most evaluation methods being orientated for use by planning decision makers than project EIA practitioners or being based on complex valuation systems which bars their use from most European EIAs due to time and resource constraints.

Evaluation techniques can be classified into two groups. The first group are, Cost-Benefit Analysis (CBA) techniques. CBA techniques rely on assigning monetary values to resources and calculating whether the economic gains of a development will outweigh the economic losses throughout the life span of the development. This method was used extensively in the UK during the late 1960s and early 1970s for large scale public sector developments such as the Third London Airport Report (HMSO, 1971). CBA techniques, when used solely for the purpose of EIA, have a fundamental drawback in that many environmental resources are *intangible* and, therefore, cannot be priced in a meaningful way, for example air quality or the value of endangered species or landscapes. This factor prevents CBA being used as a comprehensive tool for impact evaluation in EIA.

The inability of CBA to accommodate intangibles has led to the emergence of other monetary valuation techniques based on CBA that claim to be able to include intangible resources within their calculations (DOE, 1991a; Winpenny 1991 and Barde & Pearce, 1991). The valuation of intangible resources can be achieved through a variety of methods which measure, either directly or indirectly, the preferences of consumers of environmental resources. There are many pitfalls in utilising these methods and their complexity is such that their use is confined to academic research projects and large scale public sector developments rather than project EIA.

The second major group of EIA evaluation techniques, termed *multi-criteria* methods, seek to overcome some of the strictly monetary deficiencies of CBA by giving weight not only to tangible resources but also allocating weight to the differing views and goals from within society at large concerning environmental change. Similar to the weighted matrix predictive technique detailed above, the scoring systems used in most multi-criteria analyses are open to subjective interpretation and manipulation (Bisset, 1988).

Of particular interest to this study is the emergence of a multi-criteria methodology termed Multi-Attribute Utility Theory (MAUT) which relies not just on the assignment of arbitrary units to value impacts but attempts to incorporate the values of key interested parties. Consultation with key interested parties, such as local groups, has been identified in the course of this study as an important factor that is often overlooked in the identification of indirect and cumulative impacts as well as impact interactions.

Taking this concept a stage further is the *Delphi method* which attempts to build the views of key parties into the evaluation process by the collection of expert opinion and gaining consensus on the issues being considered. Generally using a three-stage questionnaire process, the Delphi method can gather expert knowledge from individuals at relatively low cost and in a short time period in comparison with many of the evaluation techniques given above. Furthermore, there have been a number of useful applications of the Delphi method in European context, for example it was used to assess the environmental impacts of the re-development of a salt mill in Bradford, UK (Green *et al*, 1989, 1990).

In summary, there are few available techniques for the identification and assessment of indirect and cumulative impacts as well as impact interactions. Increasingly, though, there are methods available for the assessment of different environmental parameters that will identify these types of impacts, such as for air quality or noise, in the form of sophisticated computer models. However, these models have been developed over a long period of time and still require accurate data concerning the surrounding environment to be gathered before accurate predictions of potential environmental impacts can be made. Additionally, these techniques are often based on quantitative information and are therefore not transferable to more subjective impact types such as visual and landscape. Furthermore, the use of complex computer models can only be realistically applied to major impacts that have already been identified as significant and only then can the indirect and cumulative impacts as well as impact interactions be fully assessed.

In terms of evaluating these types of impact, few of the documented methods of evaluation are used within the European EIA experience due to their complexity, time and resource costs and their drawbacks.

However, the use of the MAUT and Delphi methods may be of benefit in assessing indirect and cumulative impacts as well as impact interactions, improving the amount of knowledge that is collected and analysed by formalising the utilisation of information gathered from local groups.

2.3 Integrating the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions into the EIA Process.

The assessment of indirect and cumulative impacts as well as impact interactions recognises that each additional project represents a high marginal cost to the environment, and that it cannot be considered in isolation.

The assessment of indirect and cumulative impacts as well as impact interactions can be successfully integrated into the EIA process. Table 2.1 highlights the common ground between conventional EIA and the assessment of indirect and cumulative impacts as well as impact interactions.

Table 2.1 Characteristics of conventional EIA and Assessment of Indirect and Cumulative Impacts as well as Impact Interations (Lawrence, 1994)

ASPECTS	CONVENTIONAL EIA	ICI
PURPOSE	• Project evaluation	• Management of pervasive environmental problems
PROPONENT	• Single proponent	• Multiple projects and/or no proponents
SOURCES	• Individual projects with high potential for adverse environmental impacts	• Multiple projects and/or activities
DISCIPLINARY PERSPECTIVE	• Disciplinary and, to a lesser extent, interdisciplinary	• Trans-disciplinary and, to a lesser extent, interdisciplinary
.TEMPORAL PERSPECTIVE	• Short to medium term • Continuous dispersion over time • Proposed activity	• Medium to long term • Discontinuous dispersion over time (e.g. time lags) • Past, present and future activities
SPATIAL PERSPECTIVE	• Site-specific • Focus on direct on-site and off-site impacts • Continuous dispersion over space	• Broad spatial patterns • Wide geographic area (e.g. cross-boundary impacts) • Discontinuous dispersion over space (e.g. spatial lags)
SYSTEMS PERSPECTIVE	• Tendency - single ecological system • Tendency - single socio-economic system	• Multiple ecological systems • Multiple socio-economic systems
INTERACTIONS	• Interactions among project components • Interactions among components of environment • Interactions between project and environment • Primarily major, direct interactions • Assumption that interactions are additive	• Also interactions among projects and other activities • Also interactions among environmental systems • Also interactions between activities and environmental systems • Major and minor, direct and indirect interactions • Expectation that some interactions are non-additive (e.g. synergistic, antagonistic)
SIGNIFICANCE INTERPRETATIONS	• Significance of individual effects interpreted • Assumption that if individual impacts insignificant, combined impacts also insignificant	• Significance of multiple activities interpreted • Expectation that combined impacts may be significant even though individual are insignificant
ORGANISATIONAL LEVEL	• Intra-organisational	• Inter-organisational
RELATIONSHIP TO PLANNING	• Weak links to comprehensive environmental objectives • Project-level planning • Incremental project evaluation	• Explicit links to comprehensive environmental objectives • Programme and policy-level planning • Middle ground project evaluation and comprehensive planning
RELATIONSHIP TO DECISION MAKING	• Reactive; after initial decision to initiate activity	• Proactive; anticipates future actions
IMPACT MANAGEMENT	• Monitoring and management of major, direct impacts	• Comprehensive impact monitoring and management system

ICI - Indirect and Cumulative Impacts as well as Impact Interactions

The emergence of the assessment of indirect and cumulative impacts as well as impact interactions can, in fact, be seen as a response to the shortcomings of EIA, which have led to a shift in the scientific basis and institutional context of environmental assessment to incorporate consideration of such environmental change (Spaling *et al*, 1993).

Analytical shifts include expanded spatial boundaries evident in regional approaches to environmental assessment, extension of existing EIA methodologies to include the assessment of indirect and cumulative impacts as well as impact interactions, and monitoring of these effects. Administrative shifts include "tiering" or the application of environmental assessment to policies, plans and programmes, and regulatory actions and organisational reforms that explicitly recognise indirect and cumulative impacts as well as impact interactions. There are differing views as to whether these analytical and administrative shifts in the EIA process will be sufficient to assess these type of effects, which has led to two distinct approaches to the assessment of indirect and cumulative impacts as well as impact interactions:

1. The *scientific approach* is based on the view that these shifts represent the maturing of EIA into an overarching environmental assessment framework, and that the assessment of indirect and cumulative impacts as well as impact interactions therefore is an improved form of EIA, more comprehensive and more effective (Bronson *et al*, 1991); and,

2. The *planning approach* views the shifts as insufficient to overcome the shortcomings of EIA, and therefore differentiates between EIA and the assessment of indirect and cumulative impacts as well as impact interactions, considering the latter as a form of planning.

The distinction between the two approaches is one of emphasis; the scientific approach emphasises the quantitative analysis of indirect and cumulative impacts as well as impact interactions whereas the planning approach takes a normative policy perspective. The scientific approach considers indirect and cumulative impacts as well as impact interactions as information generation and it is the most common approach to assessing such effects. The scientific approach is distinct from planning and decision making, but linked to it through the flow of information from scientist to decision maker.

The planning approach goes beyond the analytical functions of information collection, analysis and interpretation to also include value setting, multi-goal orientation and decision-making by utilising planning principles and procedures to determine an order of preference among a set of resource allocation choices. The latter approach regards indirect and cumulative impacts and impact interactions as a correlate to regional planning (Bardecki 1990; Davies 1991; Hubbard 1990; Stakhiv 1988, 1991; Smit and Spaling 1995).

In summary, the scientific approach adopts a narrower focus emphasising the analytical function, whereas the planning approach adopts a broader focus including normative evaluation and management. In effect, these two approaches represent different interpretations of the scope of the assessment of indirect and the cumulative impacts as well as impact interactions. Smit and Spaling (1995) suggest that the differences between the two approaches should be reflected in the terminology used, so that the scientific approach is linked to the term analysis, and the planning approach to evaluation.

One approach does not preclude the other, and indeed it has been suggested that both are essential for effective management. A planning approach can thus provide the regional context for assessing the significance of any proposed activity at the project level.

Interestingly, this distinction between the scientific and the planning approach is not unique to the issue of indirect and cumulative impacts as well as impact interactions. It is also present in the evolution of environmental assessment generally. The development of Strategic Environmental Assessment (SEA) reflects the distinction between the scientific and the planning approach. SEA refers to a type of EIA process that intersects with planning at a discrete point in the decision process, whereas integrating EIA into planning refers to a complete merging of the EIA process within the planning process (Armour, 1990; Spaling *et al*, 1993).

The original mandate of NEPA was often seen as a comprehensive environmental planning framework rather than the information-generating activity that EIA has become with its focus on the Environmental Impact Statement (Andrews, 1973; Spaling *et al*, 1993). The narrowing of NEPA's original mandate and the failure of EIA to merge fully with the planning process over the last two decades have contributed to the re-emergence of regional or comprehensive planning under the guise of the assessment of indirect and cumulative impacts as well as impact interactions (Davies, 1991; Lane *et al*, 1988; Hubbard, 1990; Spaling *et al*, 1993).

However, the implementation of a regional or comprehensive planning framework is constrained by similar factors that hindered the integration of EIA into planning. Spaling *et al* (1993) identified the following factors:

- decision-making is characterised by the interaction of economic, social and environmental values and trade-offs among these values in the political arena, which often results in a disjointed incremental approach to planning;

- the planning process is typically institutionally fragmented with responsibilities for economic planning, environmental planning and social planning divided among multiple agencies; and

- planning is normally carried out at local or sub-regional scales to avoid overlapping jurisdictional problems whereas the assessment of indirect and cumulative impacts as well as impact interactions, by definition, requires the setting of broader spatial boundaries.

While the above factors have acted as barriers to the implementation of a regional or comprehensive planning approach to the assessment of indirect and cumulative impacts as well as impact interactions, the scientific approach to assessing these types of impacts has progressed further in its realisation than the planning approach. In accordance with Spaling *et al* (1993), reasons for this include:

- scientific criticism of the research design and analysis in environmental impact statements, which included inadequate data on indirect and cumulative impacts as well as impact interactions, prompted researchers to improve the theoretical and analytical bases for investigating environmental change;

- the legislative and administrative components of EIA, with only minor adaptations, provided an institutional context for the scientific approach to indirect and cumulative impacts as well as impact interactions; and

- planning and decision making processes responded to the increasing complexity of environmental problems by demanding more scientific information, rather than altering the priority of social norms or restructuring planning institutions.

2.4 Conceptual Framework for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

The lack of experience in the field of the assessment of indirect and cumulative impacts and impact interactions was initially reflected in the absence of useful definitions and concepts. That ambiguity has been reduced over time as efforts have been devoted to clarifying the meaning and interpretation of such impacts (see Volume 3). Many attempts to do this have adopted a process orientation, focusing on developing a conceptual approach.

There is still, however, no single, universally accepted conceptual approach to the assessment of indirect and cumulative impacts as well as impact interactions although a number of conceptual approaches have been developed that broadly outline how to understand and more effectively address these effects. Early work was focused on differentiating key attributes of environmental change, whereas more recent research has focused on a model of causality. A conceptual framework that builds on and integrates well established work based on the latter focus, mainly undertaken in the US, has been presented by Spaling (1994).

Spaling's conceptual framework of environmental change builds on work by CEARC and USNRS (1986), Sonntag *et al* (1987), Peterson *et al* (1987), Lane *et al* (1988), CEARC (1988), and Cocklin *et al* (1992a and 1992b). The framework is a tool that can help guide the analysis and assessment of indirect and cumulative impacts as well as impact interactions. It emphasises the fact that change occurs in several dimensions and that it is important to distinguish in what specific ways the change will occur. It also provides a basis for the classification of effects and serves to identify the key stages in analysis and assessment, pointing to some of the key methodological problems.

Spaling, uses concepts and principles derived from environmental change theory as a basis for the conceptual framework for these impacts. The framework is based on an input-process-output model (see Figure 2.2):

- Input is represented by sources of environmental change (or impact), where the sources are characterised by time, space and the nature of the perturbation.

- Process is manifested in pathways of environmental change which are distinguished as additive or interactive.

- Output is represented by the resulting indirect or cumulative impacts or impact interactions, broadly differentiated as structural or functional.

As illustrated in Figure 2.2, Spaling identifies two types of connection between the components source, pathway and effect: downward linkages which illustrate cause and effect relationships between components, and upward linkages which illustrate feedback mechanisms. The feedback mechanisms indicate that a pathway may stimulate other sources of environmental change and that an effect itself may become a source, or activate other pathways, of environmental change.

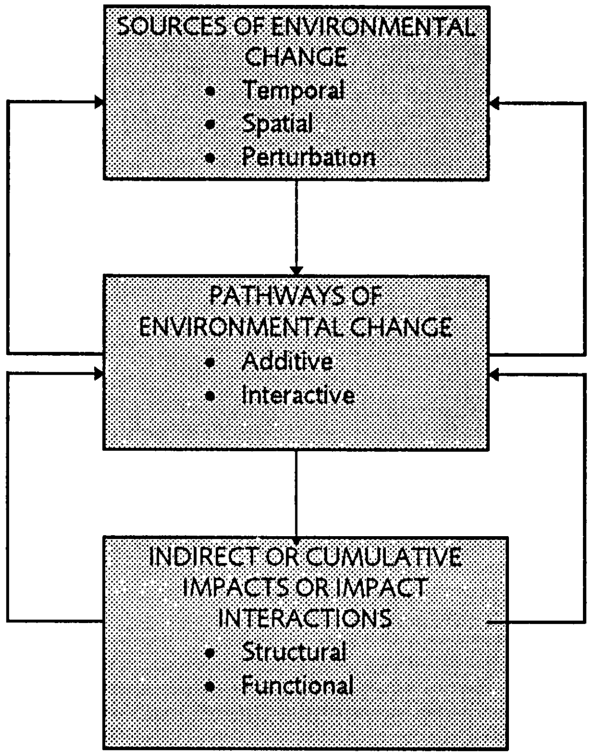

Figure 2.2: A conceptual framework of environmental change (Spaling, 1994)

A brief elaboration on each of the three components of the conceptual framework is set out below.

Sources of Environmental Change: Spaling puts forward a typology to describe and classify various sources of environmental change as identified in Table 2.2. This typology broadens the consideration of sources (i.e. human actions) beyond the bounded projects typically appraised by environmental impact assessments to include activities which are repeated over time and dispersed across space.

Table 2.2: A typology describing the source of environmental change (adapted from Spaling, 1994)

Temporal Attributes	scale	short/long
	frequency	discontinuous/continuous
Spatial Attributes	scale	local/regional/global
	density	clustered/dispersed
	configuration	point/linear/area
Perturbation Attributes	type	similar/different
	quantity	single/multiple

Pathways of Environmental Change: Environmental changes accumulate through different processes or pathways, which vary by number, type, temporal and spatial attributes. A perturbation may follow single or multiple pathways and involve additive or interactive processes. Additive pathways allow one unit of environmental change to be added or subtracted from a previous unit of environmental change. Interactive pathways are synergistic, in that net accumulation is more, or less, than the sum of all environmental changes. Temporally, pathways may be characterised by instantaneous processes or involve time lags. Spatially, pathways may function at local, regional or global scales, and involve cross-boundary movement among systems at the same scale.

Indirect and Cumulative Impacts as well as Impact Interactions: A typology of these types of effect which explicitly incorporates temporal and spatial attributes is based on dividing effects into two categories, functional and structural effects:

- Functional effects refer primarily to the accumulation of time-dependent environmental changes (e.g. time crowding, time lags). Temporal accumulation occurs when the interval between perturbations is less than the time required for an environmental system to recover after each perturbation.

- Structural effects are primarily spatially oriented (e.g. space crowding, cross-boundary movement, fragmentation). Spatial accumulation results where the spatial proximity between perturbations is smaller than the distance required to remove or disperse each perturbation.

- Other types of indirect and cumulative effects as well as impact interactions include compounding, triggers and thresholds, which are indicative of the manner of accumulation. These types generally contribute to or manifest themselves as functional or structural effects, or both.

Spaling emphasises that there are distinct benefits of linking these types of impacts to pathways of accumulation, as it enhances the understanding of system response to perturbation in two ways. Firstly, it provides an indicator of potential impacts in the future when detectable changes in pathways occur, as such it provides the basis for a predictive tool. Secondly, when such an effect is observed and the cause is unknown, the linkages and pathways amongst effects can be used to trace and identify sources of environmental change. In this case, the association between effects provides the basis for a form of hindsight analysis.

The above conceptual framework is seen as a heuristic tool that can help guide the analysis and assessment of these types of effects. However, there still remain challenges to undertaking the assessment of indirect and cumulative impacts as well as impact interactions based on sources, pathways and effects. The least understood of the three components of the above framework are the pathways of accumulation. Pathways can follow multiple routes, feedback loops, and processes that are interactive, synergistic, antagonistic or involve compounding. Tools to identify, monitor and analyse these pathways are not readily available.

2.5 Difficulties Encountered in Assessing Indirect and Cumulative Impacts as well as Impact Interactions

Many of the practical difficulties encountered in the assessment of indirect and cumulative impacts as well as impact interactions are not unique to that process, but occur in traditional EIA processes as well. These include issues such as the determination of "acceptable" limits for environmental change (be it physical or social), and the establishment of the scope of the assessment. However, the assessment of indirect and cumulative impacts as well as impact interactions involves a more complex process than conventional EIA, and thus imposes additional problems.

A basic question that must be carefully considered is what is known and what can be known. It is important to remember that practitioners are faced with real world issues, while working with finite resources within specified time frames (Damman *et al*, 1995). The difficulties encountered in the assessment of indirect and cumulative impacts as well as impact interactions are of two types, technical and institutional, both being of equal importance. While the technical, or scientific, dimension is perhaps more obvious, it is clear that the institutional arrangements which currently exist in many countries, are often not consistent with effective assessment of these types of impact (Cocklin *et al*, 1992a). Some specific problems encountered are discussed below.

SPATIAL BOUNDS

One of the first questions to address is the limits of the study area, or the spatial bounds. The physical boundaries of a project do not provide the required scope for assessment of indirect and cumulative impacts and impact interactions. However, can administrative borders be adopted, or is it necessary to look at the geographic scale appropriate to the ecosystem which sustain biological resources?

The US Council on Environmental Quality (CEQ) recommends that agencies look beyond site level effects and assess impacts within an ecosystem, landscape or broader regional context. In order to do this, the proponent needs access to the environmental baseline corresponding to that scale/level in order to judge possible alternatives. In line with this, Clark (1994) argues that the appropriate spatial scales are at the community, watershed, airshed or ecosystem levels, and that these geographical boundaries are unlikely to match administrative boundaries.

The conflict between the two is not significant where there are regional planning agencies, but remains a problem where the regional planning framework is not in place. It has also been argued that project-level assessment of indirect and cumulative impacts as well as impact interactions should be carried out "within the context of regional plans that have assessed the carrying capacity of the region's resources for the cumulative impacts of proposed actions" and that in the absence of these larger regional plans, the necessary context for the assessment is lost (Westman, 1984).

Finally, Sample (1991) suggests yet another approach, with no fixed spatial boundaries at all. The boundaries of the analysis would remain fluid, determined by the particular environmental value under consideration. Each of the valued components that may be affected are identified, and the area of consideration determined by the range over which each valued component is likely to be affected. The spatial bounds would, therefore, be adjusted to the resource being evaluated.

TEMPORAL SCALE

The second challenge is to decide how far into the future and how far into the past it is necessary to go in order to capture all "past, present and reasonably foreseeable" effects (NEPA, 1969). There are no guidelines on this question, and it has to be recognised that all decisions are made in some uncertainty, and that uncertainty generally increases with the time period considered and the variables introduced, including the size of the study area. Clark (1994) points out that without some limits to the "everything is connected to everything" doctrine, there will be "paralysis by analysis" and decisions will be made without even a casual understanding of these types of impact.

It is necessary to recognise that the existing state of the environment is the product of events throughout history, but that the shortage of data on environmental change through time reduces the ability to consider the historical perspective. In practice, empirical analysis is therefore focused on documenting the present and anticipating future changes in state (Cocklin *et al*, 1992a). However, it may be of little value to attempt to assess indirect and cumulative impacts as well as impact interactions more than just a few years into the future, as the projects seldom take place in a given sequence, unanticipated significant events can take place, and new information will become available (Sample, 1991).

Therefore, it is useful to keep in mind that boundaries, be it spatial or temporal, are only a tool to help rationalise the assessment task. Additionally, boundaries should always be treated flexibly, as environmental change does not conform with any artificially imposed spatial or temporal bounds.

ENVIRONMENTAL BASELINE DATA

Assessing indirect and cumulative impacts as well as impact interactions using available information sources can be difficult as empirical evidence is scarce, and quantitative analyses of effects are hindered by insufficient data. The assessment of such effects requires a long temporal duration and geographic representation at various scales (Spaling, 1994). In many cases the baseline environmental data does not exist, is incomplete, not at the appropriate scale, or not easily retrievable (Clark, 1994 and Damman *et al*, 1995). Where databases exist to support EIA work, they cover a limited time span and have a local focus, and they are not subject to standard formats, quality assurance and control, or other criteria that would help provide consistency.

This is explained by the fact that data has often been generated for a specific purpose and that EIA is heterogeneous, indicating that data collection will probably never be based wholly on an "off the shelf" principle. It is, however, possible to strive for standardisation; Clark (1994) suggests that national environmental baseline databases should be set up, based on input from various agencies contributing information by ecological region, and stored using common protocols. An additional advantage would be the way that such a database could act as a catalyst for co-ordination between agencies at different levels, from federal or national to local level.

An associated problem is the phenomenon of the "creeping baseline" which implies that the baseline condition will be worse for each subsequent development (Purnell, 1995). This presents a problem for local authorities in deciding where to draw the line in making planning decisions, and it may lead to a race to get a project approved before other projects in the area bring the overall indirect or cumulative impacts or impact interactions to a critical threshold, beyond which projects with additional impact would be severely restricted or prohibited (Sample, 1991).

SYSTEM RESPONSE CHARACTERISTICS

There is an urgent need to increase the understanding of system response characteristics. The assumption that the environment will respond linearly to human input is not always valid, especially when considering indirect or cumulative impacts or impact interactions. Complex ecological interactions give rise to non-linear responses in environmental systems, including synergistic effects, threshold effects and compounding effects. The environment can offer natural 'integration' or 'accumulation' properties, as well as natural dispersal and cleansing (Cornford, 1986). However, little is yet known about these response characteristics, despite the fact that they hold the key to understanding these types of impacts in a holistic manner.

In practice, this complexity and the uncertainty associated with system response processes often means that the accurate anticipation of outcomes simply is not possible (Cocklin *et al*, 1992a). It is also important to remember that although many social and economic implications of development can be relatively easy to anticipate, there are those which pose difficulties, for example social impacts such as the loss of a sense of community, which cannot be quantified and does not exhibit linear responses. Hirsch (1994), notes that the modelling of physical systems, such as ground water, surface water and air quality, is more highly developed than that of biological and social systems. As models are refined and extended, particular attention needs to be given to the interconnections between the physical, biological, social and economic systems.

INSTITUTIONAL ARRANGEMENTS

The two main approaches, scientific and planning, that can be adopted in the assessment of indirect and cumulative impacts as well as impact interactions were introduced previously (see Section 2.3 above). However, there is a further concept that can be put forward as a valid approach to assessing these types of impact, the ecosystem approach. Taking this third approach into account it is possible to distinguish the following : *project approach* (corresponding to the scientific approach), *regional approach* (corresponding to the planning approach) and *ecosystem approach*. Each approach implies different institutional arrangements and procedures.

The project approach is focused on identifying the indirect and cumulative impacts as well as impact interactions arising from a specific development project. The approach attempts to identify how the project will directly impact on the environment and how the impacts will interact with each other and other impacts to bring about environmental change. This approach offers greater simplicity than any of the other two, it also conforms well with the traditional EIA approaches and the way in which developers operate. However, it is a reactive approach, rather than a proactive one, and it does not allow for comprehensive consideration of such impact types.

The regional approach is focused on the full range of impacts within a spatially defined area, thus allowing the identification of various interactions and linkages within the area. The basis for this approach is the recognition that environmental change is not the product of developments occurring in isolation, but that a multiplicity of small, independent decisions by numerous individuals may lead to an increment of environmental change that is individually insignificant but, repeated over time and space, may accumulate and contribute to significant environmental change. This is the principle of the "tyranny of small decisions" (Odum, 1982). The regional approach is more complex than the project approach, but to its advantage it allows for a more comprehensive and forward-looking assessment.

The ecosystem approach is a variation of the regional approach, with the difference that the study parameters are defined more by ecological processes than by socio-economic or political boundaries. As such it exhibits the same disadvantages and advantages as the regional approach. In addition, it may provide a better basis for assessment than the regional approach as administrative boundaries usually have little relevance in social or environmental terms. However, in practice it is precisely the administrative boundaries that tend to establish the spatial patterns of environmental management (Cocklin *et al*, 1992a).

The benefits of a regional/ecosystem approach can be highlighted further by drawing links between the assessment of indirect and cumulative impacts as well as impact interactions and the wider concept of sustainability which requires a proactive planning approach and "within which ecological integrity is the governing factor and the permissible level of economic activity is the dependent variable" (Rees, 1988). The advantages of both the regional and the ecosystem approach over the project approach have been generally recognised for some time. However, the necessary institutional adjustments have not taken place as these approaches are not consistent with the traditional approaches that have been associated with impact assessment and their associated institutional frameworks. The challenge, therefore, is to divide existing political units into functional planning regions based on such ecological criteria as climatic and vegetation patterns, soil classification, and watershed boundaries (Rees, 1988).

Advances in this direction have already been made in New Zealand (see Section 4.2), where a reform of environmental administration in 1989 gave rise to fourteen regional councils defined according to major water catchments, in line with the assumption that environmental management would be primarily the responsibility of this middle-level government. Furthermore, new legislation introduced in 1989 placed emphasis on integrating environmental assessment more effectively within the wider planning process. This institutional arrangement contains the necessary ingredients for effective regional-scale, proactive assessment of these types of impact (Cocklin *et al*, 1992a).

Outside of New Zealand, until these more fundamental institutional adjustments are in place, there are still ways of improving the opportunities for assessment of these types of impact. It is important to recognise that the assessment of indirect and cumulative impacts as well as impact interactions concerns several administrative levels simultaneously, it is inter-jurisdictional by its nature. In practice it is often hindered by institutional barriers, which more flexible mechanisms for inter-agency co-operation and control can remove or lessen. Lawrence (1994), emphasises that innovative institutional arrangements are an essential element of the assessment of such effects, with the project level as the final tier. With such arrangements in place, it is argued that project-level assessment of indirect and cumulative impacts as well as impact interactions can be an effective and essential element of a broadly based strategy for the anticipation, analysis and management of environmental change.

A similar view has been put forward by Spaling *et al* (1993) who argue that there is a need for a plurality of approaches to the assessment of these types of impact, as each provides a particular contribution to the analysis, evaluation and management of environmental change. This is illustrated by the view that the extension of traditional EIA to encompass the assessment of indirect and cumulative impacts as well as impact interactions is suitable in relation to multiple large projects, but that as the most significant conceptual and administrative problems of dealing with such impacts are in the consideration of the multitude of smaller projects and changes, none individually having impacts of sufficient importance to warrant an environmental assessment, there is a clear role to be fulfilled by the planning function (Bardecki, 1990).

The two tier approach has been put into practice by the Forest Service in the United States, where attempts have been made to systematically introduce the consideration of these impact types. A two level decision process with a strategic EIA at the forest plan level, and a site-specific EIA at the project level has been found to be the most appropriate approach. The site-specific EIAs are not prepared for each and every project, but for small groups of projects. Reliance purely on the planning approach with assessment of these impact types of all planned activities over a ten-year period for an entire national forest or district was seen as insufficient in providing site-specific information, and in the provision of useful long-term information, as the assessment becomes quickly out of date as individual projects are modified, rescheduled, or dropped. Another argument for combining the planning approach with the scientific approach was that activities by other owners on adjacent land can seldom be anticipated in a forest plan, and that there is, therefore, a need for analysis of these impact types with each new project/group of projects (Sample, 1991).

The scientific difficulties identified in this section indicates a requirement for the assessment and refinement of existing methods of assessment of indirect and cumulative impacts as well as impact interactions and, where appropriate, the design and testing of new analytical tools capable of investigating such effects. The institutional difficulties identified above suggest that their resolution will require some institutional and legislative adjustments, possibly in line with those already implemented in New Zealand. However, it is likely that the institutional and legislative context for the assessment of indirect and cumulative impacts as well as impact interactions in many countries will remain similar to that in which EIA evolved (Spaling *et al*, 1993).

2.6 Methods and Techniques Applicable to the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

There is a distinct difference between methodological approaches to the assessment of indirect and cumulative impacts as well as impact interactions and assessment techniques for these impact types. The more detailed guidance as to how that assessment can be undertaken is found in individual methods and techniques for assessing such impacts. There are many methods and techniques available to assist in the analysis of impacts, some of them are used generally in EIA processes (see Section 2.2) and others have been specifically adapted to suit the requirements of indirect and cumulative impacts as well as impact interactions.

There are several ways of classifying such methods. It is traditional to classify EIA methods into checklists, matrices, networks and so forth. But it can be useful to start one step higher by distinguishing between different approaches to the assessment of indirect and cumulative impacts as well as impact interactions and categorising the individual methods under each approach. Section 2.3 outlined the two distinct, but related, approaches to assessing these impact types: the scientific, or analytical approach, and the planning approach. Smit and Spaling (1995) have proposed a scheme for classifying assessing these impact types methods in this way. The scheme, which is illustrated in Figure 2.3, identifies the level of analytical versus planning orientation of each method.

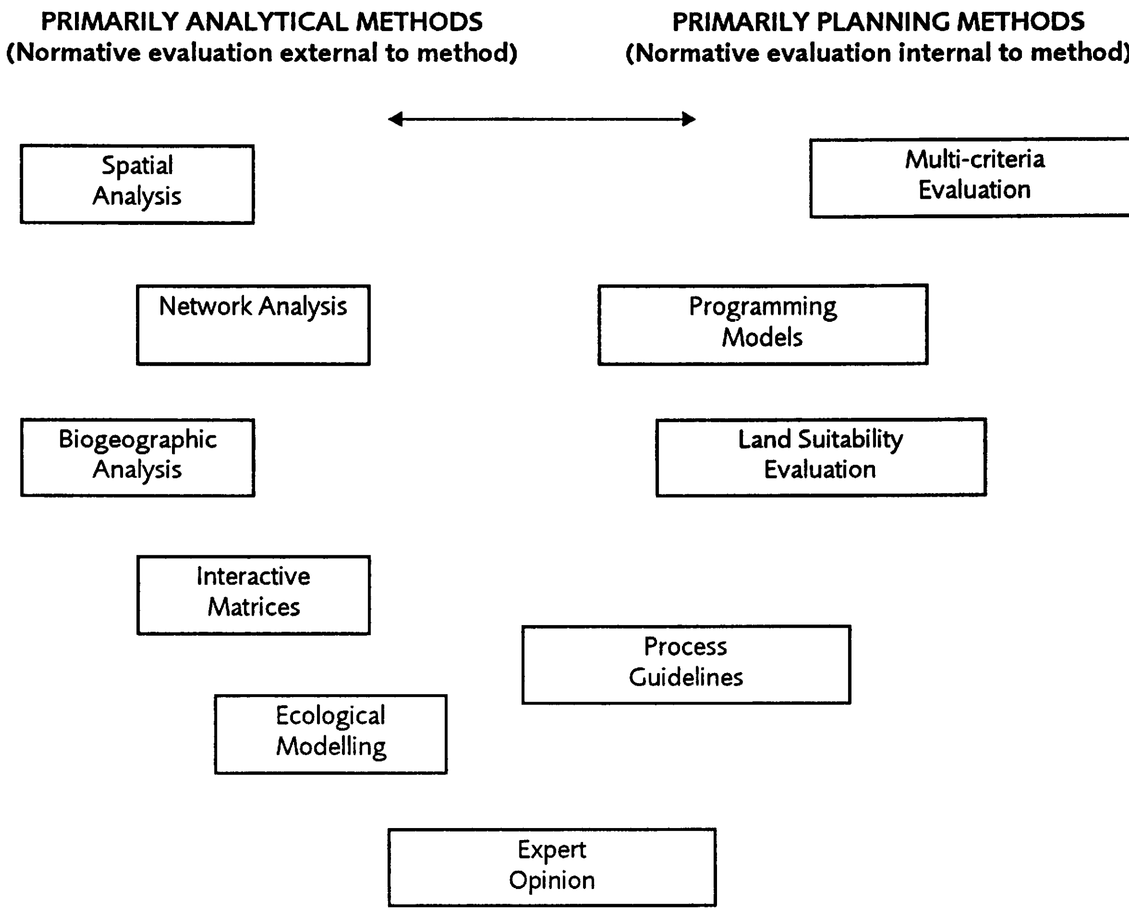

Figure 2.3 Schematic classification of methods (Smit and Spaling, 1995)

The above classification scheme has been further refined as shown in Tables 2.3 and 2.4, where each method is characterised by its main feature, its distinguishing mode of analysis and representative methods.

Table 2.3 Analytical Methods (Smit and Spaling, 1995)

Category	Main Feature	Mode of Analysis	Representative Method
Spatial analysis	map spatial changes over time	sequential geographical analysis	Geographic Information Systems
Network analysis	identify core structure and interactions of a system	flow diagrams; network analysis	Loop analysis; Sorenson's network
Biogeographic analysis	analyse structure and function of landscape unit	regional pattern analysis	Landscape analysis
Interactive matrices	sum additive and interactive effects; identify higher order effects	matrix multiplication and aggregation techniques	Argonne multiple matrix; synoptic matrix; extended CIM; modified CIAP
Ecological modelling	model behaviour of an environmental system or system component	mathematical simulation modelling	Hypothetical modelling of forest harvesting
Expert Opinion	problem solving using professional expertise	group process techniques (e.g. Delphi, nominal group technique)	Cause-and-effect diagramming

Table 2.4 Planning Methods (Smit and Spaling, 1995)

Category	Main Feature	Mode of Analysis	Representative Method
Multi-criteria evaluation	use of a priority criteria to evaluate alternatives	weighing of parameters and computational ranking of scenarios	Multi-attribute trade-off analysis
Programming models	optimise alternative objective functions subject to specified constraints	mass-balance equations	Linear programming
Land suitability evaluation	use ecological criteria to specify location and intensity of potential land uses	define acceptable levels of ecosystem health and target thresholds utilising ecological indicators	Land disturbance target; Ecosystem-based planning
Process guidelines	logic framework	systematic sequence of procedural steps	Snohomish guidelines; decisions tree

Smit and Spaling (1995) have undertaken an evaluation of the above methods based on criteria derived from the conceptual framework described in Section 2.4 and its three key components: multiple sources of environmental change; additive or interactive processes of accumulation; and various types of indirect or cumulative impacts or impact interactions. These notions form the basis for six evaluation criteria:

1. Temporal accumulation requires that a method consider time scale and frequency of a perturbation. A method should incorporate an extended time horizon to detect long-term, incremental environmental change, and also account for time lags.

2. Spatial accumulation requires that a method recognise the geographic scale of perturbations and set spatial boundaries accordingly. It should also account for cross-boundary movements at the same scale (e.g. intra-regional) and movements between different scales (e.g. local to regional to global). A method should acknowledge variation in spatial density because perturbations and effects are differentiated over space. Configuration is a significant characteristic because some methods may be oriented toward a

certain pattern (point, linear, aerial) more than others. The ability to consider an aerial pattern is particularly important because the assessment of indirect and cumulative impacts as well as impact interactions is often conducted in a regional context.

3. A method should be able to account for different types of perturbation, i.e. perturbations that are single or multiple in kind. It should therefore recognise perturbations that originate from multiple sources, or the same source repeated over time or across space. A method should also consider whether an action stimulates or propagates additional development that trigger further sources of perturbation.

4. A method should have the ability to trace and account for the process of accumulation, i.e. the processes of environmental change. It should differentiate between additive and interactive processes, and incorporate a technique that aggregates the effect of each.

5. A method should be able to identify, analyse and assess functional change in an environmental system, or a system component or process, after perturbation. The criterion of functional effects generally implies time-oriented changes and includes time-crowding, time lags and triggers and thresholds.

6. A method should be able to identify, analyse and assess structural change in an environmental system, or a system component or process, after perturbation. Structural change is viewed as essentially spatial and includes space-crowding, cross-boundary flows and fragmentation effects.

The above evaluation criteria are thus focused on the theoretical basis of methods and in particular on the capacity of each method to address the main components of the conceptual framework. Of the two main approaches to the assessment of indirect and cumulative impacts as well as impact interactions, the analytical approach has been used to provide the six evaluation criteria that focus on the analytical function, rather than the appraisal of planning or management options. More pragmatic criteria, such as data and technology requirements, time demands and cost, are not considered in this context. The conclusions of the evaluation are briefly described below. A summary evaluation of selected methods is presented in Table 2.5 below.

Table 2.5 Summary Evaluation of Selected Methods (Smit and Spaling, 1995)

Method	Temporal Accumulation	Spatial Accumulation	Type of Perturbation	Process of Accumulation	Functional change	Structural change	Reference
GIS	S	S	S	X	P	S	Johnston *et al.* (1988) Cocklin *et al.* (1992b)
Loop analysis	X	X	S	S	X	X	Lane *et al.* (1988)
Landscape analysis	S	S	S	S	P	S	Gosselink *et al.* (1989)
Argonne multiple matrix	X	P	S	S	X	X	Bain *et al.* (1986)
Simulation modelling	S	S	S	S	S	S	Ziemer *et al.* (1991)
Cause-effect diagramming	X	X	S	S	X	X	Williamson *et al.* (1987)
Multi-attribute trade-off analysis	X	P	S	X	X	X	Jordonnais *et al.* (1990)
Linear Programming	P	S	S	P	P	S	Stakhiv (1988, 1991)
Land disturbance target	S	S	P	P	S	S	Dickert *et al.* (1985)
Reference Guide	S	S	S	P	S	S	Lane *et al.* (1988)

Abbreviations: S - satisfactorily meets criterion
P - partially meets criterion
X - does not meet criterion

No standard method of assessment for indirect and cumulative impacts as well as impact interactions exists among the variety of analytically and planning oriented tools. The methods vary in their consideration of the main components of the conceptual framework. Some are project or activity oriented, for example, Argonne multiple matrix, emphasising the source of environmental change. Others, such as loop analysis or cause-effect diagrams focus on pathways or processes of accumulation. Still others, for example land disturbance target, stress a specific type of effect, such as thresholds. Furthermore, simulation modelling is capable of considering sources, pathways and effects, but requires information on processes and responses determined using other methods.

In general, methods of assessment are capable of considering the spatial dimension more frequently than temporal aspects. This is to some extent related to time-limited databases, such as historical records, but more importantly because of the inherent difficulty in accounting for time-dependent processes - uncertainty levels increase exponentially as predictions are made further and further into the future.

On the basis of the above, it is widely accepted that a single method would be unlikely to meet all the criteria required for the assessment of indirect and cumulative impacts as well as impact interactions, just like no single method can be identified as the best one for undertaking environmental impact assessments in general (Shopley and Fuggle, 1984). The wide range of available methods provides a rationale for *methodological pluralism*: various methods and techniques can be combined in an adaptive approach to perform individual assessments. Furthermore, if methods are combined in a sequential manner, an analysis can progress from a simple investigation of major impacts to a more detailed study of the principal areas of concern.

Smit and Spaling (1995), suggest that the suitable combination of methods will depend on the nature of the problem, purpose of the analysis, access to and quality of data, and available resources. For comprehensive assessment of indirect and cumulative impacts as well as impact interactions, a mix of methods is appropriate, if not necessary, to analyse and evaluate sources, pathways and effects. As an example, this may incorporate a method useful for conceptual understanding, such as cause-effects diagramming, more comprehensive approaches and empirical analyses, landscape analysis or simulation modelling for instance, and a normative evaluation, such as multi-criteria evaluation and land suitability evaluation, that contributes to environmental policy and decision making.

Section 3.0: The Legislative Situation in the European Union

3.0 EIA LEGISLATIVE FRAMEWORK IN THE EU MEMBER STATES

3.1 Objective

This report provides an overview of the legislative framework for Environmental Impact Assessment (EIA) in the Member States of the European Union, with a view to identifying for each country the relevant EIA legislation; the main steps in the EIA process; the transposition of the requirement to consider indirect impacts, impact interactions and cumulative impacts into national legislation and guidance; and the extent to which strategic environmental assessment is covered by current EIA or other legislation.

The country profiles do not provide an evaluation of national compliance with Directive 85/337/EEC, nor do they offer a view on the quality of the EIA legislation and processes in the different Member States.

3.1.1 STRUCTURE

Each country profile includes a table that sets out the current requirements for EIA, and strategic environmental assessment (SEA). The table also indicates whether the terms 'indirect impacts', 'impact interactions' and 'cumulative impacts' have been transposed into national EIA legislation. SEA legislation has been included for two reasons, firstly for completeness and secondly because of the close relationship between SEA and the assessment of indirect and cumulative impacts as well as impact interactions.

This is followed by a description of what these requirements entail and how they are applied. Each country profile only provides a brief outline, and further information can be found from the sources used. The following standard headings have been used to structure the analysis: EIA Legislation; Indirect Impacts, Impact Interactions and Cumulative Impacts; Strategic Environmental Assessment.

3.1.2 FINDINGS

The review of the legislative framework for EIA in the different Member States reveals that although most Member States have transposed the terms indirect impacts (12 out of 15) and impact interactions (10 out of 15) into national EIA legislation, the term cumulative impacts has only been transposed into national legislation by 7 out of the 15 Member States. The national EIA legislation of only six Member States incorporates all three terms (see Table 3.1). In addition, where these terms have been transposed, this has not always been done in a way which reflects the intentions of Directive 85/337/EEC.

Furthermore, the review has shown that there is a clear lack of government guidance on how to address these impact types, with only Germany having published guidelines that include advice on the consideration of impact interactions and cumulative impacts.

Finally, this review has also shown that comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice is very scarce, and that when these types of impact are mentioned in an EIS, they have generally not been considered in any detail.

3.1.3 INFORMATION SOURCES

The information has been gathered through contact with government agencies, including environment ministries and environment agencies, as well as EIA Centres in each of the Member States, complemented by a comprehensive literature review. Responses to an initial request for information were few, but a second approach based on drafting each country profile and sending it for confirmation/corrections to national representatives has proved useful.

Table 3.1: Overview of transposition into national EIA legislation of the terms indirect impacts, impact interactions and cumulative impacts.

Member State	Indirect Impacts	Impact Interactions	Cumulative Impacts	All three
Austria	✓	✓		No
Belgium	✓		✓	No
Denmark	✓	✓		No
Finland	✓	✓		No
France	✓			No
Germany	✓	✓	✓	Yes
Greece	✓	✓		No
Ireland	✓	✓	✓	Yes
Italy				No
Luxembourg				No
Netherlands	✓	✓	✓	Yes
Portugal	✓	✓	✓	Yes
Spain	✓	✓	✓	Yes
Sweden				No
United Kingdom	✓	✓	✓	Yes
Positive	12	10	7	6
Negative	3	5	8	9

3.2 Austria

Issue	National Legal Requirement
EIA	Legislation introduced in 1994
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	No
SEA	No statutory requirement

EIA Legislation

Work on preparing the 1993 Austrian Environmental Impact Assessment Act started in the mid 1980s after the so called "Hainburg Syndrome" which led to the Federal Chancellor admitting that prevalent decision-making processes did not allow for a comprehensive consideration of environmental issues nor for appropriate public participation (Davy, 1995). The 1993 Act entered into force on 1 July 1994, but at that stage certain procedures were optional. EIA regulations were enacted under a specific law, also on 1 July 1994. The 1993 Act fully entered into force on 1 January 1995.

The 1993 Act addresses two issues; environmental impact assessment and citizens' participation in environmental and land-use decision-making processes. The Act requires an environmental impact assessment of all developments which are likely to have significant effects on the environment by virtue of their nature, size or location and which are listed in Annex 1 of the Act.

In addition to the EC requirements, the 1993 Act establishes a comprehensive permit system that supersedes other permit requirements for a development, thus giving developers the advantage that they only need to deal with one administrative agency and can defend their proposals in one single procedure. The Act also allocates the right of participation to certain citizens' groups (any group of 200 citizens, who are registered voters for local elections in the host community or adjacent communities and who sign a petition obtains a *locus standi* in the permit procedure) (Davy, 1995). Furthermore, the Austrian EIA law requires a scoping phase at the beginning of the procedure, and consultation of neighbouring states in the case of possible transboundary impacts (implementing the Espoo Convention).

Indirect Impacts, Impact Interactions and Cumulative Impacts

The Austrian EIA legislation makes reference to indirect impacts and impact interactions, but does not require the consideration of cumulative impacts. There are no government guidelines for addressing the above impact types. There is also no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice (Aschemann, 1997a).

Strategic Environmental Assessment

There are no requirements yet for SEA (Grasser, 1994). However, the Austrian National Environmental Plan 1995 recommends the introduction of EIA procedures for policies, plans and programmes within the next five years. Furthermore, environmental considerations are taken into account in various sectors, including agriculture, energy, forestry, industry, land use planning, mining, transport, tourism, water and waste management. Finally, five provinces have introduced a new planning instrument called 'Spatial Impact Assessment', which is applied at the strategic level before the EIA, and addresses the spatial impacts of projects on the environment, society and economy. This is seen as a useful starting point for implementing SEA. (Aschemann, 1997b).

3.3 Belgium

Issue	National Legal Requirement
EIA	Instituted regionally: - in Brussels 1992 - in Flanders 1989 - in Wallonia 1985
- Indirect Impacts	Yes
- Impact Interactions	No
- Cumulative Impacts	Yes
SEA	EIA requirement for certain land use plans in the city of Brussels

EIA legislation
Environmental impact assessment regulations have been instituted regionally. There are three EIA systems, one each for Brussels, Flanders and Wallonia. Furthermore, some environmental matters, such as the assessment of the environmental effects in the nuclear sector, are regulated at the federal level (EIA Centre, 1996).

Brussels
The legal basis for EIA is provided by the Ordinance of 30 July 1992 on the prior assessment of the environmental effects of certain projects, which became operational and was modified and complemented in 1993. This EIA legislation provides for the integration of environmental concerns with urban development, and addresses the need to conduct environmental assessments for a wide range of projects. In particular, this provides an EIA requirement for certain land use plans developed in the city of Brussels, thus introducing EIA at an area-wide level (Devuyst, 1997).

Flanders
An Environmental Licence Decree introduced in June 1985 requires EIA of industrial installations. In March 1989 further EIA regulations were introduced through six Administrative Orders. These apply to industrial projects, certain infrastructure related projects and the building permit procedures (Glasson et al, 1994). By the end of 1994, a draft EIA decree, including EIA for certain plans and programmes, had been finalised (EIA Centre, 1996). This has not yet been adopted (Devuyst, 1997).

Wallonia
EIA for projects was introduced through the Decree on the Organisation of the Evaluation of Environmental Effects in the Walloon Region on 11 September 1985, and an Administrative Order in

December 1987 (CEC, 1993). The 1985 Decree was completed and fully implemented by the Administrative Order of 31 October 1991.

Indirect Impacts, Impact Interactions and Cumulative Impacts
The Belgian EIA legislation notes that direct, indirect and cumulative impacts must be taken into account, although none of the EIA systems pays special attention to such impacts. There are no government guidelines on how to address indirect and cumulative impacts or impact interactions. In practice, the requirement to address these impacts has not yet been fulfilled. The consideration of impact interactions is hindered by the common approach of engaging specialists from different disciplines to write individual chapters of the EIS without much interaction between the different chapters. This problem is now being addressed in Flanders, where an attempt is being made to introduce "co-ordinators" of the EIA teams (Devuyst, 1997).

Strategic Environmental Assessment
See section on the Brussels region.

3.4 Denmark

Issue	National Legal Requirement
EIA	Legislation introduced in 1972. Directive 85/337/EEC enacted partly in 1989, and fully in 1994
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Not directly
SEA	Required since 1993 for all governmental proposals with major environmental impacts

EIA Legislation

The aim of the Danish Planning Act is to "ensure that the overall planning synthesises the interests of society with respect to land use and contributes to protecting the country's nature and environment, so that sustainable development of society with respect for people's living conditions and for the conservation of wildlife and vegetation is secured" (Wulff, 1994a).

Considerations of the environment are an integral part of the planning process. Projects with environmental effects require permission. The permission requires an environmental impact assessment to be prepared, and describes the conditions under which the planned activity must operate in regard to the environment. Public participation is an important part of the process and is required before any decision on the implementation of the activity can be taken (ECE, 1992).

Environmental assessments have been carried out in Denmark for most of the projects included in Directive 85/337/EEC since 1972. Directive 85/337/EEC as such was implemented by an amendment to the National and Regional Planning Act and an Executive Order on the 23 June 1989 (ECE, 1992). A revised Executive Order came into force in autumn 1994.

Indirect Impacts, Impact Interactions and Cumulative Impacts

The Danish EIA legislation makes reference to indirect impacts and impact interactions, but does not directly require the consideration of cumulative impacts (Wulff, 1997). There are no government guidelines for addressing the above impact types. There is also no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice.

Strategic Environmental Assessment

An Action Plan approved by Parliament in February 1989, ensures that sectoral ministries and authorities bring activities and policies into line with the principle of sustainable development. The Ministries of Transportation, Energy and Agriculture have developed their own plans including consideration of the impact on the environment (ECE, 1992).

In October 1993 the Danish government implemented an Executive Order on bills laid down for Parliament, requiring the assessment of economic and environmental impacts. This is currently the only formal requirement for SEA in Danish legislation (Elling, 1993). The Ministry of Environment has published guidelines for this undertaking of environmental assessment of proposals for legislation and other government decisions (Miljoministeriet, 1994). It is intended that this requirement will, together with existing and future environmental targets and action plans, assist the total assessment of whether legislative initiatives under consideration will support the overall environmental policy or whether supplementary measures are needed (Wulff, 1994c).

The intention is to give environmental assessment a more significant role within physical planning in the future, and procedures and guidelines are being developed for this.

3.5 Finland

Issue	National Legal Requirement
EIA	Legislation introduced in 1994
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Not directly
SEA	Required since 1990 for all state action plans, economic strategies and proposals for legislation, and since 1994 for all plans, policies and programmes which may give rise to significant environmental impacts

EIA Legislation
The Planning and Building Act specifies that the principle of sustainable development must guide the preparation and implementation of land use plans (Nordisk Ministerråd, 1990). EIAs and SEAs were undertaken on a trial basis by 13 municipalities participating in a project set up in 1989 to promote the application of environmental assessment in municipal planning and decision making processes (Suomen Kaupunkiliitto et al, 1992).

The EIA Act and Regulations were enacted on 1 September 1994, and apply to projects that could have a significant environmental impact (incorporating the requirements of Directive 85/337/EEC), including projects with transboundary impacts, and to policies, plans and programmes, prepared by authorities, that could have a significant environmental impact. Acts on the use and protection of land and the environment have been amended to reflect the EIA Act (Ympäristöministeriö, 1994b).

Indirect Impacts, Impact Interactions and Cumulative Impacts
The Finnish legislation makes reference to indirect impacts and impact interactions. Cumulative impacts are also referred to in section 4 of the EIA Act as one of the criteria to be considered in determining the need for an EIA ("taking into account the combined impacts of different projects"). There are as yet no detailed government guidelines with legal status. However, the Ministry of Environment has issued general guidance, and sectoral authorities have issued their own guidance. A guide on social impacts has also been produced, dealing extensively with the type of impacts that are indirect or follow from impact interactions. Practice shows that indirect impacts, impact interactions and cumulative impacts are seldom addressed in great detail (Hildèn, 1997).

Strategic Environmental Assessment

Environmental assessment of policies was introduced in 1990 for all State action plans and economic strategies prepared by the various administrative authorities, and for all preparatory work done in committees before legislation is drafted. In addition, directives for the drafting of legislation are required to include assessments of the environmental impact of proposed actions (ECE, 1992).

The 1994 EIA law introduced a requirement for environmental assessment of policies, plans and programmes. In the case of land use planning, the implication of the 1994 EIA law is that all levels of land use plans are subject to an environmental assessment. The Planning and Building Act states that environmental impacts, socio-economic, social, cultural and other impacts must be adequately assessed in the plan making process. The extent and detail of the assessment depends on the level of the plan. Mitigation measures can be incorporated in the regulations that accompany each land use plan. Where environmental impacts are expected to be significant, the EIS should be incorporated into the plan (Ympäristöministeriö, 1994a).

3.6 France

Issue	National Legal Requirement
EIA	Legislation introduced in 1976
- Indirect Impacts	Yes (required since 1993)
- Impact Interactions	Not directly
- Cumulative Impacts	Not directly
SEA	Required since 1977 for urban development plans, and since 1990 for certain Parliament reports. A simplified version of SEA required since 1992 for major state transport infrastructure programmes, and since 1993 for certain other programmes

EIA Legislation

Rules and procedures for EIA were implemented in France in 1976 and 1977 through legislation on nature protection. These made environmental impact assessment compulsory from 1 January 1978 for construction works and development projects initiated by public authorities or private developers where these could affect the environment. Two different assessments were defined, one at project level and one for planning documents. The law established that land use plans are required to contain an environmental study, but this does not amount to an EIA (CEC, 1993).

In France, the scope of EIA for projects is broader than the one established by Directive 85/337/EEC. Hence, it is applied to a larger number of projects, including urban development plans (zone d'aménagement concerté). The EIA for urban development plans is of equal quality to that of other projects (Lafont, 1993).

The law for the protection of nature establishes a two-level procedure, depending on the degree of impact of the project. The higher level is a full EIA and the lower level is a simplified procedure called a "notice d'impact". The notice d'impact must however, comply with all the requirements of the law, particularly with regard to its content (CEC, 1993). A decree of 25 February 1993 introduced a simplified assessment for programs, when projects are part of a programme in certain ways. These are cases where the program is implemented step by step over a long time (such as transportation programmes, river management programmes etc.), and where different individual actions are implemented in a defined geographic area (such as parkways and residential/tourist buildings, mining operations, motorways, roads and railways etc.) (Lafont, 1993).

Indirect Impacts, Impact Interactions and Cumulative Impacts
The French legislation makes reference to indirect impacts, but not explicitly to impact interactions or cumulative impacts. However, the Circulaire of implementation of the Decree of 25 February 1993 makes reference to cumulative impacts concerning the working programme (Circulaire 27 September 1993, par. 3.2 and 3.3.3.) (Turlin, 1997). There are no government guidelines for addressing the consideration of these impact types. There is also no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice.

Strategic Environmental Assessment
Physical planning procedures for master plans (schéma directeur) and zoning plans (plan d'occupation des sols) are subject to environmental assessment (Lafont, 1993). They must include an environmental study as part of the report that presents a plan for the use of an area at the communal level. An environmental study is also required when a plan is revised (ECE, 1992). Since 16 May 1990, reports prepared by Parliament for a project or bill likely to have an impact on the environment has to include an annex with an ecological balance describing the impact of the proposed legislation on the environment, natural resources and energy consumption (ECE, 1992).

3.7 Germany

Issue	National Legal Requirement
EIA	Legislation introduced in 1990.
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Yes
SEA	Required since 1975 for public measures of the federal government, and since 1990 for specific local land development plans

EIA Legislation

Germany's first environmental programme of 1971 contained the main principles of EIA. A cabinet resolution from 1975 introduced "Principles for the assessment of the environmental impact of public measures of the federal government" (Wagner, 1993). Similar resolutions have also been adopted by some Länder, for example Bavaria, Berlin and Saarland (ECE, 1992). Environmental considerations form an important part of the German planning process. However, it took Germany five years to enact the EC 85/337/EEC Directive. The German EIA Act was adopted on 12 February 1990. EIA is mandatory for some 40 projects listed in Directive 85/337/EEC. Furthermore, EIA is compulsory not only for the final authorisation procedure for projects, but also in the context of so called preceding procedures (vorgelagerte Verfahren), i.e. certain planning procedures (Bunge, 1993).

Indirect Impacts, Impact Interactions and Cumulative Impacts

The German legislation makes reference to indirect impacts, impact interactions and cumulative impacts. The German Federal Government have adopted a General Administrative Guideline to ensure the translation of Article 3 of Directive 85/337/EEC into German law. The guideline divides the concept of interaction into two sub-groups; problem shifting, and overall burden on the environment. General evaluation criteria and principles for evaluation are provided for both sub-groups. Practice shows that indirect impacts, impact interactions and cumulative impacts are seldom addressed in great detail. This is illustrated by a study undertaken by UVP-Förderverein in which 150 German EIS were analysed. Only about 50 mentioned the term 'interaction', and only about 10 treated the issue thoroughly (Wagner, 1997).

Strategic Environmental Assessment

The 1979 Rheinland-pfälzisches Act on Nature Conservation introduced the first requirement for regional plans to be environmentally compatible. This includes a requirement for EIA (Hübler, 1992). In addition, the 1990 EIA Act expanded the EIA requirement beyond Directive 85/337/EEC to include a mandatory environmental assessment for specific local land development plans (bebauungsplan) which may provide the basis for decisions on the approval of projects that are listed in the Act. The Federal Building Code and supplementary rules issued by some 150 cities and towns, set out the requirements for environmental assessment of local development plans (Bunge, 1993).

The Federal Nature Protection Act includes a requirement for landscape planning as the legal basis for the protection, management and development of the landscape (ecosystem, natural resources, plant and animal species, landscape and nature). This is, among other things, concerned with impact interactions and cumulative impacts, and provides evaluation guidelines for the environmental impacts and compatibility of projects and measures. The potential for the landscape planning instrument to form an essential part of the environmental assessment of plans and programmes has been recognised (Federal Minister for Environment, Nature Protection and Nuclear Safety, 1994).

Many municipalities have introduced procedures for ensuring that environmental considerations are considered in the planning process (Kommunale Umweltverträglichkeitsprüfung) (Glaser, 1994).

3.8 Greece

Issue	National Legal Requirement
EIA	Legislation introduced in 1990
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	No
SEA	No statutory requirement

EIA Legislation

Environmental assessment has traditionally been applied to public works and activities within Greek politics in order to prevent environmental pollution and degradation. A number of laws therefore include requirements for environmental assessment (ECE, 1992). Article 45 of the Constitutional Law 998/1979 introduced EIS requirements for the protection of forests and forested land, mining and quarrying activities, tourist developments and athletic infrastructures. The EIS specification was drafted by ministerial decision, and several hundred EISs were prepared before Directive 85/337/EEC became part of Greek legislation in 1990 (Psaltaki, 1997).

The legal framework for EIA was created in 1986 when the Law for the Protection of the Environment was passed. This law established a system of environmental licensing requiring EIA of new, or major modifications to, projects and activities that might significantly affect the quality of the environment (CEC, 1993). However, this law was not implemented until October 1990 when Directive 85/337/EEC for "environmental impact assessment of public and private works" was formally incorporated into Greek legislation through two Ministerial Decisions.

The law provides for the protection of the environment from all kinds of human activities. Since the 1990 EIA legislation, all proposed projects are subject to EIA and approval by the Ministry for the Environment, Physical Planning and Public Works. The first Ministerial Decision (69269/5387/25-10-90) classifies public and private projects and activities in categories, defines the level of EIA required, the content of EIS and the approval process for each type of project. The second Ministerial Decision (75308/ 5512/26-10-90) defines the ways in which the public is informed of the content of the EIS (ECE, 1992).

Indirect Impacts, Impact Interactions and Cumulative Impacts

The Greek legislation makes reference to indirect impacts and impact interactions, but not to cumulative impacts (Psaltaki, 1997). There are no government guidelines for addressing the above impact types.

There is also no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice.

Strategic Environmental Assessment

There is no requirement for environmental assessment of plans, policies and programmes (ECE, 1992).

3.9 Ireland

Issue	National Legal Requirement
EIA	Legislation introduced in 1990
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Yes
SEA	No statutory requirement

EIA Legislation
The first Irish EIA regulations were introduced in 1976. They applied only to projects costing over £5 million, where the project was polluting or likely to cause pollution. Directive 85/337/EEC was put into effect in Irish domestic law through 12 different regulations between 1988 and 1990. The regulations may be grouped under three headings as follows: regulations relating to motorways; principal regulations relating to private and public projects; and other regulations (Glasson et al, 1994).

The main enabling measure is the European Communities (Environmental Impact Assessment) Regulations, 1989. These regulations amend a number of Acts to make provision for EIA in relation to relevant projects requiring planning permission (nearly 90 % of all EIA projects) and a relatively small number of other projects which require Ministerial consent such as local authority works, fisheries, foreshore development, arterial drainage, some gas pipelines and petroleum development. Separate regulations have been made in relation to the different consent mechanisms involved but the Local Government (Planning and Development) Regulations, 1994 (and later amendments) are by far the most important of these regulations accounting for about 95 % of all EIA projects (Brangan, 1997).

Indirect Impacts, Impact Interactions and Cumulative Impacts
The Irish legislation includes reference to indirect impacts, impact interactions and cumulative impacts. However, there are as yet no detailed government guidelines for addressing the above impact types, although the EPA has issued draft guidelines (1995) and Advice Notes on Current Practice (in the preparation of EISs), both of which refer to indirect impacts, impact interactions and cumulative impacts (Brangan, 1997). There is considerable variation in the range and quality of information considered in Irish EISs. Where impact interactions are included they are usually discussed under individual topic headings rather than as a separate "interactions" section (Crowley, 1997). There is no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice.

Strategic Environmental Assessment

There are no formal requirements or procedures in place under which the environmental impacts of plans, policies and programmes are assessed. However, it is quite common for plans prepared in Ireland to address in a general manner, the environmental implications of actions proposed. An Environmental Action Programme published in 1990 provides a certain degree of integration of environmental issues into planning. In addition, there are some planning authorities who have applied experimental environmental assessment in various forms to plans (McCarthy, 1994). Finally, in a recently published strategy document the Department of the Environment states that "Government will bring forward proposals, within three years, to develop a strategic environmental impact assessment (SEA) system for major plans and programmes, in addition to supporting EU proposals for SEA of land use plans and programmes" (Department of the Environment, 1997).

3.10 Italy

Issue	National Legal Requirement
EIA	Legislation introduced in 1986. Expansion of regulations in 1992 and 1996.
- Indirect Impacts	No
- Impact Interactions	No
- Cumulative Impacts	No
SEA	No statutory requirement.

EIA Legislation
Directive 85/337/EEC on environmental assessment of certain public and private works was partly implemented in July 1986 through Law n. 346. Two Prime Ministerial Decrees on EIA were given in 1988. This legislation incorporated the requirements of Annex I of Directive 85/337/EEC, and included regulations for the preparation of environmental impact statements and for deciding on environmental compatibility (Glasson et al, 1994).

Between 1990 and 1992, the Italian Parliament approved eleven legislative acts which extended the EIA provisions to other projects of national interest, and co-operative infrastructure projects in developing countries. Some of these projects are not contained in Annex II of Directive 85/337/EEC (EIA Centre, 1996).

In 1996 a further decree was passed, which represented a significant development in Italian legislation as it regulates the application of Annex II of Directive 85/337/EEC to be applied directly by regional authorities. The implementation of this decree was expected by January 1997, with the adoption of regional legislation. However, by August 1997 no corresponding regional acts had yet been adopted (Berrini, 1997).

Some regions enacted their own EIA legislation before the 1996 decree was passed, for example the regions of Veneto, Valle D'Aosta, Abruzzo, Friuli, Venezia, Giulia and Trento, Toscana, Liguria, Bolzano, Basilicata. As these regions acted before the national legislation was passed in 1996, some details of these regional acts are different from the national legislation.

Indirect Impacts, Impact Interactions and Cumulative Impacts
The Italian legislation does not include reference to indirect impacts, impact interactions and cumulative impacts (Berrini, 1997). There are no government guidelines for addressing the above impact types. There is also no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice.

Strategic Environmental Assessment
There is currently no formal requirement for environmental assessment of policies, plans and programmes.

3.11 Luxembourg

Issue	National Legal Requirement
EIA	Legislation introduced in 1967, expanded in 1982, and 1990, and 1994 but does not implement Directive 85/337/EEC
- Indirect Impacts	No
- Impact Interactions	No
- Cumulative Impacts	No
SEA	No statutory requirement

EIA Legislation

Until 1994 environmental impact assessments were carried out in Luxembourg under the 1967 law on the creation of a communication network, the 1982 law on the protection/conservation of nature and natural resources, and the 1990 law concerning the control of dangerous, dirty or noxious installations. These laws essentially introduced a requirement for impact studies in order to assess the influence of certain developments on the environment (Glasson et al, 1994).

The 1967 law establishes that every road building project is subject to an assessment, stating the possible effects on the human and natural environment. The law does not specify the content for the assessment or public participation procedures.

The 1982 law establishes that all proposed developments outside built up areas which are likely to cause damage to the environment, owing to their size or effect on the natural environment, can be made subject to an impact study. This law does not specify the content for the assessment or public participation procedures. The Ministry of Territorial Planning and the Environment is the competent authority to decide the necessity of an EIA.

The 1990 law specifies that an assessment of the possible effects on the environment may be required for all industrial, craft or commercial establishments/projects, whether public or private, and all manufacturing installations or processes, whose existence, operation or bringing into service could result in danger or inconvenience, especially to the environment. The Ministry of Territorial Planning and the Environment is the competent authority to decide the necessity of an EIA (CEC, 1993).

Directive 85/337/EEC as such was not implemented until 1994, when the Grand-Ducal Regulation of 4 March 1994 on the assessment of the effects of certain public and private projects on the environment was implemented. This literally implemented the provisions of Directive 85/337/EEC relating to Annex I projects, EIA content and transboundary co-operation (EIA Centre, 1996).

Indirect Impacts, Impact Interactions and Cumulative Impacts

The Luxembourg legislation does not include reference to indirect impacts, impact interactions and cumulative impacts. There are no government guidelines for addressing the above impact types. There is also no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice (Feltgen, 1997).

Strategic Environmental Assessment

There is no formal requirement for environmental assessment of policies, plans and programmes.

3.12 Netherlands

Issue	National Legal Requirement
EIA	Legislation introduced in 1987
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Yes
SEA	Required since 1987 for certain land use plans, national policy plans, and key national planning decisions that establish the location of activities that come under the EIA ruling

EIA Legislation

The Environmental Protection Act of 1986 introduced requirements for project and strategic EIA. The Environmental Impact Assessment Decree implementing the Act came into effect on 1 September 1987. The Decree incorporated the main requirements of Directive 85/337/EEC, and it contained a comprehensive schedule of criteria to determine where an environmental assessment is necessary (Environmental Protection Act Evaluation Committee, 1990). The Notification of Intent Environmental Impact Assessment Decree 1987 designated the requirements and contents of the notification of intent. The Dutch EIA legislation was revised in 1992 (Environmental Impact Assessment Decree), 1993 (Notification of Intent Environmental Impact Assessment Decree) and 1994 (Environmental Protection Act and Environmental Impact Assessment Decree) to remedy deficiencies in compliance with Directive 85/337/EEC, most notably by extending the scope to include the remaining part of Annex II and implementing the Espoo Convention.

Indirect Impacts, Impact Interactions and Cumulative Impacts

The Dutch legislation makes reference to indirect impacts, impact interactions and cumulative impacts. The Explanatory Memorandum that accompanied the introduction of the EIA Act requires, among other things, that indirect impacts, secondary impacts, the consequences of cumulation of impacts, and synergistic impacts must be described in the EIS. These types of impact are also included in the guidelines prepared in collaboration between the EIA Commission and the competent authority. However, remarks are often rather global and do not seem to have a significance in the review stage. In certain cases, remarks about these types of impact are more specific (especially if methods are available to predict certain interactions) and then they do play a role during the review stage (Scholten and van Eck, 1997).

Strategic Environmental Assessment

The 1987 Environmental Impact Assessment Decree requires that certain plans related to land development, expansion of the infrastructure for water supply, exploration and production of oil and gas on the continental shelf, disposal of domestic refuse, and production of electricity are subject to an obligatory environmental assessment report when preparing a decision (ECE, 1992). Key planning decisions at national level that establish the location of activities which come under the compulsory EIA ruling also require EIAs (Ministry of Housing, Physical Planning and the Environment, undated). In addition, a number of national policy plans require EIA. These are the structure plans for civil aviation sites, rural planning, drinking and industrial water supply and power supply (Ministry of Housing, Physical Planning and the Environment, 1991). However, other policies and plans at a national level are seen to be too general for a constructive environmental assessment procedure. These are instead influenced by the National Environmental Policy Plan (NEPP) (Cerny and Sheate, 1992).

Furthermore, the Dutch government has initiated experiments with environmental tests for certain decisions at national level (Scholten and van Eck, 1997). This is intended for policy proposals which are not EIA-mandatory (van der Lee, 1993).

3.13 Portugal

Issue	National Legal Requirement
EIA	Legislation introduced 1987, extended 1990/1991/1992/1996
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Yes
SEA	No statutory requirement

EIA Legislation

The Portuguese Environmental Act 1987 includes environmental assessment requirements, under which some environmental impact assessments were undertaken during 1987-88. The Act did not provide details as to content and procedure for the environmental assessment. Separate provision was also made for EIA studies of forest projects (CEC, 1993).

Directive 85/337/EEC was implemented in 1990 for Annex I projects (Glasson et al, 1994) through Decree Law No. 186/90 and Decree Regulation No. 38/90 on the EIA Process. These formally implemented most of the articles of Directive 85/337/EEC. The requirements were further extended in 1991 through Decree Law No. 109/91 and Decree Regulation No. 10/91 on Licensing Procedures for Industrial Activity, and Decree Law No. 258/92 on EIA of Large Commercial Developments. Finally, Despachos 78/MA/96 and 79/MA/96 were published by the Minister for the Environment in September 1996. These latter require developers to submit more than one copy of the EIA report and define some of the roles to be undertaken by the National Institute of Environmental Development (EIA Centre, 1996).

Indirect Impacts, Impact interactions and Cumulative Impacts

The Portuguese legislation makes reference to indirect impacts, impact interactions and cumulative impacts (de Lourdes Poeira, 1997). There are no government guidelines for addressing the above impact types, nor is there any evidence of comprehensive consideration of them in practice.

Strategic Environmental Assessment

There is no formal requirement for environmental assessment of policies, plans and programmes.

3.14 Spain

Issue	National Legal Requirement
EIA	Legislation introduced in 1988.
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Yes
SEA	No statutory requirement at national level. Some autonomous regions have made statutory provisions for SEA in sectors including land use planning, waste management, agriculture, transport, industry, energy, forestry, nature conservation, mineral resource management and infrastructure.

EIA Legislation

A Decree on environmental impact assessment applying parts of Directive 85/337/EEC has been in force since 30 September 1988. This sets out the procedure to implement a legislative decree from 1986. The 1988 Act on Highways, and the 1989 Act on conservation of natural areas and wildlife also include EIA regulations. All these pieces of legislation apply to all Annex I projects, but only some Annex II projects (Herranz, 1997).

Several regions have also introduced their own EIA legislation, which in some cases applies to all or almost all Annex II projects (Glasson et al, 1994). EIA provisions at the regional level have been instituted by regions including Andalucia, Aragón, Asturias, Baleares, Cantabria, Castilla y León, Cataluña, Extremadura, Galicia, Islas Canarias, Madrid, Navarra, Pais Vasco and Valencia. Of these Madrid, Canarias, Baleares, Cantabria and Valencia have included all or nearly all Annex II projects, although they are subject to a simplified EIA procedure (CEC, 1993).

Indirect Impacts, Impact Interactions and Cumulative Impacts

The Spanish legislation makes reference to indirect impacts, impact interactions and cumulative impacts. However, there are no government guidelines for addressing the above impact types. There is also no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice.

Strategic Environmental Assessment

At national level there are no formal requirements for environmental assessment of policies, plans and programmes, although a clear need for EIA at a higher and more strategic level of planning has been identified (EIA Centre, 1992). However, seven of seventeen autonomous regions have made statutory provisions for SEA in sectors including land use planning, waste management, agriculture, transport, industry, energy, forestry, nature conservation, mineral resource management and infrastructure (Lee & Hughes, 1995).

There are plans to introduce SEA at the national government level within the sectors of agriculture, forestry, energy, water resources, industry, transport, tourism, land use planning and coastal development (Lee & Hughes, 1995).

3.15 Sweden

Issue	National Legal Requirement
EIA	Legislation introduced in 1991.
- Indirect Impacts	No
- Impact Interactions	No
- Cumulative Impacts	No
SEA	Required since 1987 for all investment plans prepared by the National Road Administration. Required since 1990 for certain plans and actions related to the Natural Resources Act. Furthermore, required for local municipality energy plans, national and regional road plans and measures taken by the Forestry Board.

EIA Legislation

Since 1987, the National Swedish Road Administration is required to prepare EIAs at all stages of their investment plans, from preliminary projections for road construction to specific road construction projects (Nordisk Ministerråd, 1993). Sweden became a member of the European Union in 1995, but Directive 85/337/EEC was considered implemented already by legislation from 1991. On 1 July 1991 requirements for project-EIA were incorporated into the National Resources Act (NRA). The NRA is an umbrella act, in that its rules and regulations of the use of land and water areas are applied in decisions in different permission laws that are connected to the NRA (Lerman, 1994b). EIA is also required through the NRA-connected laws, including the acts on Planning and Building, Water, Environment Protection, Nature Conservation, Peat, Road, Electricity, Pipelines, Aviation, Minerals, Channels, and Continental Shelf. For example, the Planning and Building Act requires that land use plans which have potentially significant environmental impacts should be based on a programme including an EIA (Lerman, 1994a).

Indirect Impacts, Impact Interactions and Cumulative Impacts

The Swedish legislation does not include reference to indirect impacts, impact interactions and cumulative impacts. There are no government guidelines for addressing the above impact types, although non-binding guidance has been prepared by the National Boards. There is no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice (Lerman, 1997).

Strategic Environmental Assessment

There is no comprehensive legal requirement for environmental assessment of all policies, plans and programmes. There is a general demand though, for an overall impact assessment, including SEA, for the municipal-wide comprehensive plan (master plans). Furthermore, some municipalities have also chosen to interpret the regulation in the NRA that "Land, water and the physical environment in general shall be used so as to promote positive long-term management from an ecological, social and socio-economic point of view (The Natural Resources Act, article 1)" as an indirect requirement for environmental assessment. The interconnection between the NRA and the Planning and Building Act, as well as the generally widespread environmental awareness and involvement in municipality-based environmental protection programmes ("eco-municipalities" etc.), has resulted in a number of municipalities (about 1/3) voluntarily adopting policies and programmes requiring environmental assessment in the planning process.

Due to the current voluntary nature of strategic environmental assessment, there are no national guidelines as to how the assessment should be undertaken etc. Each municipality has developed and adopted their own methods and guidelines for the practical undertaking of environmental assessment.

3.16 United Kingdom

Issue	National Legal Requirement
EIA	Legislation introduced in 1988
- Indirect Impacts	Yes
- Impact Interactions	Yes
- Cumulative Impacts	Yes
SEA	No statutory requirement

EIA Legislation

Directive 85/337/EEC is implemented in the UK through seventeen different regulations, plus a number of amending regulations and associated measures. These came into effect between 1988 - 1992 and relate to all Annex I projects and those Annex II projects expected to have significant environmental impacts. The majority of the project categories listed in Annex I, and of the project categories and sub-categories listed in Annex II, are covered under the planning regulations. However, certain project classes, and project categories and sub-categories, are covered by other regulations (e.g. afforestation, major roads) (CEC, 1993).

With a few minor exceptions, the UK EIA legislation implements Directive 85/337/EEC comprehensively. Furthermore, the Planning and Compensation Act 1991 allows for the extension of EIA to projects other than those listed in the Directive where those projects require planning permission. The competent authority or the Secretary of State determines whether EIA is required on a case-by-case basis (CEC, 1993).

In 1994, the government used these powers to add privately financed toll roads to the list of projects requiring EIA in every case. The following projects were added to the list for which EIA is required where the proposed development is likely to have significant effects on the environment: windfarms, coast protection works and motorway service areas (EIA Centre, 1996).

Indirect Impacts, Impact Interactions and Cumulative Impacts

The UK legislation makes reference to indirect impacts, impact interactions and cumulative impacts. However, there are no government guidelines on how to address these types of impacts. A study conducted in 1991 found, among other things, that the consideration of indirect and cumulative impacts often appears to be incomplete (Jones, Lee and Wood, 1991). There is no evidence of comprehensive consideration of indirect impacts, impact interactions and cumulative impacts in practice.

Strategic Environmental Assessment

At national level, there is no statutory requirement to undertake environmental assessments of policies, plans and programmes. However, the Department of the Environment published a non-mandatory guidebook on Policy Appraisal and the Environment in 1991. This was aimed at assisting civil servants in considering environmental impacts of their decisions (Glasson et al, 1994). At the local level, local authorities are encouraged to undertake environmental appraisals of their plans. Planning Policy Guidance Note 12 (DoE, 1992) defines an environmental appraisal as the process of identifying, quantifying, weighing up and reporting on the environmental and other costs and benefits of the measures which are proposed. An environmental impact statement like the type needed for projects is not required, but an explanatory memorandum or reasoned justification should be prepared for development plans. Local authorities are referred to the DoE guidebook mentioned above (DoE, 1991) and to the good practice guide "Environmental Appraisal of Development Plans" (DoE, 1993) for guidance on how to consider environmental impacts in land use planning.

3.17 Summary of Available Guidance

During the course of the study, only 3 Member States were identified as having any official environmental assessment guidance concerning cumulative impacts, indirect impacts and/or impact interactions, Germany, the Netherlands and the United Kingdom. As Germany and the United Kingdom were the subject of case study reviews as part of this project, the guidance available in these countries was investigated in greater detail.

Two German guidance documents were identified during the course of the study, published by Ministry of the Environment of Schleswig-Holstein ("Wechselwirkungen" in der Umweltverträglichkeitsprüfung) and the Research Society for Road and Traffic 1997 (Die Berücksichtigung von Wechselwirkungen in Umweltverträglichkeitsstudien zu Bundesfernstraßen). Three documents were identified from the UK offering guidance, one from the UK Department of the Environment concerning general good practice in the undertaking of EIAs 1995 (or Environmental Assessment as it is termed in the UK). The second document is aimed at Best Practicable Environmental Option (BPEO) 1997 Assessments undertaken under UK environmental legislation. Finally, the UK Department of Transport Design Manual for Roads and Bridges, 1993 Volume 11 is specific to EIA. Some of the guidance in this document can be applied to the assessment of indirect and cumulative impacts as well as impact interactions.

The lack of available guidance on the assessment of cumulative impacts in other Member States involved in this study was confirmed by the results of Questionnaire 1, in which no available guidance was identified from Finland, Greece or Portugal.

3.17.1 MINISTRY OF THE ENVIRONMENT OF SCHLESWIG-HOLSTEIN

This document deals with the definition and approach to the assessment of impact interactions in the EIA-process. The information contained within the guidance document is, however, general in nature. The approaches to the assessment of impact interactions described in the document are:

1. Project-Environment-Matrix
2. Inter-relationships
3. Secondary impacts and impact translation
4. Pollution pathways
5. Impact on the entire eco-system as a impact structure
6. Impact interaction between emissions (Ozone depletion)
7. Conflicts between environmental requirements
8. Synergistic, antagonistic and multiple impacts

The document also includes a framework for the integration of EIA into the German planning regime. Finally it offers a view on where developments should go in the future and proposes the development of a database to log all experiences of impact interactions in specific landscape units.

3.17.2 *THE RESEARCH SOCIETY FOR ROAD AND TRAFFIC*

This document was written by Sporbeck *et al.* (1997), some of the concepts described in the document are discussed in section 5.1.8. It is a comprehensive document, which considers impact interactions in terms of the legal framework and the approaches that can be developed from research in landscape ecology and eco-systems. The guideline goes on to describe recent approaches in the context of the planning regime and defines impact interactions.

Eco-systematic impact interactions relevant to the planning regime are then developed and a methodology proposed for the consideration of impact interactions. This methodology is outlined in section 5.1.8 of this report.

Sporbeck's document suggests that the preferred approach to undertaking the assessment of impact interactions at the regional level should be through SEA rather than project EIA:

> *A particular aspect of ecosystematic impact interactions is regional impact from air emissions that transgress ecosystems. E.g. the design of a road could by-pass a specific habitat but would still contribute to the regional nitrogen emissions that could have a significant if not destructive impact on said habitat. This type of regional impact could not be detected by carrying out project specific EIAs. That is why it is necessary to consider ecological assessments for whole traffic concepts that include all contributing parties as suggested by the Strategic EIA.*

3.17.3 *UK DEPARTMENT OF THE ENVIRONMENT GOOD PRACTICE GUIDE*

The UK Department of the Environment's 1995 publication, *The Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: A Good Practice Guide* highlights that indirect impacts are required to be assessed through an EIA and that,

> *"Analysis of pathways may lead to the identification of successive changes that may be described as 1st, 2nd or 3rd order impacts."*

Unfortunately, the guide provides no details as to how this assessment should be undertaken. Further general advice given in the guide reminds practitioners that, *"In considering the nature of impact it will be necessary to assess whether the effects will be: direct or indirect; short, medium or long term; reversible or irreversible; beneficial or adverse; or, cumulative."*

3.17.4 *UK ENVIRONMENT AGENCY TECHNICAL GUIDANCE NOTE E1*

The UK Environment Agency's recent publication (1997), entitled *Best Practicable Environmental Option Assessments for Integrated Pollution Control*, sets out a quantitative methodology primarily designed to identify the Best Practicable Environmental Option (BPEO) for an industrial process in order to minimise environmental pollution. Assessments are generally conducted for processes that release substances to multiple environmental media: air, water and/or land.

The methodology claims to represent a first step in an evolving approach in the UK to environmental assessment of Integrated Pollution Control (IPC) processes (see Volume 2):

"The methodology may also be used by developers submitting Environmental [Impact] Statements to a Planning Authority ... its use is only appropriate to that part of the EIS which addresses the releases from the process as described"

The guidance recognises that an key element of the BPEO assessment is the evaluation of emission impacts on the environment as a whole and that such evaluation is extremely complex, dependent on a large number of factors including:

- the amount of each substance released;
- the rate of release of each substance;
- other release characteristics, such as release location, release velocity, concentration of substance in the release material, temperature of release material and so forth;
- the physical properties of the released substance, such as physical form or particle size;
- the chemical properties of the released substance;
- the nature of the receiving medium, particularly and its dispersion and transfer characteristics and how these vary with time;
- ambient concentrations of released substances already in the environment;
- the locations of receptors in the environment that are sensitive to the released substances; and,
- the degree of sensitivity of these receptors to enhanced concentrations of released substances.

The method for demonstrating the overall effects of emissions in water, air and land is undertaken by calculating an Integrated Environmental Index (IEI), which can be represented by the following equation:

$$IEI = EQ_{(air)} + EQ_{(water)} + EQ_{(land)}$$

where $EQ_{(Medium)}$ (Environmental Quotient) is the sum of the $EQ_{(Substance)}$ released to a particular medium and is represented by the following equation:

$$EQ_{(Medium)} = EQ_{(a)} + EQ_{(b)} \ldots + EQ_{(i)}$$

where a, b ... i are substances released to a particular medium. $EQ_{(Substances)}$ can be calculated by the following equation:

$$EQ_{(Substances)} = \frac{PC}{EAL}$$

where Process Contribution (PC) is the concentration of a substance, at the location in the environment where that concentration will be at its greatest, which can be attributed to releases from the process being considered. For example, for releases to air it would be at the location of maximum ground concentration, and for releases to water it would be after the mixing zone. The EAL (Environmental Assessment Level) can be defined as the concentration of a substance which, in a particular environmental medium, the Environment Agency regards as a comparator value, enabling a comparison to be made between the environmental effects of different substances in that medium and between environmental effects in different media, and to enable a summation of those effects. Where there exists an environmental quality standard for a polluting substance, the EAL will be equivalent to the quality standard.

In recognising the complexities involved in assessing the effects on the environment from multiple source emissions, the methodology developed by the UK Environment Agency has been simplified but designed to provide robust indicators of relative environmental impact between different processes. The methodology presented is based on three assumptions:

1. effects are linearly proportional to the concentration of a substance in the environmental medium into which they are released;
2. that the Environmental Assessment Levels (EALs) correspond to identical levels of effect for all substances and all media; and,
3. there are no synergistic or antagonistic effects between substances.

Although simplistic the UK Environment Agency's approach appears to be a first attempt to quantify the assessment of cumulative environmental impacts.

3.17.5 *UK DESIGN MANUAL FOR ROADS AND BRIDGES: VOLUME 11, ENVIRONMENTAL ASSESSMENT*

The Design Manual for Roads and Bridges (DMRB), first issued in 1993 by the UK Department of Transport, is a comprehensive set of documents providing guidance to consultants and contractors undertaking road building or improvement works to trunk roads and motorways within the UK. Volume 11 of the DMRB relates specifically to EIA, or Environmental Assessment as it is termed in the UK, and provides detailed advice on how to undertake an EIA for a road scheme based on the requirements of the EIA Directive and its implementing regulations in the UK.

The DMRB provides guidance on the level of EIA required at the key stages in the development of a trunk road scheme and the requirements for reporting the effects on the environment. Each stage becomes more in-depth than the previous stage. However, progression from stage to stage is not automatic and the Overseeing Department, the Government Agency or Department responsible for the scheme, may stop the development project after the completion of stages 1 and 2. The key stages are identified as follows:

Stage 1 - Sufficient assessment to identify the environmental advantages, disadvantages and constraints associated with broadly defined route corridors of the road scheme.

Stage 2 - Sufficient assessment to identify the factors and effects to be taken into account in choosing the route options and to identify the environmental advantages, disadvantages and constraints associated with those routes.

Stage 3 - Prior to the publication of an EIS - an assessment in accordance with the requirements of section 105A of the Highways Act 1980 (England and Wales) or Sections 20A and 55A of the Roads (Scotland) Act 1984, or in Northern Ireland Article 39B of the Roads (Northern Ireland) Order 1980, implementing EC Directive 85/337.

The DMRB recognises that impacts may be cumulative, indirect and interact. In the introduction to Volume 11, the DMRB states:

> *"In some cases assessment may need to cover the combined and cumulative impacts of several schemes. Consideration of longer routes or a number of related schemes together can give a clearer sense of the impacts of the proposal seen as a whole and may allow better choice of alignment and design in both environmental and traffic terms."*

The DMRB goes on to explain that this style of joint consideration of schemes will,

> *"...also help to ensure that schemes which should be assessed together at later stages, because of the interaction of their environmental effects, are not considered in isolation."*

The DMRB considers this approach to be strategic in nature. The discretion for undertaking this strategic assessment of the road scheme(s) is placed with the Design Organisation, the organisation commissioned to undertake the various stages of the scheme preparation and supervision of construction. However, the scope of any such assessment must be agreed with the Overseeing Department.

The DMRB recommends that the methodology outlined for a Stage 1 assessment is applicable to any "strategic" appraisal. The Stage 1 methodology deals with the EIA of a road scheme on an issue by issue basis. The key points of the stage 1 technique are summarised in table 3.2 below.

The DMRB does however acknowledge that since road schemes are initiated and progressed with different timescales the adoption of such an approach may not be possible in practice. In addition, many of the more local effects of road schemes are specific to precise alignments, and cannot be appraised until the design of the scheme is reasonably detailed.

The assessment and reporting of the overall impacts identified at stage 1 is based on the overlay technique (see Section 2.2), which could perhaps be superseded by GIS techniques given enough resources (see Section 2.6). At stage 1, the first stage of the assessment would be to map all the relevant constraints identified, such as population centres, historic buildings and designated ecological sites. The most important constraints would then be brought together onto a single map along with the possible route corridors. Any other aspects of the environment which could be significantly affected should also be included on the map. An assessment of the potential impacts could then be made from this overlay map.

Table 3.2: Stage 1 Environmental Impact Assessment: Volume 11 of the United Kingdom Design Manual for Roads and Bridges.

Air Quality
- Identify locations with sensitive populations, likely to experience higher than average pollution concentrations and where air quality may be improved.
- Map buildings / areas within 200m where air quality may change.

Cultural Heritage
- Obtain information and map designated archaeological / built heritage sites and other recorded sites.

Disruption due to Construction
- Identify possible disruption due to construction (e.g. close to population centres, need for tunnelling).

Ecology and Nature Conservation
- Obtain details of any designated sites and existing surveys and map the information obtained.

Landscape Effects
- Obtain information on the location and nature of all designated areas of landscape importance.
- Assess existing landscape character and quality and identify any sensitive areas.
- Where a significant landscape effect could occur (e.g. areas of valuable landscape affected) undertake a site visit. Note broad areas of landscape character and quality and significant individual features.
- Map all designated landscape areas, and non-designated areas identified as being of importance.
- Indicate changes in visual impacts, and the potential magnitude of change.

Land Use
- Identify location and status of areas of land used by the public, map areas and assess potential land-take.
- Inspect planning authority plans, policy statements or other documents and map route corridors on a map of land use planning designations.
- Identify the potential land-take from areas which have been designated for future development.
- Assess how local planning authority designations may be affected.
- Use Agricultural Land Classification Maps (ALC) to establish agricultural land quality.
- Obtain information on statutory or non-statutory areas of agricultural importance.

Traffic Noise and Vibration
- Identify roads where traffic changes of plus or minus 25% are expected in the year of opening.
- Obtain information about existing noise nuisance.
- Identify and map areas which are especially sensitive to noise or vibration (e.g. schools).
- Estimate the number of houses within 300m of the existing roads and possible new routes subject to traffic changes of over 25%.

Pedestrians, Cyclists, Equestrians and Community Effects
- Identify and map existing and proposed routes, rights of way and important community facilities used by pedestrians and others which may be affected.
- Assess whether journeys would be lengthened or reduced, whether the amenity value of journeys would change, and whether some people would be deterred from making journeys.

Vehicle Travellers
- If area of outstanding landscape value affected assess the view from the road.
- Assess driver stress for the existing road network and new routes.

Water Quality and Drainage
- Identify and map principal water courses and their classification, floodplains, groundwater protection zones, and any other sensitive areas.

Geology and Soils
- Identify and map designated sites.
- Obtain information on geology of area, agricultural land quality and contaminated land.

Impact of Road Scheme on Policies and Plans
- Obtain copies of relevant development plans.
- Check if any regional planning exists for the area and note any relevant national policies.
- Produce a schedule of relevant policies and assess effect on the achievement of the policy objectives.

Section 4.0: Experience of Indirect and Cumulative Impacts as Well as Impact Interactions Outside the European Union

4.0 EXPERIENCE OF INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS OUTSIDE THE EUROPEAN UNION

Since the implementation by the USA of NEPA in 1969, EIA has become a global institution. Most countries in the developed world and an increasingly large number of less developed countries use some form of EIA. Additionally, the use of EIA is often a prerequisite employed by international funding organisations, such as the World Bank, before money is lent for development and infrastructure programmes.

The assessment of indirect and cumulative impacts as well as impact interactions has been recognised as posing a major problem in terms of the effectiveness of EIA throughout the world. Several countries outside of the European Union have already attempted to address the problems surrounding such impacts through a variety of means. Described below are the measures used by Hong Kong, New Zealand and Australia in an attempt to solve the problem.

4.1 Hong Kong

Environmental Impact Assessment at the project level has been undertaken in Hong Kong since 1974, the assessment of indirect and cumulative impacts as well as impact interactions has been undertaken as part of major development study analysis from 1989 and Strategic Environmental Assessment (SEA) from 1995. In Hong Kong the EIA process has been applied through administrative means, the Environmental Protection Department (EPD) requiring project proponents to submit EIAs through lease conditions on Crown Land. The requirements for EIA and the assessment of indirect and cumulative aspects as well as impact interactions have been incorporated into the administrative process which requires a mutual Environmental Review stage in addition to conventional EIA studies. The assessment of indirect and cumulative impacts as well as impact interactions is undertaken by the EPD on local and regional plans, with these types of impact being identified from individual project level EIAs.

In 1996 Environmental Impact Assessment legislation was introduced in Hong Kong. When fully enacted, all public and private sector projects will be screened against a list of designated projects, EIA undertaken as appropriate and a formal system of monitoring and audit during project implementation brought into effect. It is intended that the formal system of environmental permits for all new projects will ensure that indirect and cumulative impacts as well as impact interactions are identified at an early stage in the planning process.

The assessment of indirect and cumulative impacts as well as impact interactions is undertaken in Hong Kong at three levels: firstly, such impacts are identified through review of project EIAs submitted to the

Hong Kong EPD; Secondly, the EPD undertake an assessment of indirect and cumulative impacts as well as impact interactions of regional proposals e.g. new town developments and regional planning studies; and thirdly, SEA is undertaken at the territory strategic development planning level and includes transboundary considerations. In addition, assessment of these types of impact is undertaken to enable management of impacts resulting from the interaction of complex infrastructure projects where significant impacts of these types have been found to occur particularly during the construction phase.

In Hong Kong, indirect and cumulative impacts and impact interactions of complex and interactive infrastructure projects are identified by EPD during the preliminary study, planning and implementation stages by a focused review at the project level. A manual for the assessment of such effects is available for each project and group of projects providing a framework of check lists and flow charts for assessment of project impacts against environmental management and audit databases for the project group.

Strategic Environmental Planning involves integrating land use, transport and environmental requirements to define long-term and broad-scale development plans and strategies, which are usually conceptual in nature. In the early 1990s a number of strategic planning studies including the Territorial Development Strategy Review were undertaken. A process of integrating environmental factors into the strategy formulation has been adopted to define environmental carrying capacities in broad terms and evaluate environmental implications of development options.

The territorial development strategy, equivalent to a nation-wide development plan, provides a long term land-use-transport-environment framework for Hong Kong up to 2011 to cater for an additional 1 to 1.8 million population in addition to the existing 6.3 million population. As part of the review of the strategy, a SEA study was completed in December 1995, as a means to assess indirect and cumulative impacts as well as impact interactions and regional environmental implications and environmental sustainability. The SEA conducted has a major bearing on Government's thinking and further actions towards development and sustainability in Hong Kong.

The SEA analysed the environmental implications of more than a dozen different alternative development scenarios for different rates and extents of economic and regional development. These scenarios included Hong Kong being the regional pole to serve the nearby Guangdong province in China as well as being the centre to serve a wider part of mainland China.

The SEA was conducted in a systematic, structured process, fully integrated with the formulation and evaluation of alternative development scenarios. The steps taken included:

- a territory-wide environmental baseline environmental study;
- the establishment of environmental principles and criteria for formulation of development scenarios;
- the identification of strategic environmental issues for further assessment. The key issues being environmental carrying capacities of airsheds and water basins, the loss of ecological resources, indirect and cumulative impacts and impact interactions of development scenarios, cross-border environmental implication of sectorial policies;
- the development of suitable models to predict and evaluate indirect and cumulative impacts and impact interactions and environmental carrying capacities; and,
- an environmental sustainability analysis.

The SEA covered two main dimensions: the issues of environmental carrying capacities and sustainability within the Hong Kong context; and the environmental implications of the regional development in mainland China and the regional dimension of sustainability. Using simplified territory-wide models, territory-wide indirect and cumulative impacts as well as impact interactions resulting from economic development and the increase in population for sewage disposal, water quality, noise, air quality, waste disposal and ecology were assessed. Both the bottom-up analysis through impact prediction and the top-down analysis were adopted to conduct the environmental sustainability analysis. A set of indicators for environmental sustainability were employed for evaluating different development scenarios. To overcome the limitations of data and time, the scenarios were also evaluated against the Agenda 21 principles.

The SEA of the Territorial Development Strategy Review concluded that it:

- proved to be a useful, effective tool to address the question of environmental carrying capacities, environmental sustainability, indirect and cumulative impacts and impact interactions and cross-sectorial policy implications;
- moved beyond EIA and conventional SEA into assessment of environmental sustainability;
- was conducted in a systematic, structured process with integration with the strategy formulation;
- has incorporated the environmental sustainability analysis, leading to changes in Government's thinking on sustainability and development;

- was based on a combination of bottom-up and top-down analysis, with a proper study management through an inter-departmental (or agencies) working group;
- avoided environmentally damaging development components and led to further actions and high-level commitments to address environmental sustainability.

4.2 New Zealand

The institutional context for the assessment of indirect and cumulative impacts as well as impact interactions in New Zealand has been strengthened by relatively recent reforms of local government and resource management law (Dixon *et al*, 1995). An important effect of these reforms is that reduced government intervention leads to greater emphasis on regional and local level decision-making regarding resource issues. This has a positive implication for the assessment of indirect and cumulative impacts as well as impact interactions.

4.2.1 REQUIREMENTS OF THE RESOURCE MANAGEMENT ACT

EIA was fully incorporated into planning practice in New Zealand in October 1991, when the new Resource Management Act (RMA) was passed, providing a framework for integrated resource management, of which environmental impact assessment forms a central part. The Fourth Schedule (Assessment of Effects on the Environment) Section 88(6)(b) specifies matters that should be included in an assessment and matters that should be considered when preparing an assessment.

The practice of environmental impact assessment is determined by two definitions in particular: those of the words "environment" and "effects". Environment is defined so as to encompass ecosystems, people and communities. Effects is defined to encompass the following:

1. any positive or adverse effect;
2. any temporary or permanent effect;
3. any past, present and future effect;
4. any cumulative effect that arises over time or in combination with other effects (regardless of the scale, intensity, duration, or frequency of the effect);
5. any potential effect of high probability;
6. any potential effect of low probability that has a high potential impact (Resource Management Act, 1991).

The Act thus provides for cumulative change, over time as well as over space. Furthermore, the Act provides for EIA to be undertaken at two levels which are integrally linked: in policy analysis and plan preparation at regional and local levels; as well as in the assessment of applications for resource consents or permits. This hierarchy between policies and plans on the one hand and projects on the other, ensures that the EIAs are undertaken in a consistent manner, as the policies and objectives in policy statements and plans set the criteria for consideration of applications for resource consents on a day-to-day basis.

4.2.2 *POLICY ANALYSIS AND PLAN PREPARATION*

The Act requires that regional authorities prepare regional policy statements that provide an overview of the main resource management issues and policies to achieve integrated management of natural and physical resources. Within the context of these policy statements, regional plans can be prepared on a range of matters. Similarly, the Act requires district and city councils to prepare district plans in order to assist councils in achieving the objectives of the Act. In the preparation of these policy statements and plans, an environmental assessment must be undertaken of the objectives chosen, and the expectations of those policies must be made clear. The emphasis is on strategic approaches and forward-looking planning. As part of this assessment, there is a requirement to consider indirect and cumulative impacts as well as impact interactions which occur as a result of adopting these policies.

Although the above framework has been enacted in law, it is yet to prove its practical effect. Few regional policy statements prepared under the new Act actually make specific reference to the identification and analysis of such environmental effects. When it comes to the regional plans, most regional authorities and district councils are only now starting to prepare these under the new legislation, so in the meantime resource consent applications are having to be considered in the context of the Act and existing plans prepared under the old legislation. It will therefore be some more years before the effects of the new Resource Management Act become clear and evident in day-to-day practice (Dixon *et al*, 1995).

Applications for resource consents have to be accompanied by an Environmental Impact Assessment. Applications must be made for a wide range of development activities, including permits for use and discharge of water, coastal development, aerial emission of contaminants, vegetation clearance, and land development. In preparing the information for the application, the Fourth Schedule, which outlines "An assessment of effects on the environment", must be referred to. Although not specifically mentioned in this context, indirect and cumulative impacts as well as impact interactions must nevertheless be assessed, as the overarching definition of effects includes the concept of such change.

The new Act signals an attempt to establish a consistent, broad context for sustainable management within which staff in regional authorities and district councils prepare policies and evaluate applications for resource consents. Within such a framework, it should be possible to make site-specific decisions with greater reference to established policies in regional policy statements and regional and district plans. In principle this should allow a more holistic approach towards resource development be achieved. The requirement for regional overviews and integrated approaches to resource management is seen to provide a significant opportunity to incorporate assessment of these types of impacts into environmental planning practice (Dixon *et al*, 1995).

In developing policy statements and plans, staff need to develop an understanding of:

- the interrelationships between natural resource systems;
- community needs;
- existing land-use patterns; and
- projected developments.

It will be necessary to reflect this in the form of integrated policies and objectives. This in turn will require co-operation on an interdisciplinary basis and specific abilities in terms of presenting an overall assessment of the local and regional "state of the environment" before policies and objectives can be articulated. Finally, professionals in city and district councils as well as regional authorities need to develop new methods for evaluating proposals in line with the objectives of the Resource Management Act, drawing on a range of disciplines.

These changes are still relatively new. The trend seems to be that political accountabilities and vested interests often hinder effective co-operation and communication between levels of government (Veart, 1994). The implementation of the objectives of the Resource Management Act will, to a large extent, depend on the willingness and ability of professionals in councils to adapt and engage in new practices of assessment (Dixon *et al*, 1995). Several issues can affect the efforts to do this, including the following:

- boundary problems within and between public agencies;
- organisational structures;
- disciplinary boundaries;
- allocation of functions;
- formal and informal processes for co-ordination and co-operation between agencies, developers, and other interested parties;
- attitudes of the participants.

The experience of New Zealand has shown some reluctance among professionals to address the issue of indirect and cumulative impacts as well as impact interactions in consent applications because defining questions have not yet been dealt with in case law. Another issue which is receiving public attention in New Zealand, is that of the costs of rigorous evaluation of plans and proposals. Developers are complaining about the costs of providing more environmental information. There is no doubt that implementation of the requirements of EIA and the assessment of indirect and cumulative impacts as well as impact interactions is imposing greater costs on both applicants and councils.

4.2.3 *IMPLEMENTATION*

The Ministry for the Environment (1991) has produced guidelines for EIA. Some councils have also produced guidelines on what should be contained in EIAs, but the quality of these guidelines varies considerably. As many applicants, particularly for smaller proposals, prepare their own assessments, there is a great need for further assistance regarding matters which should be addressed. There appears to be a weakness at the local level in how best to scope matters for an EIA. The net result is that applications are accepted on the basis of very poor information or, in the reverse, councils request a disproportionate amount of information. This, however, may be a transitional problem before councils have developed their policies and plans under The Resource Management Act (RMA) (Veart, 1994).

For comprehensive implementation of the Resource Management Act it is important to be clear on whose responsibility it is to assess indirect and cumulative impacts as well as impact interactions. Although there is a requirement that applications prepared for resource consents to incorporate assessment of such impacts, it is questionable whether it is reasonable to expect the applicant to do so, due to lack of both expertise and the baseline information to evaluate the impacts of their proposals in the broader context of district or regional resource management. In New Zealand it is therefore seen as the responsibility of council staff to assess these impacts resulting from proposals in the context of regional and district policies and plans, which in turn must reflect the overall objective of the Act, specifically sustainable management.

4.3 Australia

The Australian Commonwealth established the application of EIA through the 1974 Environmental Protection (Impact of Proposals) Act. The Act seeks to ensure that environmental matters are examined and taken into account in the Commonwealth's decision-making process. In summary the Act and its Administrative procedures set out (CEPA, 1992):

- the types and activities to which the Act applies;
- the powers of the Commonwealth Environment Minister;
- the content of an Environmental Impact Statement (EIS) or Public Environment Report (PER) for proposals of lesser environmental significance;
- arrangements for public participation;
- provisions for recommending provisions to attach to approvals;
- arrangements for holding public inquiries.

The Act applies to the following types of projects:

- activities and projects carried out by Commonwealth departments and authorities;
- grants to state governments for specific programs;
- proposals that require Commonwealth approval to export primary products; and,
- proposals involving foreign investment approval.

It is interesting to note the inclusion of national policy initiatives in the types of proposals that could be the subject of an Environmental Impact Statement (EIS), an attempt to introduce Strategic Environmental Assessment, but which are now omitted from the current Commonwealth Environmental Protection Agency (CEPA) guidelines to the Act. The Act was amended in 1987 to provide for the introduction of PERs, covering proposals of lesser environmental significance. The consideration of "environmentally significant" (screening) is the responsibility of the relevant Action Minister. If significant then the Action Manager is obliged to refer it to CEPA for consideration.

The procedures refer to four levels of assessment involving CEPA with and without the preparation of a PER or EIS, as well as examination by a Commission of Inquiry. Significance criteria are provided by the procedures to justify either a PER or EIS; they also specify the matters to be addressed by such documents as well as providing for consultation with CEPA on their contents.

There is no requirement in the Act or its administrative procedures to take account of indirect and cumulative impacts and impact interactions, to assess these impact types or to carry out SEA. Neither are there any formal provisions for EIA to be carried out within an appropriate regional planning context involving assessment of such impact types or SEA.

Environmental regulation in Australia to date has been accomplished by development control through the exercise of land use zoning constraints, the EIA of specific development proposals and activities, and pollution control activities, performed generally at State level through State Government legislation:

Table 4.1 Summary of State EIA Legislation in Australia

STATE/TERRITORY	LEGISLATION
Victoria	Environmental Effects Act 1978
New South Wales	Environmental Planning and Assessment Act (1979)
South Australia	Development Act 1993
Northern Territory	Environmental Assessment Act 1982
Western Australia	Environmental Protection Act 1986
Queensland	Local Government (Planning and Environment) Act 1990 proposed Development And Environment Act
Australian Capital Territory	Land (Planning and Environment) Act 1991
Tasmania	Land Use Planning and Approvals Act 1993 State Policies and Projects Act 1993

Except for New South Wales, all decisions on the requirement for EIA are taken on a case-by-case basis. The 1979 New South Wales Environmental Planning and Assessment Act provides a link between planning, development and the environment and it provisions are most pertinent to the consideration of the assessment of indirect and cumulative impacts as well as impact interactions and SEA. However, the application of such techniques has so far been limited in the application to date.

In 1994, Court, Wright & Guthrie issued a report on the Assessment of Cumulative Impacts and Strategic Assessment in Environmental Impact Assessment on behalf the Commonwealth Environmental Protection Agency (CEPA). The report investigated how Australia could reach its nationally agreed goal of Ecologically Sustainable Development through the incorporation of assessment of these impact types with SEA. The report offered a number of options for achieving this goal, from total reform of the present system to a minimal change with corresponding diminishing benefits. The options incorporated a complete range of policy, administrative and legal measures as well as resourcing implications for various options.

Since the publication of the 1994 report there has been some progress in the development of assessment for these impact types in Australia. However, the implementation of recommendations from the report have been suspended pending the outcome of a further, more general review of the EIA process in Australia. The Commonwealth government is working co-operatively with the State and Territory governments to review their respective roles and responsibilities in the EIA process. Australia looks likely to try and incorporate assessment of such impacts into SEA procedures with the Environmental Protection Group of Australia (formerly the Commonwealth Environment Protection Agency) currently looking at approaches to SEA implementation (O'Leary, Pers. Com., 1997).

Section 5.0: Methodologies For Environmental Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

5.0 METHODOLOGIES FOR ENVIRONMENTAL ASSESSMENT OF INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS

This section discusses the various methodologies that have been developed and identified in the relevant literature for undertaking assessments of indirect and cumulative impacts as well as impact interactions.

5.1 Available Methodologies

To date practitioners and researchers have published few methodological approaches to the assessment of indirect and cumulative effects as well as impact interactions. Those that have been published have generally been designed for individual projects and have limited application. For example, they may not address interactions comprehensively, the number of variables may be limited, or they may not address space or time complexities (Clark, 1994). The problem associated with defining a single methodology is largely due to lack of consensus regarding spatial and temporal boundaries, there is a difficulty in agreeing the geographical boundaries of the study area and how far into the future and into the past it is necessary to look so that these types of effects can be adequately assessed.

Damman *et al* (1995) point out that for the assessment of indirect and cumulative impacts as well as impact interactions to become integrated in environmental impact assessments and other important decision-making processes, such as land use planning, practical methodologies must become available to practitioners. In order to be practical such methodologies must be:

- "Doable" given the available environmental information, time and financial resources;
- Based on available data and applicable impact prediction techniques;
- Related to agency responsibilities for implementing the findings;
- Focused, as on impacts to valued ecosystem components, to allow for adequate attention on the most important environmental features and processes;
- Linked to criteria for assessing the significance of predicted effects;
- Traceable with the ability to identify the relationships between predicted effects and the recommendations for policy, mitigation and monitoring; and,

- Able to lead to conclusions about the most cost-effective approach to impact mitigation and monitoring (Damman *et al*, 1995).

Additionally, Davies (1992) has identified six themes as relevant to the development of a methodology. These themes often reoccur in the published methodologies and are as follows:

1. Defining boundaries;
2. Assessing interactions between the environmental effects of the project;
3. Identifying past projects and activities and their environmental effects;
4. Identifying future projects and activities and potential environmental effects;
5. Assessing interactions between the environmental effects of past projects and future projects and activities; and,
6. Determining the likelihood and significance of the indirect or cumulative impacts or impact interactions.

An outline of some published methodologies is presented below.

5.1.1 INTEGRATING THE ASSESSMENT OF INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS INTO THE EIA PLANNING PROCESS

Lawrence (1994) stresses that it is essential to recognise that the assessment of indirect and cumulative impacts as well as impact interactions is not a stage to be added to the EIA process, but that it is a dynamic EIA approach which facilitates systematic consideration of interactions among project characteristics, environmental components and other activities. The assessment of indirect and cumulative impacts as well as impact interactions must therefore be incorporated into every stage of project-level EIA. The stages of problem definition, goal setting, boundary establishment and alternatives assessment require particular attention. The various methods suggested by Lawrence (1994) for incorporating such a perspective into each stage of the project-level EIA planning process are identified below.

Problem definition

- Place project need and opportunity within the context of systematic environmental problems and opportunities
- Design process to address links to broader planning levels at key decision points
- Use area-wide and programme EIAs to address middle ground between project review and pervasive problems

Definition of ends

- Ensure that project goals and objectives are consistent with and supportive of system goals and objects (Williamson, 1992)

- Ensure that system objectives are specific and supportive of individual project review (Munro, 1986)

Bounding of analysis
- Extend temporal and spatial boundaries to allow for potential indirect and non-linear effects
- Ensure that natural, social and economic boundaries allow for potential interconnections across systems
- Allow for connections to other jurisdictions and involve interest groups with broader perspectives

Assessment of alternatives
- Link project alternatives to systems patterns (e.g. precedent-setting developments, nibbling effects) (Spaling and Smit, 1993)
- Consider consistency of alternatives with policies, programmes, systems and real planning (Fox, 1986)
- Incorporate broader level goals into project evaluation criteria (Bedford and Preston, 1988)
- Combine alternatives into alternative strategies

Impact assessment
- Place project-related concerns within broader context of public environmental concerns
- Involve broader environmental interest groups in planning process
- Adjust scoping and baseline characterisation to allow for links from local to regional systems
- Identify, predict, interpret and manage interactions among project and environmental component; consider potential for additive and non-additive effects

Impact management
- Formulate general impact management policy and strategy at outset of planning process
- Integrate individual mitigation measures into overall impact management strategy
- Link project-level impact management to broader planning-level impact management strategies (e.g. integrated monitoring) (Hicks and Brydges, 1994; Williamson, 1992)
- Work across planning levels to address public concerns and conflicts that transcend individual projects
- Develop, refine and set mechanisms for inter-organisational and inter-jurisdictional co-operation
- Consider alternative institutional arrangements for monitoring and joint planning purposes (Peterson *et al*, 1987)

This methodology provides general guidance as to what the key issues of assessing indirect and cumulative impacts as well as impact interactions are and at what stage of the EIA planning process these should be incorporated. It provides a rather comprehensive framework, but at the same time it raises the question of which approach it best serves. It sets out to be focused on the integration of the assessment of indirect and cumulative impacts as well as impact interactions into the project level EIA process, but seems to be based on the situation where project EIAs are undertaken primarily by government agencies, as is the case in Canada and the United States. However, when it comes to private projects it becomes more difficult to envisage that the above methodology could be comprehensively implemented. The need to involve other interest groups in the process, and to make links to broader planning levels and goals at both local and regional levels may be difficult to fulfil within the private sector, at least without substantial support and involvement by the planning authorities, or other regulatory bodies.

5.1.2 CLARK'S SEVEN STEPS

Clark (1994) has developed a seven steps approach to serve as a basis for EIA practitioners to work to improve and advance the state of the practice. The seven steps can be summarised as follows:

1. Set goals
Goals drive decisions on how a proposed activity will be implemented and therefore what impacts it will have. It is essential that the assessment is undertaken with a clear understanding of the goals of the proponent, the proposed activity and the surrounding community. This is particularly important in respect of indirect and cumulative impacts as well as impact interactions, as without the wider understanding it is not possible to predict or foresee other potential future activities. Where the goals are known it is also easier to define useful alternatives for inclusion in the assessment, and to take into account multiple objectives (e.g. those of the project and those of the community). Accommodating multiple objectives without compromising the environmental carrying capacity may contribute to sustainable development.

2. Establish spatial and temporal boundaries
The boundaries of the study area must be defined during the initial scoping process, this involves the identification of issues to be addressed in the EIA. Clark (1994), suggests that the appropriate spatial boundaries should be defined in relation to the distance the environmental effects travel, regardless of administrative and geographic boundaries. However, the boundaries must be narrowed to study only the resources that the project is likely to affect.

It is more difficult to define temporal boundaries, as questions such as when will the region reach its environmental carrying capacity, and is there enough known about future development to take that development into account, are raised. Clark (1994), argues that 5 to 20 years, which is often the time framework used for long term land-use planning, is an appropriate level to address "reasonably foreseeable" effects.

3. Establish the environmental baseline

The next step is to begin the collection of baseline environmental data, determine gaps in the data, and identify methods for filling those gaps to ensure that a comprehensive assessment can take place. Data collection can be undertaken using several methods and sources, including aerial photograph interpretation, analysis of existing databases, habitat inventories, water quality surveys, studies of social and economic patterns in the community. In some cases the data collection may require sampling over longer periods or during different seasons, to ensure a full understanding of ecosystem processes, social interactions within the community and so forth.

4. Define impact factors

Still within the scoping process, it is necessary to define impact factors. It is important to ensure that not only the directly affected physical resources, such as air and water quality, are included but also the ones that are less obvious or direct, for example human social interaction or visual amenity. The question of indirect impacts, cumulative impacts and impact interactions should be specifically considered at this stage, as it will help to guide the thinking in a comprehensive manner, thus ensuring that issues such as other existing or planned activities are taken into account when defining impact factors.

5. Identify thresholds

The key to sustaining development is carrying capacity, not the amount of land, air or water. It is, therefore, important to establish ecosystem functions and values as well as a threshold at which the ecosystem cannot perform its functions adequately anymore. It is equally important to consider the question of the limiting factor, or the weakest link, in the carrying capacity of the region.

6. Analyse the impacts of proposals and their alternatives

Clark suggests that the focus at this stage should be on the environmental impacts regardless of scale. It is then necessary to determine how these impacts interact with the resources, are they additive or synergistic, will they be too great when added to the impacts of other projects in the region and so forth? Trade-offs between the development alternatives will usually be necessary and it is important to be explicit about these and to make recommendations on the criteria that the decision makers should use to make the trade-offs.

7. Establish monitoring

Determining whether impact predictions are accurate or not is crucial from the point of view of learning but also from the point of view of supporting future assessments by providing baseline information, or by pointing to the need to lower (or higher) expectations regarding the amount of development that an area can carry.

Clark (1994), suggests that impact analysis can best be undertaken at the programme or policy levels, as irretrievable commitments generally have not yet been made at that stage. So, for example, when the indirect or cumulative impacts of impact interactions of a road project are being described, it is too late to revisit policy-level decisions regarding a national transport programme. The options available at the project level are therefore not as flexible as they could be at the planning level. The benefits of undertaking analysis of indirect and cumulative impacts as well as impact interactions at the programme or policy levels include the explicitness with which choices among alternatives affect each of the other objectives defined by the affected community, and the way decision makers can be helped to optimise both environmental and economic values. At the programme or policy levels environmental impact analysis is a means to more holistically address the indirect and cumulative impacts as well as impact interactions on an ecological region.

Compared to the previous approach, this methodology provides less comprehensive, but more concrete and focused advice, both on the process and the particular issues involved in undertaking an assessment of indirect and cumulative impacts as well as impact interactions. Although not explicitly stated, this methodology seems to be applicable at both project level and the wider planning levels. It prescribes fewer wide-ranging tasks, which makes it more readily applicable at the project level, while it nevertheless takes into account the long-term perspective essential to indirect and cumulative impacts as well as impact interactions. For a planning approach to indirect and cumulative impacts as well as impact interactions, the methodology may actually not be ambitious enough, precisely because it does not clearly prescribe that wider interest groups should be involved or that wider policy, programme and plan objectives should be taken into account.

5.1.3 ADDRESSING INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS THROUGH ACTS WITH REGULATORY POWERS

According to Bardecki (1990), the management of indirect and cumulative impacts as well as impact interactions is to some extent already being accomplished in a variety of situations in many jurisdictions, through the operation of regulatory frameworks. It is suggested that this vehicle for addressing these impacts could be utilised more efficiently, by recognising the significance of such impacts, identifying specific concerns and tailoring the regulatory powers accordingly.

One of the examples that Bardecki uses, is that of the lake and lakeshore planning process in Ontario, Canada, which is:

"essentially one of assessing the carrying capacity of the environment from a variety of perspectives and regulating the cumulative impacts

from development within the most restrictive of the thresholds identified. For lakes this involves an attempt to assess the repercussions of several planning options which might be implemented as part of a lake management plan. The basis for lake management in Ontario is proactive, involving, in advance of development proposals, the establishment of planning objectives at a municipal level based on the municipal Official Plan. Seventeen agencies are identified for the participation in the plan review stage to assure that the objectives are in compliance with the provincial lake and lakeshore planning process (Ontario Ministry of Natural Resources, 1983)."

"Each lake and its shore is given a specific role assignment (for example, for cottage use, for fishing, and for wildlife management). The role is assessed vis-à-vis a series of constraint models (land use, water quality, fisheries and wildlife habitat) which allow the capacity of the lake for various potential uses to be quantified and the cumulative impact of development alternatives on the lake to be assessed (Ontario Ministry of Municipal Affairs and Housing, 1982*). The output is a series of alternative zoning plans which may be prioritised based on cumulative environmental impact, economic benefit and protection of social values."* (Bardecki, 1990).

With this information it is possible to, for example, determine an appropriate cap on cottage development, and/or to regulate appropriate mitigation measures in development regulation.

The basis for this methodology is the assumption that managing these types of impact means following an appropriate goal-oriented management plan. The initial task is then to establish specific goals, followed by that of developing practical criteria and indicators for the assessment of proposals. It has been argued though, that goal setting can be the most taxing process in the assessment of such impacts (Gosselink *et al*, 1987). The goals need to be established at the appropriate level of authority, whether it be national, regional or local. There are several ways of establishing and supporting specific goals, including:

- using scientific evidence;
- using already established criteria, particularly those established in some accepted form as goals for the state, region or communities involved; and,
- using policy directions, program descriptions and guidelines, government directives, existing plans and legislative initiatives as general measures against which activities may be assessed.

Bardecki (1990) points out that not all goals are equal, but that certain goals will warrant a higher degree of consideration than others, due to factors such as:

- the centrality of the goals as an indicator of broader concerns; the relative degree of importance placed on the goal as expressed in the related policy, legislation, or guideline; and,
- the level of assurance that realisation of a specific goal could be enhanced by any given decision.

The difficulty in establishing measurable goals with definable thresholds to some extent supports the view that the assessment of indirect and cumulative impacts as well as impact interactions will not focus on technique or method but rather on process and procedure. Bardecki (1990), recognises that few, if any, analytical procedures are capable of dealing with the entire scope of potential impacts, and that the regulatory process therefore needs to lean more heavily towards an adaptive, evolving process, and that the procedures must be heuristic.

Bardecki (1990), describes the methodology as involving an incremental assessment of information needs as related to decisions as required. Criticism against such an incremental approach (Stakhiv, 1986) is overcome by arguing that although the approach is not comprehensive, it is valid, as long as the regulatory framework operates within a system of recognised and accepted goals. Such goals, even if defined on a sectoral or geographic basis, can suffice to direct development in an acceptable manner which provides for the management of these types of impact.

The approach provides the decision maker with a visible accounting of the cost of any given action through the explicit identification of which goals may be jeopardised by the undertaking (Manning *et al*, 1988). Furthermore, Bardecki argues that the continued application of approaches such as these will identify gaps in current legislation and policy, and thus act as catalysts for adjustments leading to a more comprehensive legislative and policy base for the regulation of all decisions involving the potential for these types of impact.

Finally, Bardecki points out that the scientific information necessary to support many decisions related to managing these impacts may not only be lacking at present, but may indeed never become completely available. However, he goes on to claim that the level of evidence needed to address problems related to such impacts is not necessarily that of the scientist, but of the regulator.

5.1.4 ASSESSMENT OF INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS BASED ON MONITORING AND MODELLING

Contant *et al* (1991) base their methodology on the presumption that to be comprehensive, a methodology for assessing such impacts must include mechanisms that capture the two broad categories of these types of impacts; effects resulting from a project's relationship to other development activities, and effects produced by an activity's presence within a set of many natural systems. The suggested methodology thus responds to those contextual issues and, furthermore, is focused upon the tasks of monitoring and modelling. As illustrated in Figure 5.1, the methodology includes parallel sets of analysis activities for the two categories of impact considerations.

Figure 5.1 shows how the main tasks of monitoring and modelling are the basis for the analysis in relation to both categories of impact. Monitoring identifies and tracks past and current development activities by type, by location and over time. Furthermore, monitoring includes the collection of data on sets of socio-economic system parameters that describe factors affecting the nature and rate of development activity. Within the focus of natural systems, monitoring serves the purpose of identifying existing environmental conditions and providing a database for understanding systems' responses, thresholds and interactions.

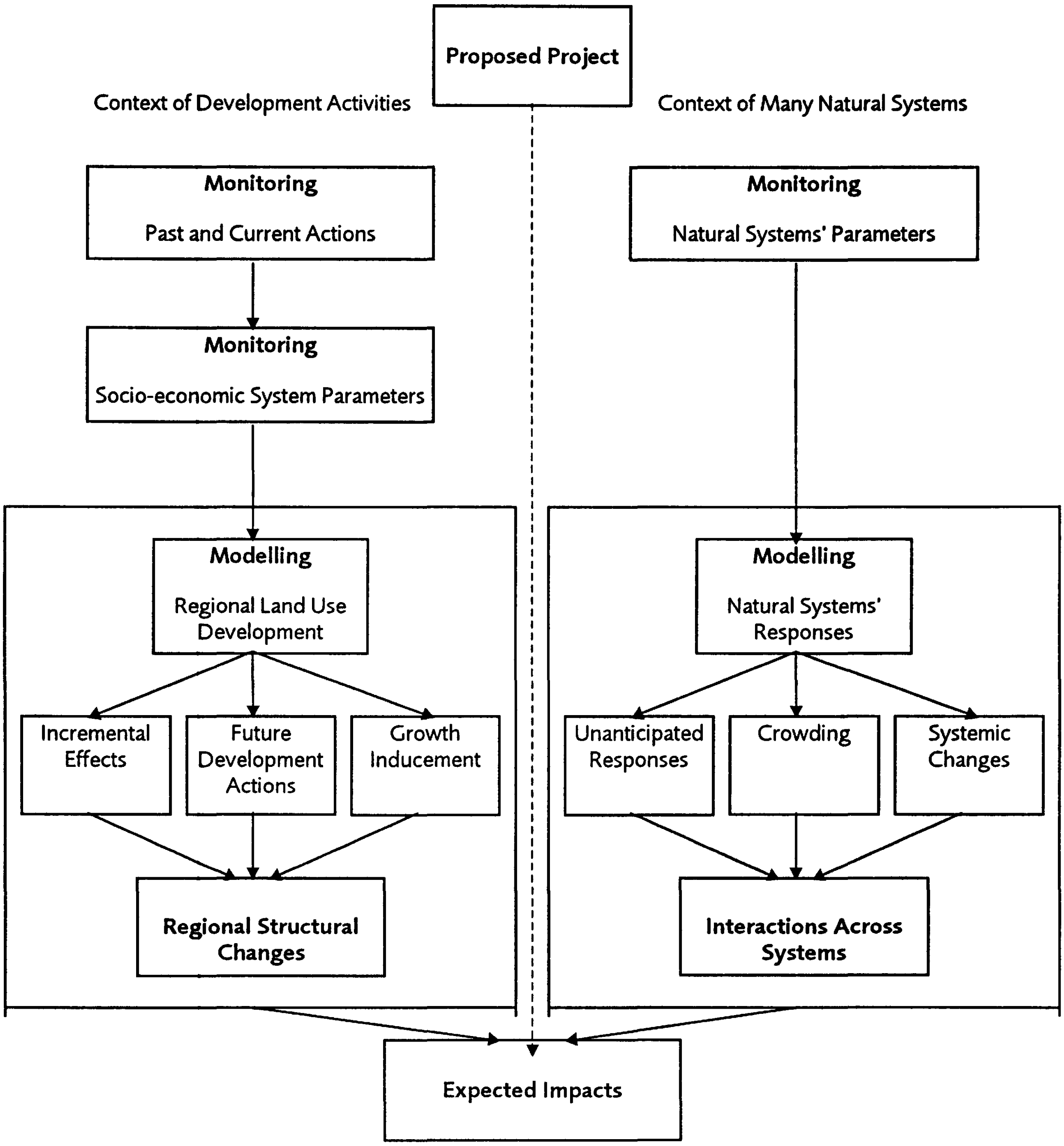

Figure 5.1: Approach for Impact Analysis (Contant *et al*, 1991)

Modelling is aimed at developing and calibrating regional land use development models on the basis of data on past activities and socio-economic system parameters. Outputs of these models provide forecasts of the type and nature of future development actions, yielding a more comprehensive picture of the incremental effect of a project in relation to other past, present and foreseeable future development. Modelling can also identify a particular project's effect in shifting the structure or type of regional development, or in changing existing rates of growth.

Within the focus of natural systems, modelling is used to understand the responses of those systems when perturbed by development activities. Contant *et al* (1991), explain the various possibilities. Crowding can be examined by determining the recovery time (or space) needed for a particular system when perturbed by a development activity. More complex responses can also be modelled for a variety of natural systems, including unanticipated effects resulting from exponential or discontinuous functional relationships, system-wide changes such as time-delayed effects, cycling, and structural alterations. Finally, where the models are based on ecosystems, rather than the more narrowly defined natural systems, cross-system and cross-media impacts can be predicted.

The main benefits of emphasising monitoring and modelling in the process of assessing indirect and cumulative impacts as well as impact interactions include:

- monitoring activities improve the capability of the analysis approach in describing existing conditions (for development activities and environmental systems) as a baseline for future comparisons and assessments;
- expanding the scope of modelling to include more sophisticated methods enhances the consideration of these types of impact resulting from non-linear, discontinuous, synergistic or cross-media effects.

The above improvements should result in more comprehensive assessments and more thorough inclusion of indirect and cumulative impacts as well as impact interactions in project-level decisions. Contant *et al* (1991), acknowledge that this new assessment approach will require significant improvements in existing administrative and managerial systems. As the lack of detailed monitoring information on previous development projects and several key environmental parameters currently is a major limitation, new information management systems will be needed. Recent developments in Geographic Information Systems (GIS) and remote sensing may well provide the opportunity for improving the monitoring tracking of project data and environmental systems' conditions (Johnston *et al*, 1988; Contant *et al*, 1989; Hawkes *et al*, 1989).

Contant *et al* (1991), also highlight the limitations resulting from the lack of scientific understanding of natural systems' phenomena, and how these can be overcome through improved modelling efforts. Some of these improvements will require greater investment in resources, for example, basic research and data collection (Preston *et al*, 1988), while others will require a shift in the type of systems studied, for example a greater emphasis on ecosystems as opposed to individual natural systems in order to gain a better understanding of interactions between several natural systems.

Furthermore, there is a need for more comprehensive modelling efforts in understanding and forecasting the complex processes in socio-economic systems that produce land use development. This would aid in predicting future development activities, identifying growth-altering projects, and indicating changes in economic development pressures. It has been suggested that the combination of GIS and land use models may provide the data and scientific capabilities to make the required spatial land use and development forecasts (Densham *et al*, 1989; Harris, 1989).

A final set of limitations which Contant *et al* (1991) set out to address reflects the inability of existing managerial systems to control expected indirect and cumulative impacts as well as impact interactions . They suggest that new management mechanisms for controlling such expected impacts should be adopted to ensure that the management of these impacts does not rely only on yes/no decisions about a project with modifications made to the original design to mitigate the impacts. Some previously suggested approaches include an additional layer of review specifically for consideration of these types of impact (Peterson *et al*, 1987), greater use of programme level impact assessments (Hapke, 1985), or use of a graduated scale for both project reviews and modifications (Contant *et al*, 1989). Most of these suggested approaches aim to resolve the mismatch that is often present between the level at which these impacts occur and the jurisdiction through which control efforts can be exercised (Beanlands *et al*, 1986). Contant *et al* (1991), argue that adequate control of these types of impact requires regional planning and co-operation, and that proper planning processes are necessary to monitor development activities, define the relevant policy goals, determine appropriate management strategies, and adopt the proper control actions. Contant *et al* (1991), claim that such enhanced regional planning conditions combined with improved monitoring and modelling can lead to more thorough and rigorous analysis of such impacts at the project level.

5.1.5 QUESTIONNAIRE CHECKLIST APPROACH

Canter *et al* (1995), have developed a questionnaire checklist for use in scoping impacts, addressing detailed impact issues and summarising the results of such impact considerations in an impact study. While the items in the proposed questionnaire checklist will not all be applicable to all projects and impact studies, it is argued that this methodology will provide a consistent beginning for systematically addressing indirect and cumulative impacts as well as impact interactions.

The questionnaire checklist was developed on the basis of a study of the types of methods being used in scientific studies, environmental impact statements and existing EIA methodologies. A list of desirable features was used as a baseline for developing the methodology. According to Irving *et al* (1986), the methodology should:

- enable multiple developments or land use practices to be addressed;
- be practical with understandable results that would aid in the decision making process;
- be adaptable to allow for the large array of possible site-resource-impact combinations;
- feature flexible boundaries in terms of time and space;
- enable the aggregation or tallying of incremental and interactive impacts to give an estimate of the overall impact to which a species or resource is being exposed; and,
- allow for differential levels of resolution (i.e. the methodology should allow for a more general, extensive analysis of the impacts of all relevant developments, projects, or land use practices, while still allowing intensive site and project-specific impact analysis).

Based on the above criteria, it was decided that the most appropriate methodological approach should be one that is simple and yet comprehensive enough to provide a broad perspective. According to Canter *et al* (1995), the proposed questionnaire checklist provides a practical and systematic approach that facilitates the planning and undertaking of an assessment within an interdisciplinary framework. Furthermore, the checklist can be modified depending on the project and site characteristics. A simplified version of the questionnaire checklist is presented in Table 5.1.

Although not shown in the table, each of the 21 environmental categories is further divided into sub-categories, making a total of 107 sub-categories. The proposed methodology satisfies the features listed by Irving *et al* (1986), except for incremental and interactive impacts, as they require quantitative information. The main limitations of the proposed methodology are thus that it does not address interactions and linkages, and does not provide for quantification of impacts.

Table 5.1: Generic questionnaire checklist for addressing and/or summarising impacts of projects (adapted from Kamath, 1993)

Environmental Category	Will the project result in: Yes Maybe No Comments	Will indirect or cumulative impacts or impact interactions of projects result: Yes Maybe No Comments
Physical environment landform Air/Climatology Water Solid Waste Noise Hazardous waste Biological environment Flora Fauna Socio-economic environment land use Recreation Aesthetics Archaeological sites Health and safety Cultural patterns Local services Public utilities Population Economic Transportation Natural resources Energy		

Notes: Due consideration has to be given to the time and space scales. The projects may have short-term or long-term impacts, and the geographical extent of the impacts may be either the vicinity of the project or considerable distances away.

Canter *et al* (1995), suggest that the above methodology can be used in conjunction with defining the study boundaries for addressing these types of impact. Key considerations at this stage include:

for defining the spatial boundaries:

- natural interrelationships between biophysical environment features;
- man-generated interrelationships between socio-economic environment features;
- the geographical locations of expected impacts;

and for defining the temporal boundaries:

- historical;
- current;
- projected developments;
- natural and man-generated interrelationships.

Geographic considerations can be facilitated by combining the checklist with the use of geographic information systems. Canter *et al* (1995), argue that the questionnaire checklist is suitable for use both in the scoping process for the preliminary identification of these types of impact, as well as these impact types in subsequent, more detailed stages to more clearly identify potential impacts and refine information needs and analyses. Finally, it is suggested that the methodology could be used to provide a convenient way to develop a summary of the findings.

5.1.6 A SYNOPTIC APPROACH

In 1992 the US Environmental Protection Agency proposed a methodology to assist wetland regulators in assessing these types of effects of individual wetland impacts within the landscape. Although designed for this particular purpose, and with a focus on state or regional wide assessments rather than individual cases, it is suggested that the methodology has broader applications and that it could be applied to issues at different geographic scales (US Environmental Protection Agency, 1992).

The synoptic approach sets out to provide resource managers with a landscape context for both project-specific decisions and regional planning. The synoptic approach is not a fixed procedure that always uses the same data sources and produces a standard set of end products. Instead, it is a creative process that relies heavily on the user to ensure that the final assessment is appropriate for the intended use. The process of conducting a synoptic assessment involves the following five steps:

Table 5.2: Steps in conducting a synoptic assessment (US Environmental Protection Agency, 1992)

Steps	Procedures
1. Define Goals and Criteria *This step may require repetition until an acceptable combination of objectives, accuracy and resource allocation is agreed upon.*	1.1 Define Assessment Objectives 1.2 Define Intended Use 1.3 Assess Accuracy Needs 1.4 Identify Assessment Constraints
2. Define Synoptic Indices *This step requires an understanding of the interactions between wetlands and regional landscapes.*	2.1 Identify Wetland Types 2.2 Describe Natural Setting 2.3 Define Landscape Boundary 2.4 Define Wetland Functions 2.5 Define Wetland Values 2.6 Identify Significant Impacts 2.7 Select Landscape Subunits 2.8 Define Combination Rules
3. Select Landscape Indicators *Goal setting, defining synoptic indices and selecting landscape indicators should occur iteratively and not simultaneously.*	3.1 Survey Data and Existing Methods 3.2 Assess Data Adequacy 3.3 Evaluate Costs of Better Data 3.4 Compare and Select Indicators 3.5 Describe Indicator Assumptions 3.6 Finalise Subunit Selection 3.7 Conduct Pre-Analysis Review
4. Conduct Assessment *Once landscape indicators have been defined and assumptions have been explicitly identified, maps and data can be obtained, and the process of producing the synoptic maps can begin.*	4.1 Plan Quality Assurance/Quality Control 4.2 Perform Map Measurements 4.3 Analyse Data 4.4 Process Maps 4.5 Assess Accuracy 4.6 Conduct Post-Analysis Review
5. Prepare Synoptic Reports *To report how the information was derived and how it can be used.*	5.1 Prepare User's Guide 5.2 Prepare Assessment Documentation

It is suggested that the most critical steps in conducting a synoptic assessment are defining the synoptic indices and selecting the landscape indicators. The synoptic indices serve as the basis for comparing the characteristics of landscape subunits; they represent the actual functions, values and impacts of concern to the manager. The resource specialist familiar with the particular landscape is responsible for defining the synoptic indices most relevant to the specific objectives. The landscape indicators used to estimate the synoptic indices are also specific to the particular assessment and are dependent on management objectives, the level of confidence required, and on constraints. The synoptic approach relies on best professional judgement for making the above decisions.

Another important step in the overall process of the synoptic approach is evaluating the accuracy of the assessment, as the accuracy determines the degree to which the synoptic results can be incorporated into real decision making. Ultimately, accuracy depends on:

- how well the indices reflect the actual environmental conditions;
- the quality of the data being used; and
- the degree to which assumptions concerning the use of indicators are valid.

It is argued that results from a simple assessment should be used only to provide broad background information, to serve as an initial screening tool, or to raise "red flags" requiring more detailed consideration. Management decisions can rely more heavily on the results if better data with higher confidence levels are used.

Finally, emphasis is placed on the need to consider carefully how to present the assessment results. The synoptic approach is geared towards displaying data on maps and elaborating the assessment results and how they can be used to meet the original objectives in a report. The intended audience for the maps and the report includes resource specialists who are involved in decision making or planning, as well as resource agencies, scientists and the public. A detailed record of the assessment process is also prepared, for internal use or distribution to interested parties.

The synoptic approach is put forward by the US Environment Protection Agency as a compromise between the need for rigorous results and the need for timely information. It is suggested that it should be an iterative approach, with analysts updating the completed assessment when better indicators or more time to gather data become available. The usefulness of the information will ultimately depend on the assessors' knowledge of the environmental processes relevant to particular management questions.

This is a thoroughly documented methodology, that provides valuable advice for resource managers in comparing indirect and cumulative impacts as well as impact interactions between areas. The particular focus on wetland impacts within overall landscapes is a limitation in that it simplifies the assessment concentrating on one particular receptor, which by definition is not normally the case in assessing indirect and cumulative impacts as well as impact interactions. However, if altered to assume a more generic focus, the synoptic approach can certainly provide an efficient tool for resource managers and planners, and possibly even for project-level assessments of indirect and cumulative impacts as well as impact interactions. Although the methodology's applicability for the latter may require further modifications, for example in relation to means for narrowing the study and for presenting results.

The level of detail and the scope of the synoptic approach as put forward by the US Environment Protection Agency (EPA) relates to a one-year exercise with human resource requirements of approximately two full-time equivalents, which clearly leans more towards serving the regional level than the individual project-level. The expertise needed to develop and use this method or one derived from it may also be a barrier to its use within the European EIA process.

5.1.7 SEVEN STEP FRAMEWORK

Damman *et al* (1995), describe a methodology developed for the assessment of five proposed uranium mine developments in Saskatchewan, Canada. A team of specialists was hired to undertake the assessment specifically to identify significant impacts that could result from interactions between the projects, interactions that might not be apparent from project specific environmental impact statements. The team's objective was to develop and apply a methodology to address these types of impact that was consistent with prevailing theory and achievable within the practical limits of data, resources and time. The work was to be completed using existing available information with little or no field work. For practical reasons, the scope of the assessment was limited to:

- the combined effects of past mining activities;
- existing mines;
- proposed mines; and
- the combined effects from other existing and proposed local and regional scale projects.

The methodology was developed based on a literature review, the character of the regional environmental setting and a review of public concerns. Figure 5.2 illustrates the action taken and the material gathered and reviewed in preparation for the assessment. The arrows leading to various steps on the right hand column indicate which stage in the assessment methodology that each category of information fed into.

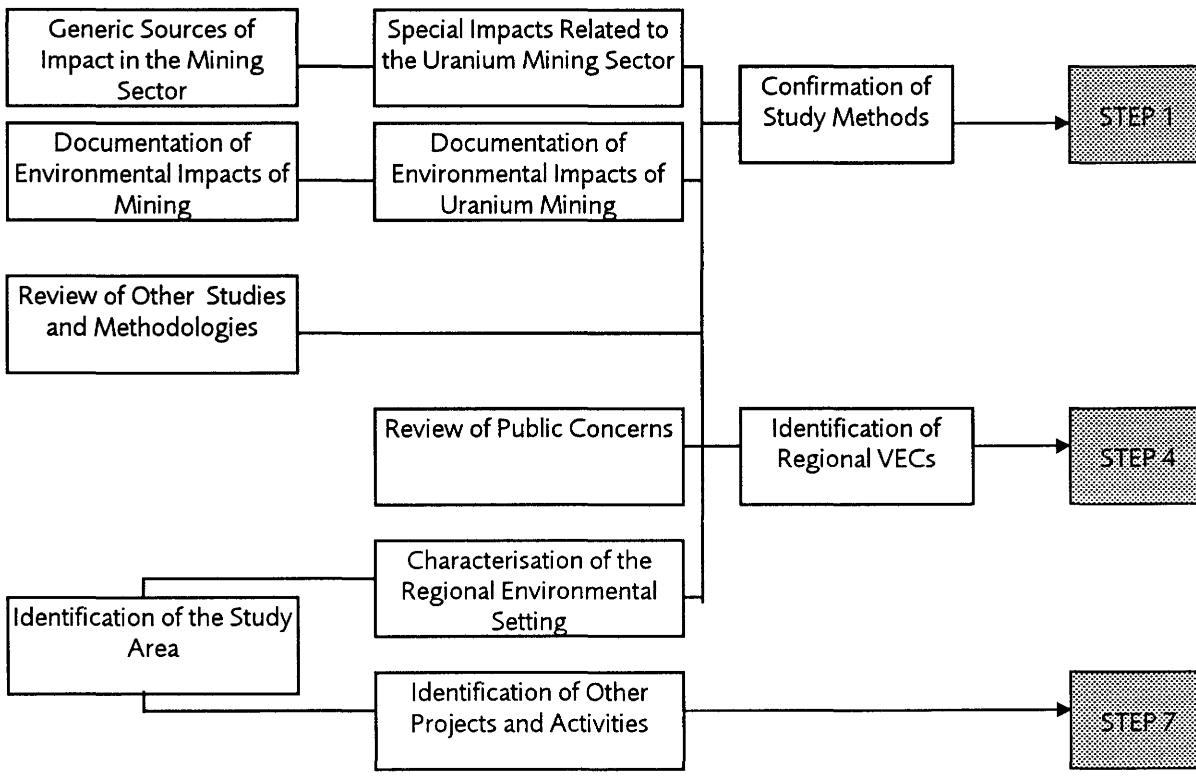

Figure 5.2. Action taken to prepare for the assessment

The assessment methodology was developed around seven basic steps, as follows:

1. Define the boundaries for project-related effects.

2. Identify the pathways through which potential environmental effects of a project could occur.

3. Identify past and existing projects, their environmental impacts, and the pathways through which these impacts occur.

4. Identify valued ecosystem components (VECs) that are within the zone of influence of the proposals.

5. Assess possible interactions among environmental effects of the proposed project(s) and the environmental effects of past and present projects through the identification of linked pathways.

6. Determine the likelihood and significance of indirect and cumulative impacts as well as impact interactions of the mining proposals on the VECs.

7. Recommend monitoring strategies.

The two main building blocks selected for the design of the methodology were valued ecosystem components (VECs) and pathways and linkages. For practical reasons, VECs were limited to those considered to be most important. A VEC is identified as,

"...the environmental attributes or components identified as a result of a social scoping exercise as having scientific, social, cultural, economic or aesthetic value"
(FEARO, 1986).

Potentially significant impact linkages among ecosystem components were identified using a pathways approach, which began with the identification of potential sources of impact from past, present and future projects and activities. Pathways are ecosystem linkages between impacts of one project and the ecosystem components affected by another project. The pathways approach was found to be particularly useful when dealing with the aquatic environment.

The study team relied on both information collected from the literature and project-specific impact predictions to identify pathways that link projects. For biophysical impacts, the potential linkages are through the surface water, ground water and air pathways. It turned out to be more difficult to identify linkages between mining projects for socio-economic and health impacts. These impacts are more diffuse in nature, may be experienced throughout the region, and are more difficult to segregate from changes induced by external forces such as government policies, historical changes in lifestyle and so forth. Information derived from the literature and community visits was used to identify these linkages.

The most challenging part of the assessment was the determination of significance. While setting limits for physical changes that can be measured is possible to some extent, setting "acceptable" limits for social change was a greater challenge. It was decided to assess these types of impact using size of the affected area, frequency and duration of the effect, and certainty in prediction.

The pathways analysis results were presented in table form, including both biophysical and socio-economic and health impacts. Table 5.3 is an extract of the analysis. Mitigation and monitoring measures were identified to minimise potentially significant indirect and cumulative impacts as well as impact interactions and reduce areas of uncertainty in the impact prediction.

The study team encountered a great deal of uncertainty in the prediction of these impact types for uranium mining. One uncertainty resulted from the difficulty to interpret the nature and significance of socio-economic effects. Another resulted form the lack of documentation regarding the impacts of existing mines on northern Saskatchewan, which made it hard to extrapolate possible future conditions. Furthermore, the study team recognised that the understanding of cause and effect relationships, and the workings of the key linkages and interactions within ecosystems is limited. In most places comprehensive monitoring programmes are not in place to help close information gaps.

Table 5.3: Analysis of Potentially Significant Environmental Effects - Extract

Pathway	Project Linkage	Concern	VEC Potentially Affected	Significance of Impact			Potential for Significant Effect			Rationale/Comments
				Area affected	Frequency and duration	Certainty in prediction	Yes	No	Uncertain	
Surface Water	Wollaston Cluster Key Lake	transfer of radionuclides and stable heavy metals	aquatic animals fish	potentially regional, downstream of projects associated with sediments downstream of tailings discharges in vicinity of mines, uptake from water and sediments near mine sites	long-term	low degree of certainty	X			Although radionuclides are shown to accumulate in fish, levels are generally far below those known to cause somatic or genetic damage
			benthic macro-in-vertebrates		long-term	low	X			Benthos often show accumulation, forage and bottom feeding large fish accumulate levels higher than piscivorous fish or plankton feeders
			aquatic plants		long-term	low	X			Lakes in the system allow precipitation of bedloads and removal of contaminated sediments to "sinks"...
			moose		short-term	low	X			
Social/ Community traditional lifestyles	all mines	depletion and deterioration of resources base	culture and lifestyle resource based activities	regional	long-term	uncertainty in prediction	X			Knowledge too limited to make judgement Important for income of native northerners
	all mines	impact on way of life	culture and lifestyle	regional	long-term	uncertainty in prediction	X			Data on utilisation of resource base are scarce.....
community impacts	all mines	breakdown in community cohesion	community cohesion	community	long-term	uncertainty in prediction	X			Community cohesion is important to the well-being of northern people
		social costs	community cohesion	community	long-term	uncertainty in prediction	X			Community cohesion is difficult to measure.....
employment	all mines	limited employment opportunities for native northerners (primary impact area)	employment wage economy	regional	long-term	uncertainty in prediction	X			Employment is the most direct benefit Mines have had varying degrees of success with hiring northerners...

5.1.8 IMPACT INTERACTION NETWORKS

Sporbeck (1997), offers a methodology to consider impact interactions in road projects (see Figure 5.3). Sporbeck's method concentrates on ecosystem and landscape units and differentiates between three elements of impact interaction. Firstly, *ecosystematic interactions*, meaning that various types of relationships exist between different elements of an ecosystem(s). These relationships include:

- interactions between separate impact receptors;
- interactions between elements of a single receptor;
- interactions between neighbouring ecosystems; and,
- interactions between landscape elements.

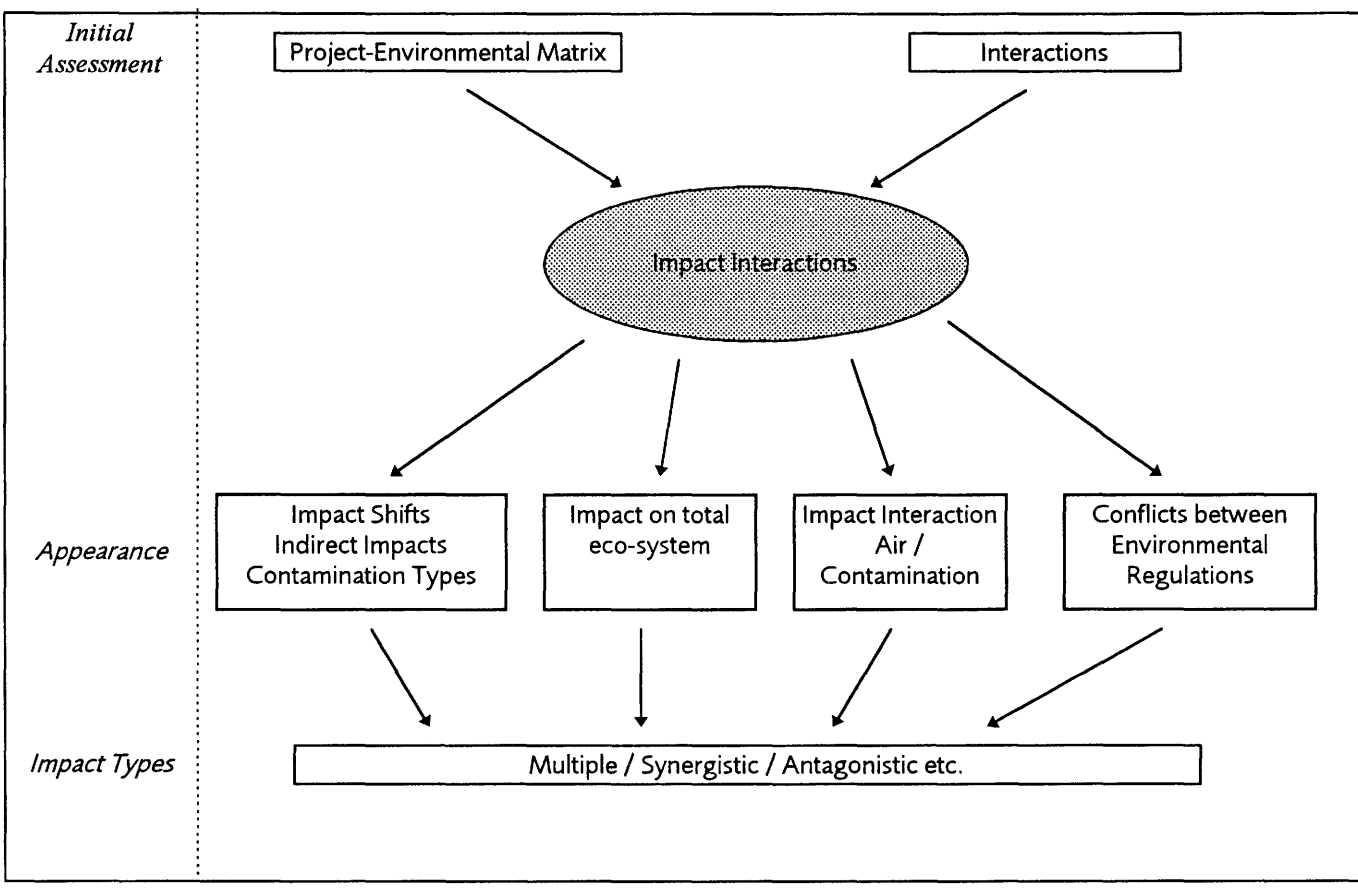

Figure 5.3 Systematic Approach to Impact Interactions

The second element of impact interaction is *the impact upon ecosystematic interactions* which are impacts acting on the different types of relationships existing between ecosystem elements (see above). These impacts are:

- impacts upon interactions between separate receptors;
- impacts upon interactions between elements of a single receptor;
- impacts upon interaction between neighbouring ecosystems; and

- impacts as a result of interactions between landscape elements.

The third element of impact interactions are *impact shifts* which are essentially the transferral of impacts from one ecosystem element to another, usually due to mitigation measures.

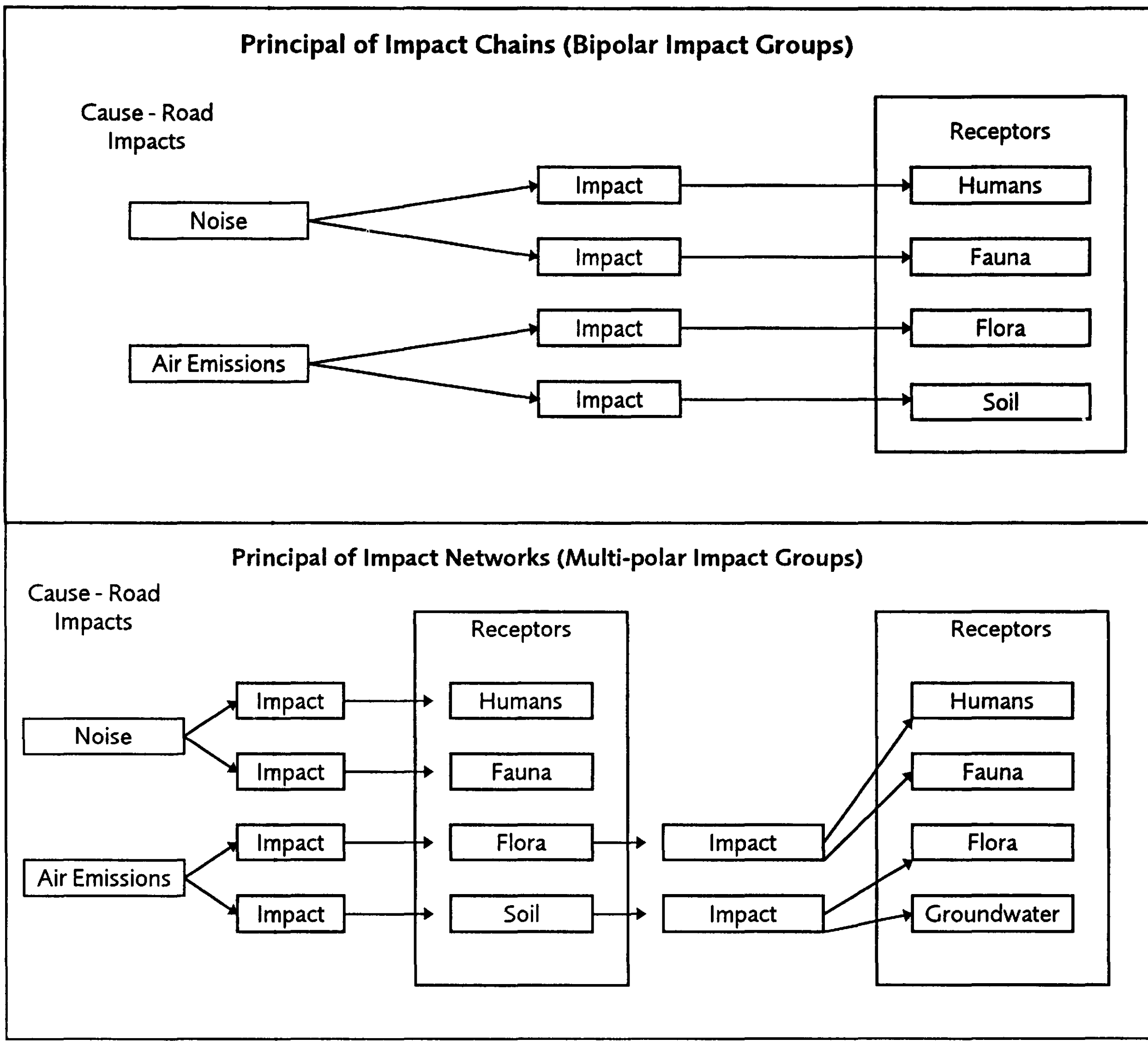

Figure 5.4 Schematic Presentation of Bipolar & Multipolar Impact Chains (Sporbeck, 1997)

Sporbeck goes on to suggest a method for integrating impact interactions within the EIA process through the following system:

1. Spatial Analysis - baseline survey to identify and describe ecosystem interactions.

2. Impact Forecast - prediction, assessment and description of impacts on the ecosystem interactions.

3. Consideration of impact shifts during the design of mitigation measures.

The spatial analysis and impact forecast will need to be based on the description and interpretation of single receptors and their relationship to other receptors. This is followed by the identification and delineation of impact interaction groups. These groups have specific functional relationships between their receptors isolated from other groups. The interaction groups represent the following different types of ecosystem and landscape units:

- Flood plains;
- Natural stream and river valleys;
- Oligotrophic Lakes;
- Dry and half-dry grass landscapes and coastal dunes;
- Natural Wetlands;
- Highland moors;
- Virgin Forests; and,
- Areas with significant site factors.

The impact networks seen in Figure 5.4 were developed to identify these groups of ecosystem impact interactions. Impact chains or impact-impairment chains are a useful method to identify impact interactions qualitatively on the basis of incomplete knowledge of ecosystematic relationships. Impact chains represent double or multi-linked impact groups that reflect the causal event and its impact chain reaction Cause/Impact/Follow-on Impact.

As can be seen from schematics below, several impacts can develop following a primary impact which in turn can result in further impacts resulting in the transfer from a linear approach on the first level to a complex approach on the second and third levels. This method enables not only the identification of direct impacts on primary receptors but also follow-on impacts on other elements of the ecosystem resulting from impact interactions between the individual system elements.

Each group of impacts is an expression of ecosystematic impact interactions that link an impacted receptor with other receptors in the structure of the ecosystem. Ecosystematic impact interactions in turn develop into impact interaction groups. These reflect a specified sequence of impacts that together impact on the total structure of ecosystems and groups of ecosystems. The delineation of impact interaction groups sets a framework for the process of identifying potential ecosystem impact interactions and impacts on ecosystem impact interactions.

5.1.9 *ASSESSING CUMULATIVE IMPACTS THROUGH COMBINING INDIVIDUAL ENVIRONMENTAL IMPACT ASSESSMENTS*

The UK environmental consultancy firm, Environmental Resources Management (ERM) developed a methodology specifically for the assessment of the cumulative effects of two projects in the UK, the Channel Tunnel Rail Link and the widening of the M2 motorway (between junctions 1 - 4). Combined effects are identified as effects which are additional to the effects of the individual schemes or their simple additive effect. The combined effects assessment was carried out by a number of specialist consultants, each responsible for an environmental topic area (Environmental Resources Management, 1994).

The ERM methodology deals only with two development projects and takes no account of any existing developments in the surrounding area. The boundaries for the assessment were defined narrowly. The temporal scope encompassed the construction and operational phases of the two schemes, and the spatial scope was defined in accordance with the actual physical boundaries of the two projects.

The fact that the environmental assessments for the individual projects had been carried out using different approaches had to be taken into account when developing the methodology for the combined effects assessment. The EIA for the Channel Tunnel Rail Link project was specifically developed to overcome the difficulties associated with assessing a large scale rail infrastructure project, whereas the EIA for the motorway widening project was carried out in accordance with UK Government guidelines for trunk road schemes.

The methodology for the combined effects assessment was developed to bring together information on the two schemes and the results of the separate EIAs as simply as possible to enable an assessment to be carried out, either quantitatively or on the basis of supported professional judgement. The combined effects assessment concentrated on effects that would result from the two schemes in combination, rather than the effects of each individual scheme. In carrying out the combined effects assessment, consideration was given to the following:

- effects of the same type which would not be significant for each scheme individually but would be significant in combination;
- effects of the same type which would be significant for each scheme individually but would not be significant in combination; and
- different types of effects (which may not be significant individually) resulting from the combination of both schemes which would give rise to a significant cumulative or combined effect on any particular resource or receptor.

The methodology consisted of five stages, as follows:

1. An overall description of the baseline environment was developed by aggregating the information and data gathered during the EIA process for the two individual schemes and the incorporated mitigation developed as part of the combined effects assessment.

2. The individually predicted changes to the environment were taken from the work carried out during the two individual EIAs, regardless of any differences in predictive techniques which may have been used.

3. The combined changes for each environmental topic resulting from the two schemes were determined by a simple additive approach where possible or by a qualitative description of all changes under each topic.

4. Appropriate criteria for evaluating the significance of effects were identified for each topic. Where available, these were based on well-documented standards or guidelines, otherwise on professional judgement.

5. The combined effects of the two schemes on particular resources or receptors were established by applying the evaluation criteria to the predicted combined changes on the environment, and by reference to the baseline where appropriate.

The methodology developed by each specialist consultant to identify the combined effects for their topic was based on the methodology used in the respective EIAs. Effects resulting from the construction and operation of the two schemes were categorised as being non-significant, significant or of particular importance.

Mitigation measures which were incorporated in the individual schemes were rationalised in the light of both schemes being built, to optimise their effectiveness. These rationalised incorporated mitigation measures were taken into account in predicting combined effects. Additional options of mitigation of the combined effects were also identified.

The combined effects assessment does not amount to a full assessment of indirect and cumulative impacts as well as impact interactions effects assessment, but obviously provides an improvement compared with isolated assessment of the effects of the two projects. The main shortcomings include the narrow temporal and spatial boundaries set for the assessment, which pays no attention to past or future activities, other activities in the vicinity, or effects on environmental values beyond the physical boundaries of the two projects; and the lack of interaction between the specialists for the environmental topic areas, which makes impact interactions and cross-media impacts impossible to assess. However, the methodology as such, as opposed to the way it was used and the way the different parameters were set, does provide a practical approach to project level assessment of these types of effect. Combined with more prescriptive advise on setting boundaries and multi-disciplinary working, this methodology could be a basis for project level assessment of such impacts.

5.2 Case Study Examples

As identified in Volume 2, only a small number of the case studies reviewed assessed cumulative impacts, indirect impacts or impact interactions in a comprehensive, scheme-wide manner. Even fewer of the EISs reviewed considered all three of these impact types comprehensively. In the sections below, examples of comprehensive assessment of the impact types, taken from the project case studies, are discussed.

5.2.1 THE THREE PRINCIPAL ELEMENTS OF THE ENVIRONMENT

The UK consultancy firm, Ove Arup & Partners (1995) developed their assessment methodology for the Strathclyde CrossRail project on the assumption that cumulative effects are the consequences of multiple sources of disturbance that affect valued environmental resources. The assessment of the interaction and cumulative effects builds upon the concept that all effects (air quality, noise, visual intrusion etc.) ultimately have an effect in the following three broad areas which comprise the principal elements of the environment:

- Amenity: encompassing both public use and perception;
- Resource base: encompassing natural resources and land; and
- Material assets: encompassing infrastructure, buildings or historic/cultural features.

The effects may be long-term or short-term, reversible or irreversible, adverse, neutral or beneficial.

The interaction of effects and the cumulative effects in any identified location was assessed in terms of their likely effects on these three principal elements of the environment, based on the significance of each individual effect identified earlier in the environmental assessment.

This analysis produced a preliminary table of results in which all receptors for all subject areas were listed, together with the assessment made. The process revealed that, while some localities or features were reported in several subject areas, others were reported in only one. Furthermore, for some aspects of the assessment, the significance of the effects was reported at an area-wide level and could not be attributed to a specific site. For example, the improvements in accessibility to an area could not be made site-specific.

In order to provide a manageable assessment of effects, the assessment process concentrated on the key geographical areas and receptors. The methodology can be varied by considering a variety of receptor types located in the same area together.

A summary of the key environmental effects of the proposed scheme were presented in a table, an extract of which can be seen in Table 5.4 below. An overall assessment of the interaction between a number of effects on a particular receptor was described in words. The results of the assessment was reported both at an overall scheme level (beneficial effects and adverse effects) and at a location-based level (in relation to the three principal elements of the environment: amenity, resource base, and material assets).

Noise, socio-economic issues, townscape, visual intrusion and cultural heritage were identified as being the subjects which were likely to have important cumulative effects over the length of the proposed scheme. The potential for consideration of further mitigation measures were highlighted, where the cumulative effects resulted in an overall level of significance greater than the individual level.

The contribution of this methodology lies in its concrete and practical concept of the principal elements of the environment. Beyond that it is difficult to assess the appropriateness of the methodology, as the documentation is very limited. However, while the methodology clearly is aimed at the project level assessment, it is also obvious that it takes too narrow a view by disregarding all action not related to the proposed scheme. The methodology therefore encompasses only one of the categories of cumulative impacts, namely the effects produced by an activity's presence within a set of natural and human systems.

Table 5.4: Extract from Table produced for the Strathclyde CrossRail Environmental Statement (Ove Arup & Partners, 1995)

	Traffic, Movement & Access	Noise & Vibration	Air Quality & EMR	Water Resources & Contam. Land	Nature Conservation	Townscape & Visual	Cultural Heritage	Socio-Economic Issues	Construction Issues
General Corridor Wide Effects	General Improvement to accessibility on east side of city centre	**Not significant** The ambient noise level is controlled by road traffic noise	Changes in air quality likely to be **not significant** to **minor beneficial**	**No significant effects** are envisaged	**No significant effects** are envisaged	**Overall moderate adverse** effect on townscape and visual amenity	**Moderate adverse** affect on setting of a Conservation Area	Improvement in pedestrian accessibility to socio-economic resources on east side of city. **Moderate to minor beneficial**	
High St/College Goods Yard	Kings car park removed. Moderate adverse Loss of 20 spaces from SRC car park. Minor adverse						Encroachment on area of high archaeological interest. **Major to moderate adverse** effect.	Loss of Kings Street car park. **Moderate adverse**. Loss of land from Scottish Studio Engravers. **Minor adverse**.	Temporary loss of Hunter Street car park. Access arrangements to Scottish Studio Engravers adversely affected

EMR - Electromagnetic radiation

5.2.2 *INTERACTION PATHWAYS*

The use of interaction pathways is recommended by both the UK Department of the Environment (DoE, 1996) and German EIA legislation, however, neither information source provides a guide as to how this could approach could be undertaken. An extensive interaction pathways approach was developed for one of the German case study projects, the EIA of the Canal connecting the Baltic and North Sea at East Rendsburg, Germany written by the Federal Institute for Hydrography (Bundesanstalt für Gewässerkunde) in August 1995.

The flow diagram seen in Figure 5.5 was created to demonstrate the impact relationships for the Rendsburg Ost phase of the rehabilitation programme for the canal connecting the North and Baltic Seas including impact interactions and repercussive impacts. The flow diagram colour scheme was introduced in order to differentiate between project aspects, ecosystem elements and social receptors. Project aspects are red, the terrestrial ecosystem is green, the aquatic ecosystem is blue, air and climate are purple, and the social receptors are coloured yellow. Impact interaction paths demonstrating relationships between the ecosystem elements were coloured based on their point of origin. Project and social impact pathways are kept in black. The flow diagram shows a very complex system of interactions even following the simplification process which always accompanies the assessment of cumulative impacts due to their inherently complex nature.

It can be seen that the system elements of fauna and flora play a central role. The quantity of impact interactions also demonstrate a high degree of influence upon the state and value of receptors. With the large number of impact interactions grows the "Potential Reactivity" and the associated reactive impacts of a receptor. This is to say that an impact on one of these central receptors has a high potential to induce major changes in the overall ecosystem.

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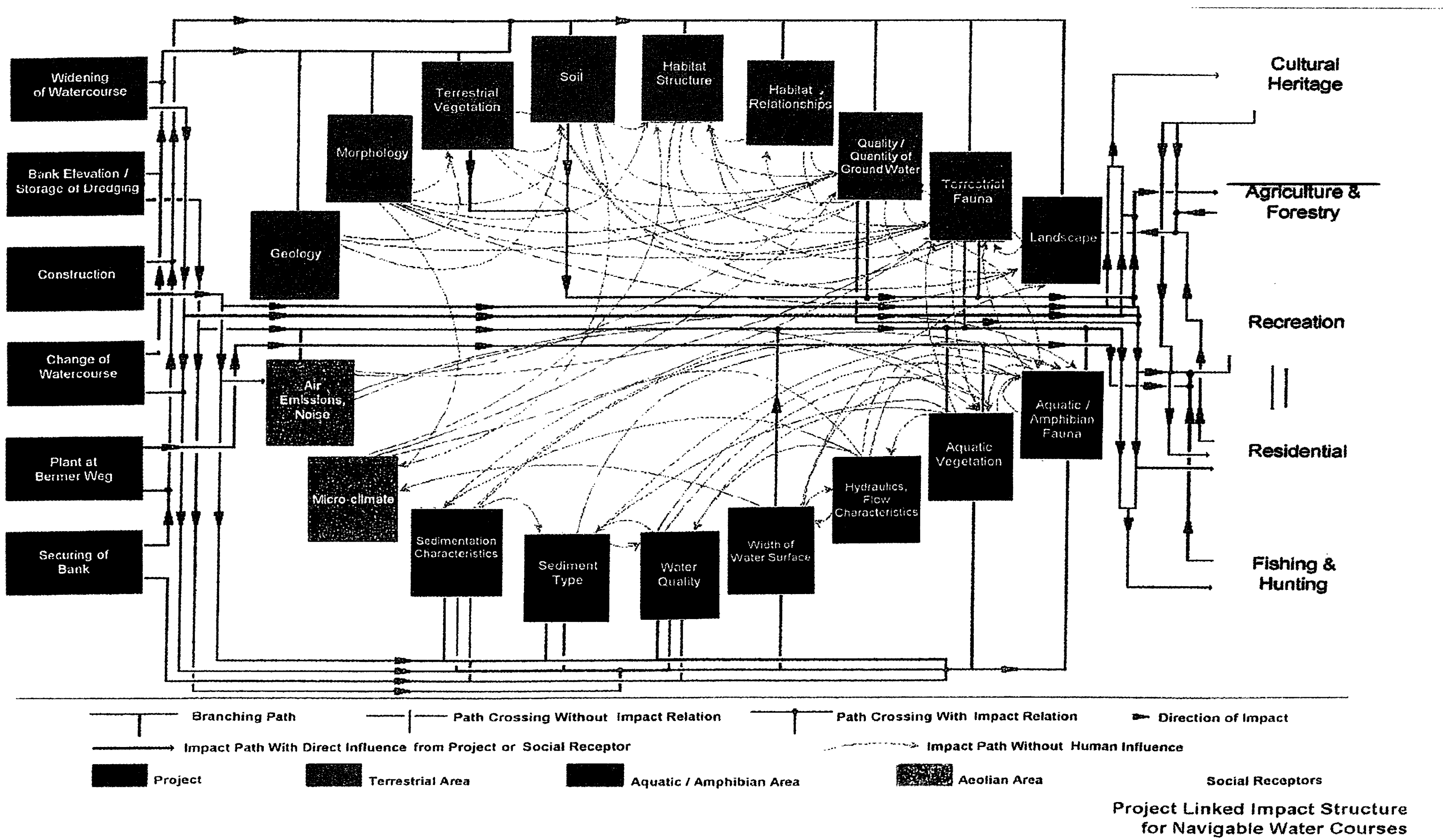

Figure 5.5 Project Linked Impact Structure for Navigable Watercourses

The first and most important conclusion from this analysis of impact interactions is that impacts from projects that are considered uncomplicated from a construction point of view, can cause complex ecosystem perturbations resulting in significant impacts on the environment.

5.2.3 *PROJECT SPECIFIC SEA*

Another interesting best practice example was the use of a small scale SEA within a project-EIA. The project-EIA was for a linear development, crossing a number of eco-system and administrative boundaries and the SEA referred only to the policies that the project-EIA affected. The impacts were summarised in table for clarity and ease of communication, see Table 5.5 below. Most of the available literature indicates that the preferred method of undertaking comprehensive assessment of indirect and cumulative impacts as well as impact interactions should ideally be a part of an SEA in some form or other (see Section 2.0). However, undertaking a small scale SEA for a project may indicate where future indirect or cumulative impacts or impact interactions may arise. This may be especially true for linear developments such as roads which are often linked to induced developments.

Table 5.5 Effects on Policies and Plans

Policy Area	Policy/Plan	Authority	Broad Planning Objectives	Effect of scheme on policy			Comments
				Facilitated	Hindered	No Effect	
Green belt	PPG2/RPG9 Structure Plan Local Plans	DOE Essex CC District/Borough Councils	Defined in PPG2, principally the separation of built up areas and the preservation of 'openness'			✓	New highways are not generally considered to conflict with the aims of Green Belt policy.
Transport	RPG9 Structure Plan	DOE Essex CC	Maintenance and improvement of the strategic road network. To direct HGVs onto suitable routes	✓			A130 Improvements are specifically included on the structure plan. The route is designed to accommodate HGVs.
Nature Conservation	PPG9 Structure Plan Local Plans	DOE Essex CC District/Borough Councils	Protection of Habitats and conservation of wildlife			✓	A County Wildlife Site would be slightly affected and there would be further general habitat fragmentation. Appropriate mitigation for protected species is included in the scheme.
Landscape	Structure Plan Local Plans	Essex CC District/Borough Councils	i. General Protection to the landscape. ii. To improve landscape quality	ii. ✓	i. ✓		There would be an adverse affect on landscape character. New landscape proposals would assist this objective.
Agriculture	PPG7 Structure Plan Local Plans	DOE Essex CC District/Borough Councils	i. Protection of 'high quality' farmland, ii. Effect of severance and fragmentation.		ii. ✓	i. ✓	No high quality agriculture land would be lost, although individual farms would be adversely affected.
Built Heritage	PPG15 Structure Plan Locals Plans	DOE Essex CC District/Borough Councils	Protection of listed buildings and the character of conservation areas.			✓	There would be no direct effect on listed buildings. The listed milestone setting would be changed.
Archaeology	PPG16 Structure Plan Local Plans	DOE Essex CC District/Borough Councils	Preservation of important archaeological remains or appropriate archaeological investigations.	✓			Investigations undertaken to date have not revealed important archaeological remains.

5.2.4 *VERBAL ARGUMENTATIVE METHODS*

Many of the EISs reviewed employed what could be termed a "verbal argumentative" method in their approach to indirect and cumulative impacts as well as impact interactions. This approach is particularly common in Germany and is defined within German EIA guidance as a method that,

> *"...analyses the impacts on the basis of the degree of change with relation to the duration of the impact and its spatial distribution. The resulting impact analysis of the individual receptors is expressed in the degree of pertinence which is necessary to differentiate between relevant and non-relevant as positive and negative impact."*
> (Bundesanstalt für Gewasserkunde, 1994)

Verbal argumentative assessments are generally used to describe qualitative impacts rather than interpret quantitative impact assessments. All of the Member States participating in this study appeared to utilise verbal techniques alone and in combination with other techniques when assessing impacts types in general and not just cumulative impacts, indirect impact and impact interactions.

The following example of verbal techniques is specific to indirect operational impacts translated from the Environmental Assessment of the Proposed 220 kV Power Line Between Chafariz and Ferro I/II, Portugal,

> "... there are the following indirect impacts:
>
> *Maintenance of a corridor of controlled height - this impact results from the necessity of maintaining a corridor below the power line where the height of the trees must be controlled [to prevent interference with the power lines]. This impact will mainly affect pine trees. The maintenance of a protection corridor beneath the power line will result in the reduction of the forest area surrounding the development line.*
>
> *In ecological terms, the significance of this impact is zero, even taking into account species of trees such as oak (Quercus sp.) which may occur throughout the project line, since they have slow growth rates and maximum heights that would hardly interfere with the line."*

The author of this ES used checklists and consultations in addition to verbal argumentative techniques in this assessment.

5.2.5 *IMPACT INTERACTION CHECKLISTS*

The use of checklists is a long established technique in EIA. The following example of using checklists for the assessment of impact interactions was taken from the *EIA for the construction of the first part of the BAB A20 Motorway, Germany.*

The initial parameters defining the relevant impact interactions are illustrated by the compilation of all identified impacts of the project on the environment. This was achieved by using the table illustrating impact interactions between receptors published by the PRO TERRA TEAM. The following tables illustrate the basic direct impacts of the project as well as the relevant impact interactions between the receptors associated with the construction, the operation and the generic development of the motorway.

Table 5.6 Illustration of Using a Checklist to Determine Impact Interactions

Triggering effect (development)	*Impacted Receptor/Function*
Receptor Soil/Geomorphology ➢ *Covering of land, destruction of natural soil horizons and geomorphological structures.*	*Humans (residential & recreational)* ➢ *Loss of land* ➢ *Loss geomorphologically important structures.* *Flora & Fauna* ➢ *Loss of habitat* ➢ *Isolation (barriers minimise exchange of individuals)* *Soil/Geomorphology* ➢ *Loss/impact on natural soil function* ➢ *Loss of valuable geomorphological structures* *Water/Water Bodies* ➢ *Impact on groundwater regeneration* *Landscape* ➢ *Visual impact on landscape*
Receptor Water/Water Bodies ➢ *Loss of soaking area* ➢ *Changes in the hydrology* ➢ *Interruption of groundwater horizons*	*Human (residential & recreational)* ➢ *Impact on recreational value* *Fauna & Flora* ➢ *Loss of aquatic and amphibian habitats* ➢ *Changes in the on site conditions* ➢ *Loss of habitat links* *Water/Water Bodies* ➢ *Changes in the natural water budget*

Table 5.6 Illustration of Using a Checklist to Determine Impact Interactions (cont.)

Triggering Effect/ Operation	*Impacted Receptor/Function*
Receptor Landscape ➢ *Loss of dividing and impressive landscape elements* ➢ *Division of landscape units*	*Human (Residential & Recreational)* ➢ *Impact on recreational amenity* ➢ *Impact on residential quality* *Fauna & Flora* ➢ *Loss of bridging elements between habitats* ➢ *Loss of habitat* *Landscape* ➢ *Visual impact on landscape*
Receptor Fauna & Flora ➢ *Loss of habitat*	*Human (Residential & Recreational)* ➢ *Impact on recreational amenity due to minimisation of the nature experience* *Soil and Water/Water Bodies* ➢ *Impact on the natural soil and water conditions* *Fauna & Flora* ➢ *Minimisation of biodiversity* ➢ *Isolation effects* *Landscape* ➢ *Loss of dividing and impressive structures*
Receptor Human ➢ *Noise*	*Human (Residential & Recreational)* ➢ *Impact on residential quality* ➢ *Impact on/Loss of recreational areas* *Flora & Fauna* ➢ *Noise impact on sensitive animals*
Receptor Climate/Air ➢ *Contamination due to pollutants*	*Human (Residential & Recreation)* ➢ *Impact on residential quality* ➢ *Health impact* *Fauna & Flora* ➢ *Changing of site conditions due to emissions (Eutrophication, heavy metals)* *Soil/Geomorphology* ➢ *Impact on filter and buffer function* ➢ *Impact on agricultural productivity* *Water/Water Bodies* ➢ *Impact on groundwater and surface water from pollutants* *Climate/Air* ➢ *Impact on air quality*

Table 5.6 Illustration of Using a Checklist to Determine Impact Interactions (cont.)

Triggering Effect / Construction	*Impacted Receptor/Function*
Receptor Soil/Geomorphology ➢ *Use of surface area for Machines & Supply Equipment etc.* ➢ *Increasing density of soil* ➢ *Digging*	*Soil/Geomorphology* ➢ *Loss or impact on natural soil function* *Fauna & Flora* ➢ *Loss of habitat* *Humans (Residential & Recreational)* ➢ *Disruption of landscape*
➢ *Construction noise*	*See noise*
➢ *Construction traffic and access roads*	*See operational impacts (impact less significant)*

Section 6.0: Analysis and Implementation of Methodologies

6.0 ANALYSIS AND IMPLEMENTATION OF METHODOLOGIES

6.1 Introduction

The methodologies set out in this volume describe a variety of means for assessing indirect and cumulative impacts as well as impact interactions from the literature, available guidance documents and individual case studies. They have all been developed in different countries, for different studies and for different reasons. Therefore, in order to determine which methodology is most applicable to the European situation a comparison must be made between them. The fifteen methodologies have been assessed by the Expert Panel and the Core Team on the following criteria:

- adaptability to project types, can the methodology be demonstrably applied to a wide range of projects?
- adaptability to environmental conditions, can the methodology be applied to a wide range of environments?
- adaptability to European EIA systems currently in operation?
- is the methodology cost effective?
- is the methodology acceptable to the international EIA community?

Additionally, the Core Team made a comparison on two further criteria, the complexity of the methodology and the utility of the methodology to the EIA practitioner assessing cumulative and indirect impacts as well as impact interactions.

The comparative criteria were weighted according to their relative importance within the context of this study. The most important factors were considered to be:

- adaptability to European EIA systems;
- adaptability to Annex I and Annex II project types;
- cost effectiveness;
- complexity of the methodology; and
- utility of the methodology to the EIA practitioner.

A summary of this comparison can be found in Table 6.1 below.

Table 6.1 Summary Table of Comparisons made between the Available Methodologies

Criteria / Methodology	Adaptability to Project Types	Adaptability to Environmental Conditions	Adaptability to European EIA Systems	Adaptability to Annex I or II Projects	Cost Effectiveness	International Acceptability	Complexity	Utility to the EIA Practitioner	TOTAL
Weighting	1	1	2	2	2	1	2	2	
Planning Process	1	1	0	0	0	0	0	-2	0
Seven Steps	1	1	2	2	2	1	0	2	+11
Acts & Regulatory Powers	0	1	-2	0	-2	1	-2	0	-4
Monitoring & Modelling	1	1	0	0	-2	1	-2	2	+1
Questionnaire Checklist Approach	1	1	2	2	2	1	0	0	+9
Synoptic Approach	1	1	-2	0	-2	1	-2	2	-1
Seven Step Framework	1	1	2	2	0	1	0	2	+9
Impact Interaction Networks - German RSRT	0	1	2	0	0	1	-2	0	+2
The 3 Principal Environmental Elements	0	1	0	0	0	0	0	0	+1
Interaction Pathways	1	1	2	2	0	1	-2	2	+7
Verbal Argumentative Methods	1	1	2	2	2	0	0	0	+8
Impact Interaction Checklists	0	1	2	2	2	1	2	2	+12
Integrated Environmental Index	-1	1	0	-2	0	0	0	0	-2

Table 6.1 (continued) Summary Table of Comparisons made between the Available Methodologies

Criteria / Methodology	Adaptability to Project Types	Adaptability to Environmental Conditions	Adaptability to European EIA Systems	Adaptability to Annex I or II Projects	Cost Effectiveness	International Acceptability	Complexity	Utility to the EIA Practitioner	TOTAL
Weighting	1	1	2	2	2	1	2	2	
UK Design Manual for Roads and Bridges	0	1	2	0	2	1	2	2	+10
CEA through Combining Individual EIAs	1	1	2	2	-2	0	0	0	+4

6.2 Methodology Analysis: Discussion

As can be seen from Table 6.1, no one methodology meets all the criteria laid down at the start of this section in a positive way. However, several of the methodologies do meet some or most of the criteria and their relative merits are discussed below. The following discussion has been generated by comments made by the Expert Panel members and the Core Team.

6.2.1 INTEGRATING THE ASSESSMENT OF INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS INTO THE EIA PLANNING PROCESS

In terms of the comparative criteria, the first methodology described, Lawrence's *Integrating the assessment of indirect and cumulative impacts as well as impact interactions into the EIA Planning Process*, is generally applicable to project types and environmental conditions. However, this methodology has not been written for the European situation. This is a recurring problem with EIA methodologies in general and methodologies to assess indirect and cumulative impacts and impact interactions especially, as most of the few methodologies that do exist originate from the USA where the institutional arrangements for EIA are fundamentally different to that for Europe.

In the United States, under NEPA regulations, EIAs are conducted by the Federal Agencies, with the most relevant Agency taking the lead in the assessment. This leads to the situation where Agencies undertake numerous, similar EIAs (over 40,000 a year are undertaken in the USA). Consequently, the US Federal Agencies can develop complex and specific EIA methodologies as they are required to undertake numerous assessments for similar projects.

In Europe, by comparison, EIA is the responsibility of the individual developer who often hires a specialist consultancy to undertake the EIA on behalf of the developer. Consequently, European EIA is generally undertaken not by specialist Agencies as in the USA, but by broad based private consultants who do not have the time or resources to develop complex EIA methodologies for specific project types or environmental conditions as they may not have to undertake a similar EIA for years.

Returning to Lawrence's methodology, another problem lies in its lack of utility to the EIA practitioner. The bullet point format, under six headings, appears to be too prescriptive in its requirements, yet not comprehensive enough to offer any real advice to an EIA practitioner attempting to incorporate consideration of indirect and cumulative impacts as well as impact interactions into an assessment.

Additionally, there is the disadvantage that by attempting to integrate the assessment of indirect and cumulative impacts as well as impact interactions into the planning process that the procedure will become more complex and time consuming, potentially causing problems for developers and making the whole EIA process even less accessible to a wider audience. Such an attempt at integration would be especially difficult throughout the EU as every Member State has a different planning process, making it very difficult to implement pan-European procedures to address these impact types within the planning process.

The approach taken by Lawrence (1994) is highly theoretical, offering apparently little practical advice to the EIA practitioner as to how to undertake an assessment of indirect and cumulative impacts as well as impact interactions. However, it is useful to see from the list of bullet points just how complex an assessment of such impacts can become with the numerous considerations to be taken into account at all stages of project EIA.

6.2.2 SEVEN STEPS TO CUMULATIVE IMPACT ANALYSIS

Clark's *Seven Steps to Cumulative Impact Analysis* appears to be the most useful in terms of implementing a methodology at the project-EIA level. The methodology is general enough to be applicable to any type of project and applied to any environmental conditions. Moreover, the seven steps methodology is non-prescriptive and with its emphasis on utilisation during the scoping stage of EIA, is flexible and cost effective enough to fit in with the European style of EIA. Most importantly, this methodology requires that potential cumulative and indirect impacts as well as impact interactions are given early consideration and identified during the scoping stage of an EIA project.

This methodology is practical and although Clark implies that it should be used for best effect at the strategic level, it could be easily applied to project EIA at the scoping stage by discounting the first step, the setting of goals, which is most relevant to SEA. Moreover, the method is not prescriptive, it directs the practitioner towards what should be considered and at what stage of the assessment this consideration should be made rather than attempting to dictate a comprehensive method for undertaking the assessment. This approach allows the practitioner to mould the methodology to the requirements of the EIA rather than the EIA be a slave to the methodology, an important consideration given the specific individual requirements of different projects and practitioners.

Overall, this methodology is, along with Damman's Seven Step Methodology, a most useful framework for considering cumulative impacts, indirect impacts and impact interactions. However, its major drawback is its lack of detail in exactly how this consideration should be undertaken.

6.2.3 *ADDRESSING INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS THROUGH ACTS WITH REGULATORY POWERS*

In relation to the comparative criteria given above, Bardecki's *Acts with Regulatory Powers* methodology has several major disadvantages. Firstly, the methodology is based firmly in the planning approach developed for the Canadian system which differs fundamentally from the European approach to EIA, following a similar, Agency led system to that employed in the USA. Secondly, if the system were to be used in Europe, the institutional changes required may result in unacceptable complexity and consequent loss of cost-effectiveness.

In contrast to the two previous methodologies, Bardecki's methodology is firmly based on the planning approach (see Section 2.3). It draws upon, among other things, the "ironic" fact that the key literature reiterates the issues first raised with the initiation of EIA. These include the need for a community/ecosystem oriented, non-linear, interactive, dynamic and contextual approach (Horak *et al*, 1983), all characteristics which EIA initially set out to provide. As the EIA process already has failed to provide this framework, it is, according to Bardecki, questionable whether the EIA process should anymore be considered for a central role in addressing concerns of these types of impact. Fundamentally, Bardecki is promoting the instigation of a comprehensive SEA system.

This methodology provides an interesting and practical approach to dealing with the problem referred to as the "tyranny of small decisions", although the methodology is firmly based on a planning approach. However, it does not offer guidance on issues of particular relevance, such as the setting of spatial and temporal boundaries, impact interactions and so forth and, therefore, its application to project EIA is limited. Although Bardecki's criticism of EIA may be valid, it is nevertheless useful and even necessary to retain the ambition of introducing perspectives relating to the assessment of these impact types into the project EIA process as far as practicable. The role of the project approach to assessing indirect and cumulative impacts as well as impact interactions is therefore not redundant, as Bardecki (1990) himself acknowledges, especially in the case of individual large scale projects.

6.2.4 *MONITORING AND MODELLING*

The *Monitoring and Modelling* methodology is perhaps the most utopian of all the methodologies discussed. In an ideal world of perfect environmental knowledge, Contant's methodology would be used to identify and predict these types of impacts. Unfortunately, in many EU countries the level of baseline environmental data available to be used in models is negligible and the costs of environmental monitoring required to reach the level where accurate modelling could occur may be prohibitively expensive.

However, the emphasis on monitoring and modelling provides a useful focus on two tasks which currently pose serious limitations on the undertaking of effective assessments of indirect and cumulative impacts as well as impact interactions:

- the lack of comprehensive monitoring; and,
- the lack of effective modelling.

The methodology is therefore helpful in pointing to the areas where significant investment and improvement is required in order to provide the right conditions within which comprehensive assessments of these types of impacts can be undertaken.

However, the suggested methodology does not yet provide a practical way forward for undertaking assessments of indirect and cumulative impacts as well as impact interactions for individual projects. It will not be until the databases have been built up through the monitoring activities, and new, more sophisticated models have been developed that comprehensive assessments of such impacts can be undertaken using this methodology. Nevertheless, the principle put forward in this methodology must be taken on board, as that is the only way that the necessary conditions for undertaking effective assessments will become available.

6.2.5 QUESTIONNAIRE CHECKLIST APPROACH

The *Questionnaire Checklist approach* methodology does not set out to be a comprehensive approach, but it does provide a practical approach towards project level assessment of indirect and cumulative impacts as well as impact interactions. Although the authors argue that the methodology can be used both at the scoping stage and at subsequent, more detailed stages, it would seem that it is, nevertheless, best suited to the scoping stage.

With regard to the objectives of this study, the questionnaire checklist essentially only provides for the identification of potential impacts and does not have the ability to consider impact interactions and linkages without relating all the 107 sub-categories to each other in a meta-matrix consisting of over 11,000 components. Nor does the checklist deal with quantifiable impacts, relying on professional judgement instead. However, in combination with other tools, such as GIS, the checklist approach can minimise its weaknesses and prove to be a useful tool for the assessment of these impact types.

In terms of the comparative criteria, the checklist methodology can be applied to most project types and environmental conditions. Moreover, checklists are suited to use within European EIA systems, although the sheer size and complexity of the checklist may result in this methodology being too difficult and time-consuming to be ultimately useful to the EIA practitioner. The advantage that the checklist approach does provide is that of a methodical way of approaching and considering potential cumulative impacts, indirect impacts and impact interactions.

6.2.6 SYNOPTIC APPROACH

The *Synoptic Approach* methodology is a good example of a complex and prescriptive methodology produced by a US Federal Agency to examine a specific issue. Such a methodology would be nearly impossible to use in a European context due to its prescriptive and selective nature. However, such methods may be of great benefit for developments where scoping has identified the potential for significant impacts in relation to specific environmental criteria, whereupon the benefits of using this type of methodology on a selective basis may outweigh its costs.

6.2.7 SEVEN STEP FRAMEWORK

Damman's Seven Step Framework is specifically developed for the project level and provides a very thorough and transparent assessment process. It facilitates the setting of both spatial and temporal boundaries sufficiently broadly to be relevant for the assessment of indirect and cumulative impacts as well as impact interactions, it takes into account wider interests of the community concerned, and it provides a very clear display of the thought process and results of the assessment.

Although originating in North America, this methodology is one of the most practical and adaptable to the European situation of all those considered. Similar to Clark's *Seven Step* methodology (see above and Section 5.1.2), seven steps are followed sequentially. However, of particular interest is that the study for uranium mining developments discussed in Section 5.1.7 was undertaken within time and resource limits and using only the environmental information already available, mimicking the conditions under which EIAs are often conducted in Europe.

The study was undertaken on a sector specific basis, for uranium mining developments, but components of this methodology have also been used for another study concerning Canada's National Parks (d'Entremont & Keith, 1996). Thus, this methodology is demonstrably transferable between project types and may be of particular benefit within the EU where similar types of project are often concentrated in certain areas, such as open cast coal mining in the UK, pig farms in Portugal and coastal tourism developments in Greece.

It can be seen, therefore, that this methodology could be the most practical and beneficial to assessing cumulative and indirect impacts as well as impact interactions within the existing EU EIA system, perhaps even more so than Clark's methodology detailed previously.

6.2.8 IMPACT INTERACTION NETWORKS

Sporbeck's methodology of *impact interaction networks* was developed for the German Research Society for Road and Traffic (see Section 5.1.8). The methodology is perceived to be highly complex which, in turn, diminishes the methodology's utility to the EIA practitioner. The methodology does appear to be very useful in that some steps for conducting the assessment are given and details of how the methodology should be used, such as the setting of boundaries.

The perceived complexity of this methodology is its main drawback, acting as a barrier for its use on small scale project EIAs that are commonly undertaken in Europe. It was also considered that the methodology was written specifically for highway projects and, therefore, it has yet to be demonstrated that the methodology can be adapted to other project types.

6.2.9 THREE PRINCIPAL ELEMENTS OF THE ENVIRONMENT

This methodology was developed by UK consultants Ove Arup & Partners for the EIA of the proposed Strathclyde CrossRail project. The contribution of this methodology lies in its concrete and practical concept of the *three principal elements of the environment*, consisting of:

- Amenity: encompassing both public use and perception of the environment;
- Resource base: encompassing natural resources and land; and
- Material assets: encompassing infrastructure, buildings or historic/cultural features.

However, while the methodology clearly is aimed at the project level assessment, it also takes too narrow a view of cumulative effects by disregarding all action not related to the proposed scheme - it is site specific and not scheme wide. Additionally, the methodology was developed to assess cumulative impact in an urban environment and has yet to proven to be adaptable to other environmental conditions and other project types.

6.2.10 *INTERACTION PATHWAYS*

The use of *interaction pathways*, or networks, to assess cumulative impacts, indirect impacts and impact interactions is well documented (see Section 2.0). Although recognised by practitioners and authorities as being suitable to assess these impact types there are two major drawbacks to the use of interaction pathways: firstly, interaction pathway diagrams can become highly complex, as can be seen from Figure 5.5 taken from the EIA of the East Rendsburg Canal, Germany, connecting the North Sea to the Baltic Sea. The level of complexity associated with interaction pathways acts as a barrier to EIA practitioners, planning authorities and the general public, reducing the transparency of the EIA process.

The second drawback to the use of interaction pathways is a knock-on effect originating from their innate complexity. The development of comprehensive pathways relies on expert knowledge which is very cost intensive. The high cost of developing interaction pathways, even at the scoping stage, acts as a barrier to the employment, especially within the EIA systems prevalent throughout the EU.

6.2.11 *VERBAL ARGUMENTATIVE METHODS*

The use of *verbal argumentative methods* is a simple and effective method of giving qualitative, expert assessment of cumulative impacts, indirect and impact interactions. The survey undertaken as part of this study has demonstrated that verbal argumentative methods are frequently used in EISs.

6.2.12 *IMPACT INTERACTION CHECKLISTS*

Checklists are perhaps the most familiar technique used in the practice of EIA. The *impact interaction checklist* is similar to the questionnaire checklist developed by Canter *et al.* (1995) (see Section 5.1.5 above). However, the use of an impact interaction checklist is considered to be less complex and, consequently, of more utility to the EIA practitioner than Canter's questionnaire checklist.

The only significant drawback to the use of impact interaction checklists, as identified by the comparative criteria, is its perceived lack of adaptability to different project types as the only documented used on the checklists is for highway developments. Therefore, it has yet to be established that the methodology is transferable to other project types.

Additionally, checklists in general are perceived to be prescriptive in their application and have the potential to miss impacts arising from the individual nature of development projects. A solution to this problem could be to combine a generic checklist with another, more flexible, methodology, such as a seven steps style approach.

6.2.13 *INTEGRATED ENVIRONMENTAL INDEX*

The *integrated environmental index* method was developed by the UK Environment Agency and described in their publication, Best Practicable Environmental Option Assessment for Integrated Pollution Control. The methodology was developed specifically for the environmental assessment and licensing of industrial processes under UK law. The methodology is the only one with its approach wholly based on the quantification of environmental effects and is perceived to be an important development in furthering quantification in EIA generally.

However, although the methodology is quantifiable and covers important cumulative, indirect and interactive effects, such as global warming potential and ozone depletion, it was developed specifically for industrial developments and would be difficult to apply to other project types. The methodology would appear to applicable across the EU as many of the environmental assessment limits used in the development of the integrated environmental index are based on environmental quality thresholds implemented by European law, such as the Freshwater Fisheries Directive (78/659/EEC) and the Dangerous Substances Directives (76/464/EEC and 86/280/EEC).

Despite its ground breaking, quantifiable approach, it was not considered that the integrated environmental index was applicable to the assessment of cumulative and indirect impacts as well as impact interactions within the context of this study.

6.2.14 *UK DESIGN MANUAL FOR ROADS AND BRIDGES*

The Stage 1 assessment as described by the UK Department of Transport's Design Manual for Roads and Bridges (DMRB) is a worthwhile and useful methodology in the assessment of cumulative and indirect impacts, as well as impact interactions. The method suggested by the DMRB combines a systematic checklist approach with overlay techniques.

The only real drawback with the DMRB method is that it was principally developed to assess the environmental impacts from road developments. Consequently, there is a question mark over its adaptability to different projects types and, therefore, its ability to transfer between Annex I and Annex II project. Some of these problems can be discounted as certain aspects of the DMRB guidance, such as landscape assessment and the assessment of policies and plans, are frequently used in UK EIAs for projects other than highways.

6.2.15 *COMBINING INDIVIDUAL EIAS*

The approach developed by UK consultants ERM to assess indirect and cumulative impacts as well as impact interactions by combining individual EIAs is considered to be far too limited in its approach to be a useful methodology within the context of this study. The major drawback to this methodology, as indicated by the comparative criteria, is its impact on the cost effectiveness of an EIA project as it requires separate environmental impacts to be undertaken for all major development projects in the study area. Whereupon, each EIA must be compared and combined with the findings of the EIA under development.

Although eminently suitable for the purpose of assessing cumulative and indirect impacts and impact interactions, this methodology could only be realistically employed for very large scale developments, Annex I projects overlapping with other Annex I projects - as was the case for the Channel Tunnel Rail Link and the M2 motorway in the UK, the project for which this assessment methodology was originally developed.

Additionally, this study has revealed that in many Member States it is often very difficult to obtain copies of EISs and the results of similar studies. This lack of baseline data would make the employment of this methodology virtually impossible across all the EU Member States.

In conclusion, although none of the identified methodologies meet all the comparative criteria, the two methodologies that are based on a seven step procedure appear to fulfil most of the criteria and have the flexibility to be applied to a variety project types. Although the seven step methodologies lack specific detail as to how an assessment of the relevant impact types can be carried out they do provide an extremely useful framework to the consideration of cumulative and indirect impacts as well as impact interactions. Additionally, either of the seven step methodologies could be enhanced with the employment by one of the three checklist based approaches, namely the questionnaire checklist, impact interaction checklist or the DMRB methodology.

6.3 Suggested Approaches for Undertaking the Assessment of Indirect and Cumulative Impacts and Impact Interactions

There are essentially two ways to strengthen the assessment of indirect and cumulative impacts as well as impact interaction within the European EIA system given the information gathered by this study:

1. Integration of the assessment of indirect and cumulative impacts and impact interactions into the project EIA system. This paradigm is a bottom-up approach that can be implemented in the short term. It is also the approach that this study set out to develop.

2. Implementation of the assessment of indirect and cumulative impacts as well as impact interactions into an SEA system. This, more radical paradigm, is a top-down approach that would require legislative change and, perhaps, institutional change within the European Union and could only be implemented in the long term. It is, however, the preferred method suggested by much of the available literature (Court, Wright & Guthrie, 1994) and the Expert Panel of this study.

A comprehensive approach to the assessment of indirect and cumulative impacts as well as impact interactions combines these two approaches in a two-tier framework where each approach provides a particular contribution to the analysis, evaluation and management of these types of environmental change. The extension of traditional EIA to encompass the assessment of indirect and cumulative impacts as well as impact interactions is suitable in relation to multiple large projects. However, as some of the most significant conceptual, technical and administrative problems of dealing with these types of impact are in consideration of the multitude of smaller projects and changes, the so-called "tyranny of small decisions" (see Sections 2.5 and 5.1.3), none having impacts of sufficient importance to warrant an environmental assessment individually, there is a clear role to be fulfilled by the planning function.

6.3.1 INTEGRATION OF INTO PROJECT EIA

The integration of the assessment of indirect and cumulative impacts as well as impact interactions into project level EIA follows the scientific approach (see Section 2.3). At the project level, the process is focused on identifying the cumulative effects, indirect effects and impact interactions arising from a specific development project.

Having reviewed and analysed the available literature and examples (see Section 6.1), it is concluded that the most practical of the existing methodologies that could be integrated into existing European project EIA processes is either Clark's *Seven Steps* (Section 5.1.2) or the similar approach developed by Damman *et al.* using open cast uranium mining as a case study, the Seven Step Framework (Section 5.1.7). A diagram explaining how a methodology to assess cumulative and indirect impacts as well as impact interactions based on Damman's methodology could be incorporated into the existing European project EIA system can be seen in Figure 6.1.

Based on the study findings and Figure 6.1, the main reasons for emphasising the use of a seven step methodology are:

1. They are flexible and non-prescriptive in their use and could be adapted to any project EIA undertaken under the requirements of the EIA Directive (85/337).

2. They are cost-effective: using a seven step methodology no significant additional resources are required, in terms of time or materials, that would otherwise be used in a European project EIA.

   Damman's concept of social scoping, closely involving statutory consultees and the general public in the identification of VECs, should only be undertaken where resources allow.

3. They can be implemented into the EIA process at an early stage, specifically at the scoping phase. As can be seen from Damman's methodology (see Figure 5.2), implementation at the scoping phase will also increase the transparency of the assessment process, allowing the involvement, at a minimum, of statutory consultees and, ideally, the public. Both methodologies advocate the delimitation of accurate spatial and temporal boundaries which is important in limiting the scope of the assessment of indirect and cumulative imapcts as well as impact interactions and thus preventing the concept of "everything being linked to everything else" from creeping into the assessment.

   The seven step methodologies can be further strengthened by amalgamating them with a checklist methodology to assist in identifying key impacts during the scoping stage of the EIA.

4. Finally, the use of impact pathways in Damman's methodology orientates the assessment of indirect and cumulative impacts as well as impact interactions firmly on individual receptors. This orientation should help the assessment avoid becoming too qualitative and promote the development of more quantitative techniques.

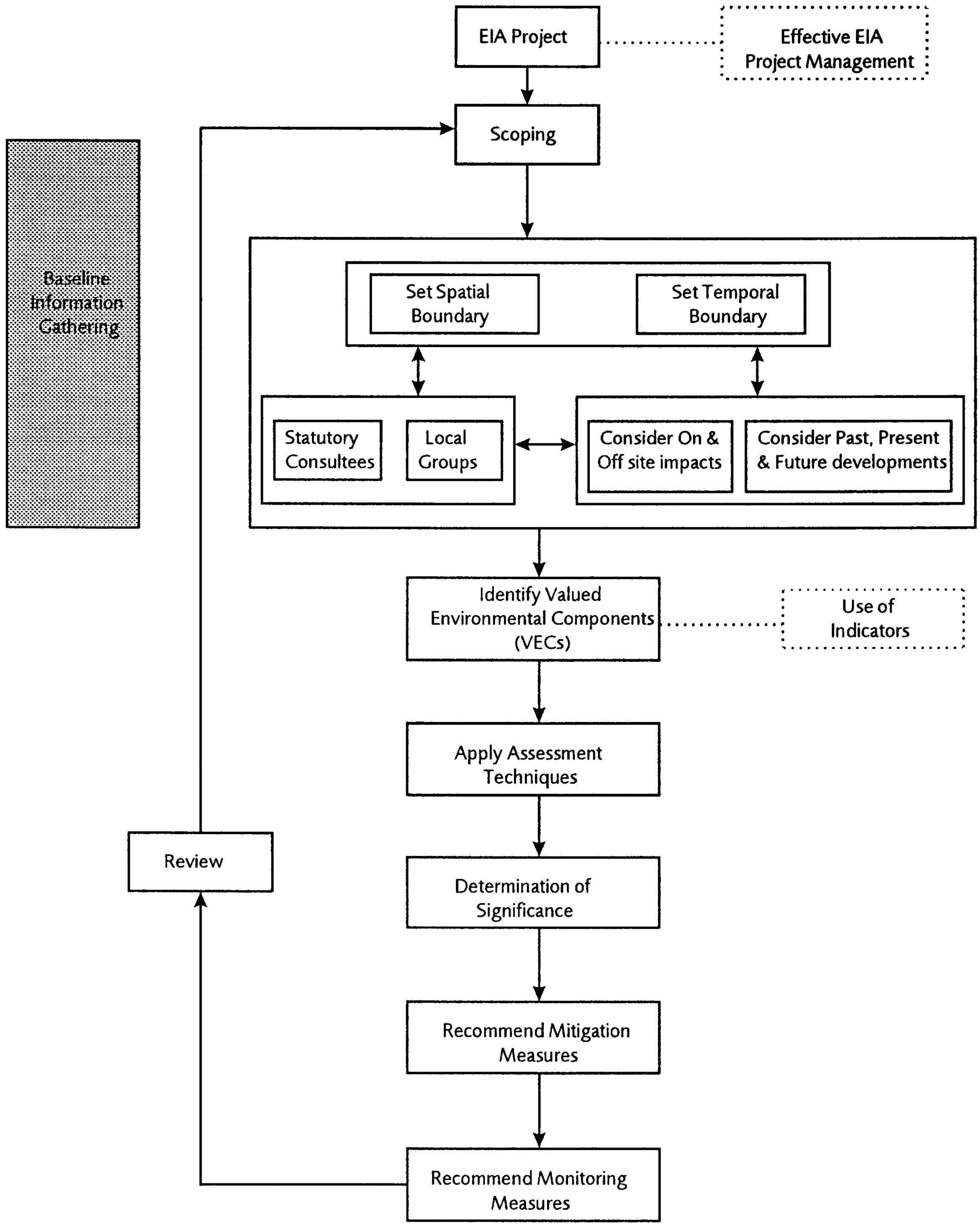

Figure 6.1 Flow diagram showing the main components of integrating the assessment of indirect and cumulative impacts and impact interactions into the existing European EIA System

However, given the great uncertainty facing EIA practitioners undertaking the assessment of indirect and cumulative impacts as well as impact interactions using more than one methodology may be more appropriate for individual studies.

As can be seen from Figure 6.1, in addition to the recommended methodology, it is possible to identify some concepts that may be useful in the planning, management and reporting of project level assessment.

The quality of an EIA is fundamentally affected by the approach taken to the EIA and how this approach is managed. An EIA should, ideally, be undertaken by a team of people who are expert in their individual field, such as an ecologist for assessing nature conservation issues, a hydrologist for water issues and so forth. The team should be managed by an individual with specialist EIA knowledge who will assist the experts in determining the EIA techniques most applicable to the project. The EIA specialist should also act as the single author for the EIS. The EIA specialist is not necessarily an expert in any one particular field but can write the EIS in an appropriate style and can communicate the specialist assessments in a clear and meaningful way to the authority receiving the EIS who may not have specialist scientific knowledge.

Ideally, the final version of the EIS should be reviewed by a third party before submission to the receiving authority to ensure compliance with the requirements of the EIA Directive.

Setting up a *working team* of interested parties which would meet at the project initiation stage can provide an opportunity for the developer to explain the project and for interested parties to comment on potential impacts. This is based on the Delphi method (see Section 2.2) by attempting to build the views of key parties into the impact evaluation process, albeit introducing the technique at a much earlier stage of the EIA process. In this manner, the potential impacts of interest to the different key parties will reach a common forum and linkages between impacts can be identified through sharing specialist knowledge.

It is important at the scoping stage to treat the setting of *spatial and temporal boundaries* with as much flexibility as possible. Boundaries should be considered as no more than another tool to help rationalise the assessment task, boundaries can facilitate a focused and efficient process. Boundaries should take into account that environmental change does not conform with any artificially imposed spatial or temporal boundaries, such as the administrative boundaries of a Local or Regional Planning Authority. The extent of spatial boundaries should be determined by the particular environmental criteria under consideration, similar to step 4 of Damman's methodology which identifies Valued Ecosystem Components (VECs). For each identified VEC an impact area can be described then assessed for cumulative impacts, indirect impacts or impact interactions using GIS or simple overlays, depending on the complexity of the EIA and/or the resources available (see Sections 2.2 and 2.6).

In order to identify a VEC it may be practical to utilise appropriate indicators to represent environmental criteria, such as NO_x for air quality, particular species for ecosystems, dissolved O_2 for water quality and so forth. The use of indicators could serve more than one purpose; indicators can be used to design monitoring regimes and also to delineate the carrying capacity of environmental criteria.

Environmental carrying capacity is derived from the ecological term used to describe the number of individuals an area of land can support. In the field of EIA environmental carrying capacity has come to mean something broader: the amount of disturbance and/or pollution an environmental criteria can withstand before it is compromised. By determining the carrying capacity for an environmental criteria, such as air quality, in the area surrounding a development project it may be far simpler to identify and assess indirect and cumulative impacts and impact interactions. However, the determination of environmental carrying capacity is far beyond the scope of most project EIAs. This task would be more appropriate to a regional SEA, the information from which could then be utilised by individual project EIAs.

However, as more Local Authorities around the world strive to implement the requirements of Agenda 21, the amount of research undertaken to identify sustainability indicators has increased dramatically. These pre-developed indicators could be employed by a project EIA to identify VECs within the development project area. If indicators are used in project EIA, several indicators should ideally be used for each environmental criteria to ensure a wide coverage of possible interactions. Additionally, indicators could be used to demonstrate the sustainability of a proposed development.

There are numerous types of sustainability indicator published, for the purposes of project EIA the more localised these indicators are the better. Indicators for regional, national or international sustainability will not be appropriate for the purposes of project EIA, but may be appropriate for aspects of indirect and cumulative impacts as well as impact interactions, such as the assessment of global warming potential or the effects ozone depleting chemicals. Some examples of localised sustainability indicators available in the UK include those published by the UK Local Government Management Board and the London Government Advisory Committee. Global indicators include those developed by the United Nations Environment Programme and the World Bank.

In terms of temporal boundaries, flexibility is important given the increasing influence of uncertainty in EIA as the assessment extends through time. It may, therefore, be of little value to attempt to assess, especially, cumulative impacts and indirect impacts but also impact interactions more than a few years into the future in project EIA due to uncertainty concerning impact prediction. Clark's methodology (see Section 5.1.2) recommends that temporal boundaries should be between 5 and 20 years. However, this estimate is based on a planning approach. A more likely temporal boundary for project EIA would probably be no more than 5 years into the future.

Early consultation with statutory consultees, planning authorities and environmental regulators can help to identify existing plans for future development projects or of other projects being developed within a particular timescale. Such consultation can assist in setting the appropriate temporal boundary for the assessment of indirect and cumulative impacts as well as impact interactions for any particular project.

When structuring the assessment process, the main focus of the assessment should always be on *impact receptors*. Instead of undertaking the measurement, assessment and evaluation of environmental issues in a compartmentalised way, such as on air, water and ecology, the assessment of indirect and cumulative impacts as well as impact interactions should be approached in a holistic way but taken from the point of view of the receptor(s). This approach can also assist in the presentation of the findings as it allows for a comprehensive and uninterrupted discussion of impacts on each receptor.

The significance of the effects of these impact types should be determined in a similar manner to direct impacts. Generally, significance should be determined through the use of a series of criteria (UK Department of the Environment, 1995), specifically:

- geographic effect (international, national, regional, district or local);
- magnitude of effect;
- beneficial or adverse impact;
- duration of effect (short, medium or long term);
- reversible or irreversible effect; and,
- an indication of uncertainty.

Ideally significance should be quantitative and linked to environmental quality standards given in law (for example the EC Freshwater Fisheries Directive (78/659/EEC) for water quality issues) or as guidance by statutory or non-statutory consultees.

In order to assist the use of this paradigm of bottom-up implementation of the assessment of indirect and cumulative impacts as well as impact interactions, it is also worth examining some institutional changes that could be implemented via guidance notices or similar non-legislative means. For example, the screening of projects early in the EIA process, generally by the relevant environmental planning authorities, could be improved by guidance on projects that carry generic cumulative and indirect impacts as well as impact interactions. Indicative impact types could be (Cocklin *et al*, 1992):

- space crowding;
- time crowding;
- compounding effects;
- trans-boundary impacts;
- exceedance of carrying capacity; and
- ecosystem patchiness.

Guidance on screening could, eventually, be translated into legislative requirement by a revision of thresholds in Annex I and Annex II of the EIA Directive (85/337/EC).

6.3.2 IMPLEMENTATION OF THE ASSESSMENT OF INDIRECT AND CUMULATIVE IMPACTS AS WELL AS IMPACT INTERACTIONS INTO AN SEA SYSTEM

Although this approach appears to be the favoured approach to the assessment of indirection and cumulative impacts as well as impact interactions in many other parts of the world, such as Australia (Court, Wright & Guthrie, 1994), it is beyond the scope of this report to assess its applicability to European EIA procedures. An SEA Directive is currently under draft in the EU and more information on European SEA can be found in the 1994 report on Strategic Environmental Assessment produced by DHV Environment and Infrastructure for the European Commission Directorate General XI.

Briefly, this approach starts at the strategic level. The strategy and SEA initially identifies a system as a whole, such as a river catchment area, before dividing the system into individual projects. In this way, potential cumulative and indirect impacts as well as impact interactions can be identified and environmental objectives for the system can be set. The strategic guidance is then applied to individual project EIAs.

Appendix A: Abbreviations and Glossary of Terms

Abbreviations and Glossary of Terms

CBA	Cost Benefit Analysis - a technique for evaluating development projects by weighing the financial advantages against its disadvantages.
DGXI	Directorate-General XI of the European Commission whose remit covers nuclear, environmental and civil protection.
EC	European Commission
EHIA	Environmental Health Impact Assessment - procedure for predicting and evaluating the effects of a proposed development specifically pertaining to environmental health issues such as the spread of disease.
EIA	Environmental Impact Assessment - a procedure for predicting and evaluating the effects of a proposed development on its surrounding environment.
EIS	Environmental Impact Statement - report prepared on the completion of an Environmental Impact Assessment often submitted to the Local Planning Authority in support of a development proposal.
EMAS	Eco-Management and Audit Scheme
EPA	Environmental Protection Agency (USA)
EPD	Environmental Protection Department (Hong Kong)
EU	European Union
FONSI	Finding Of No Significant Impact - term used in Environmental Impact Statements to demonstrate that types of environmental impact have been considered but were found not to be of consequence.
GIS	Geographic Information Systems - technique for electronically storing and manipulating geographic and environmental data.
IPC	Integrated Pollution Control - legal process in the UK by which large industrial processes are licensed and regulated.
IPPC	Integrated Pollution Prevention and Control - legal process by which large industrial processes are licensed and regulated, refers specifically to the requirements of the European Commission's IPPC Directive (96/61/EC)
MAUT	Multi-Attribute Utility Theory
NEPA	National Environmental Planning Act - introduced into US law in 1969 and seen as the first official requirement for EIA in the world.
NGO	Non-Governmental Organisation

PER	Public Environment Report - produced under Australian law for development proposals deemed to be of low environmental significance.
SEA	Strategic Environmental Assessment - procedure to predict and evaluate the effect on the environment by the implementation of policies, plans or programmes.
SIA	Social Impact Assessment - procedure to predict and evaluate the effects of a proposed development on its surrounding social environment.
UK	United Kingdom
UNEP	United Nations Environment Programme

Appendix B: References

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