

Part I

Methods for environmental components

1 Introduction

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1.1 EIA and the aims of the book

This book aims to improve practice of environmental impact assessment (EIA) by providing information about how EIAs are, and should be, carried out. Although it focuses on the UK context in its discussion of policies and standards, the principles it discusses apply universally, as do many of the assessment methods it describes. This introductory chapter (a) summarises the current status of EIA, and the legislative background in the UK and EU, (b) explains the book's structure, and (c) considers some trends in EIA methods.

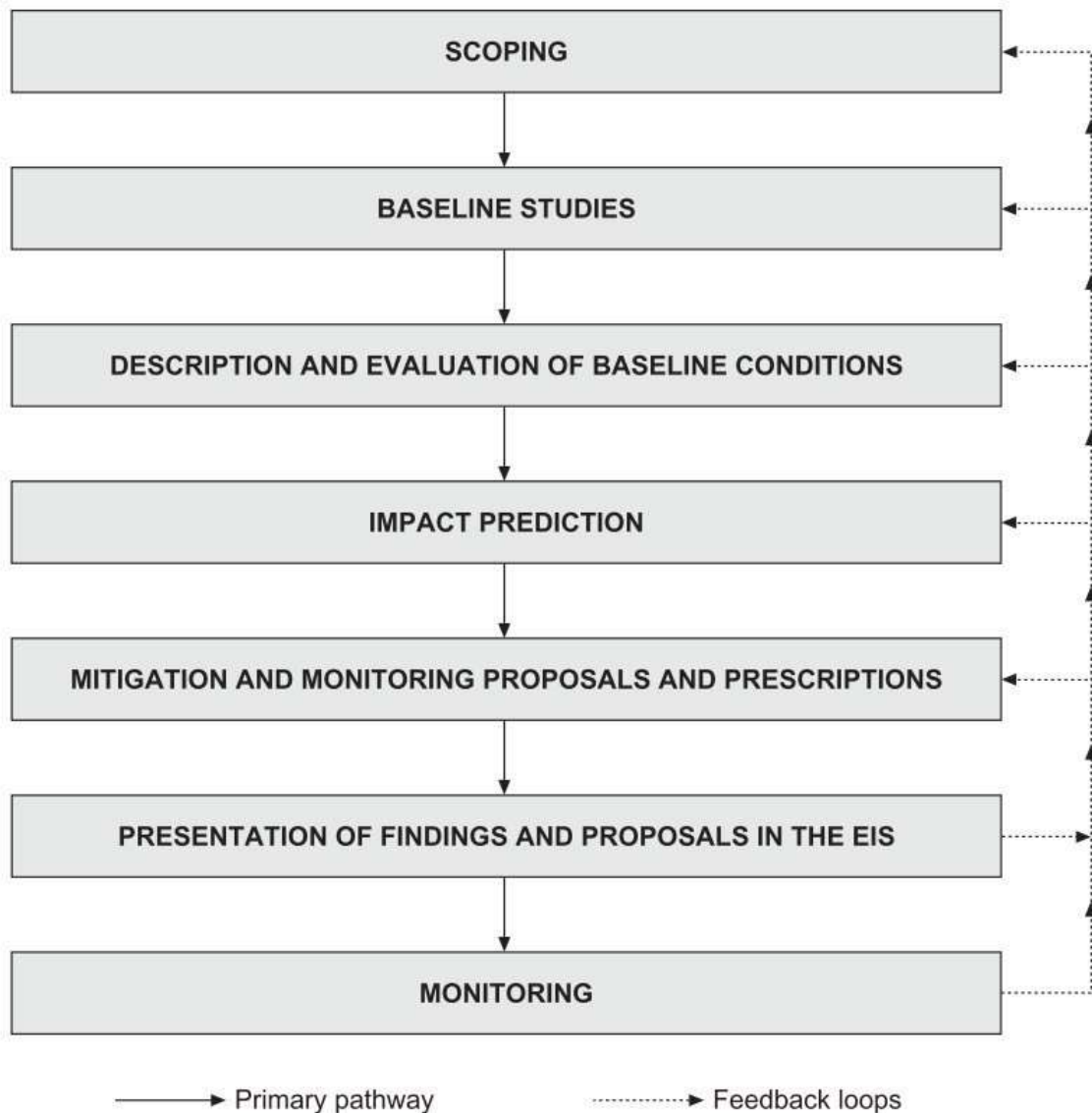
Formal EIA can be defined as “the whole process whereby information about the environmental effects of a project is collected, assessed and taken into account in reaching a decision on whether the project should go ahead or not” (DCLG 2006a). It can also be defined more simply as “an assessment of the impacts of a planned activity on the environment” (UNECE 1991). In addition to the decision on whether a project should proceed, an EIA will consider aspects such as **project options/alternatives** and mitigation measures that should be implemented if the development is allowed. The findings of an EIA are presented in a document called an Environmental Statement or (as in this book) **Environmental Impact Statement** (EIS). The overall EIA process is explained and discussed in this book's “sister volume”, *Introduction to Environmental Impact Assessment* (Glasson *et al.* 2005).

EIAs involve individual assessments of aspects of the environment (e.g. population, landscape, heritage, air, climate, soil, water, fauna, flora) likely to be significantly affected by a proposed project. This book focuses on assessment methods (practical techniques) used in the part of the EIA process concerned with analysing a development's impacts on these **environmental components**.

1.2 The EIA process

1.2.1 Introduction

The main EIA procedures that will be followed in the assessment of any environmental component are summarised in **Figure 1.1**. The figure assumes that the



The model illustrates the stepwise nature of EIA, but also the requirement for continuous reappraisal and adjustment (as indicated by the feedback loops).

Figure 1.1 Procedures in the assessment of an environmental component for an EIA.

developer has conducted feasibility studies, and that **screening** has already been carried out – and these assumptions are made in the chapters. Screening is discussed in Glasson *et al.* (2005).

1.2.2 Scoping and baseline studies

Scoping is an essential first step in the assessment of a component. The main aims are:

- to identify at an early stage (when the project design is relatively amenable to modification) what key **receptors**, impacts and project alternatives

to consider, what methodologies to use, and whom to consult. UK government policy also advocates an appraisal-led design process, and various documents (e.g. MAFF 2000) provide guidance on identifying the **preferred option** from an environmental perspective;

- to ensure that resources and time are focused on important impacts and receptors;
- to establish early communication between the developer, consultants, statutory consultees and other interest groups who can provide advice and information;
- to warn the developer of any constraints which may pose problems if not discovered until later in the EIA process.

The scoping exercise should provide a ground plan for subsequent steps by making a preliminary assessment of:

- the project's **potential impacts** on component receptors, estimated from the project description (including its size, construction requirements, operational features and secondary developments such as access roads) and the nature of components and receptors;
- the **impact area/zone** within which impacts are likely occur, estimated from the impact types and the nature of the surrounding area and environmental components, e.g. impacts on air or water may occur at considerable distances from the project site;
- possible **mitigation measures**;
- the need and potential for **monitoring**;
- the **methods and levels of study** needed to obtain reliable baseline information that can be used to evaluate the baseline conditions, make accurate impact predictions, and formulate adequate mitigation measures and monitoring procedures. The selection of methods should involve consideration of:
 - the impact and receptor variables on which the studies will focus, and the accuracy and precision needed for each;
 - the most appropriate methods for collecting, analysing and presenting information;
 - the resource requirements and timing considerations, especially for field surveys;
 - constraints such as the time and resources available.

Some commonly used aids in EIA are outlined in **Table 1.1**. Two of these, checklists and scorecards, are useful scoping tools, particularly for tasks such as identifying key impacts and receptors, and selecting appropriate consultees and interest groups. The findings of the scoping exercise should be documented in a **scoping report** that is made available to the developer, participating consultants and consultees. However, lack of detailed information at the scoping stage means that scoping estimates and decisions should be reassessed in the light of baseline information gained as the EIA progresses.

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Table 1.1 Commonly used aids in EIA

Method	Attributes
Checklists	Useful, especially in scoping, for identifying key impacts and ensuring that they are not overlooked. Can include information such as data requirements, study options, questions to be answered, and statutory thresholds – but are not generally suitable for detailed analysis. Can have various uses, e.g. (a) to identify impacts and cause–effect links between impact sources (plotted along one axis) and impacts (plotted along the other axis); (b) to link features such as magnitude and extent (e.g. localised or extensive, short or long term); and (c) to derive estimated impact significances from assessed receptor values and impact magnitudes (e.g. see Table 11.8).
Scorecards	Provide a simple, transparent method for comparing and ranking “subjects” such as receptors or impact factors. Scores for several criteria can be assigned to each subject; and various scales can be used, although summation is only possible if the same scale applies to all criteria (Table 1.2). The method can be used for assessing the relative importance of “subjects” in various contexts including scoping (e.g. identifying key receptors), impact prediction, project options appraisal, and integration of component assessments. However: (a) it does not assist in determining if criteria overlap/interact or should be given different weightings; and (b) unless based on quantitative data, the scores are subjective, and experts with differing viewpoints may assign different scores for a given criterion.
Flowcharts and networks	Can be useful for identifying cause–effect links/pathways: between impact sources; between sources and impacts; and between primary and secondary impacts. However, they cannot quantify the magnitudes of impacts or of their effects.
Mathematical/statistical models	Are based on mathematical or statistical functions which are applied to calculate deterministic or probabilistic quantitative values from numerical input data. They range from simple formulae to sophisticated models that incorporate many variables. They need adequate/reliable data, can be expensive, and may not be suitable for “off the peg” use.
Maps	Are often essential. They can indicate features such as impact areas/zones, and locations and extents of receptor sites and/or features within these. Overlay maps can combine and integrate two or three “layers”, e.g. for different impacts and/or environmental components or receptors.
GIS (Chapter 14)	Can be very valuable (a) as a sophisticated mapping tool that can relate a number of different variables by spatially referencing (overlying) datasets, and (b) in conjunction with an external tool (such as an expert system or simulation model) as a means of analysing quantitative data and modelling outcomes.

Table 1.2 A hypothetical scorecard to compare and rank four subjects in relation to four criteria assessed by means of different scales

	Criterion 1 (% scale)	Criterion 2 (1–10 scale)	Criterion 3 (0–5 scale)	Criterion 4 (+/- scale)	Sum (if applicable)	Rank (if possible)
Subject 1	15	5	5	+		2
Subject 2	40	3	2	0		3
Subject 3	60	6	4	++		1
Subject 4	10	4	1	–		4

Baseline studies form the backbone of component assessments. It is only when they provide sound information on the socio-economic or environmental systems in the impact area that valid impact predictions can be made, and effective mitigation and monitoring programmes formulated.

The distinction between baseline studies and scoping is not clear cut because (a) consultation should be ongoing, and (b) scoping includes gathering information, much of which is effectively baseline material that can at least form the starting point for more detailed studies. In both stages, it is usually possible to compile some of the required information, by means of a **desk study**. A thorough search should be made because (a) gathering existing information is generally less expensive and time-consuming than obtaining new data, and (b) it is pointless to undertake new work that merely duplicates information that already exists. However

- Scoping will usually require brief site visits (e.g. for reconnaissance or to confirm features identified on maps) – perhaps including walkover surveys. Such initial visits are best undertaken by several members of the EIA and design team, so that relationships between components can be identified.
- In most cases, existing baseline data will be inadequate or out of date, and it will be necessary to obtain new information by some form of **field survey**.

The **description and evaluation of baseline conditions** should include:

- a clear presentation of methods and results;
- indications of limitations and uncertainties, e.g. in relation to data accuracy and completeness;
- an assessment of the value of key receptors and their sensitivity to impacts.

1.2.3 Impact prediction

Impact prediction is fundamental to EIA, and the likely impacts of a project should be considered for all environmental components. In order to predict the impacts of a development it is also necessary to consider changes in the baseline conditions that may occur in its absence (a) prior to its initiation, which

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can be several years after production of the EIS, and (b) during its projected lifetime. These can be assessed in relation to the current baseline conditions and information on past, present and predicted conditions and trends. Most of the relevant information will have to be sought through the desk study although comparison of field survey data with previous data can help to elucidate recent trends. Box 7.1 gives sources of historical information.

According to the EIA legislation (§1.3) impact prediction should include assessment of

- **Direct/primary impacts** – that are a direct result of a development.
- **Indirect/secondary impacts** – that may be “knock on” effects of (and in the same location as) direct impacts, but are often produced in other locations and/or as a result of a complex pathway.
- **Cumulative impacts** – that accrue over time and space from a number of developments or activities, and to which a new project may contribute. In “*appropriate assessment*” (under the Habitats Directive), these are called “in combination” impacts.

An additional possibility is **impact interactions** – between different impacts of a project, or between these and impacts of other projects – that result in one or more additional impacts, e.g. $(A + B) \rightarrow C$. For instance, the interaction of population and air pollution may cause health effects.

All impacts may be: **positive** (beneficial) or **negative** (adverse); **short-, medium-, or long-term**; **reversible** or **irreversible**; and **permanent** or **temporary**.

Ideally, impact prediction requires:

- a good understanding of the nature of the proposed project, including project design, construction activities and timing;
- knowledge of the outcomes of similar projects and EIAs, including the effectiveness of mitigation measures;
- knowledge of past, existing or approved projects which may cause interactive or cumulative impacts with the project being assessed;
- predictions of the project’s impacts on other environmental components that may interact with that under study;
- adequate information about the relevant receptors, and knowledge of how these may respond to environmental changes/disturbances.

Methods of impact prediction vary both between and within EIA components. For example, the assessment of impact **magnitude** (severity) may be qualitative or quantitative. Qualitative assessments usually employ ratings such as *neutral*, *slight*, *moderate*, *large* – applied to both negative and positive impacts. They are typically used where quantitative assessments are difficult or impossible, for instance in landscape, archaeological and ecological assessment. Quantitative assessments involve the measurement or calculation of numerical values, e.g. of the level of a **pollutant** in relation to a statutory threshold value.

Standard techniques that can be used to aid impact prediction in assessments of most environmental components are reviewed in Glasson *et al.* (2005) and briefly summarised in Table 1.1.

It is also important to assess **impact significance**, which is the “product” of an impact’s magnitude and the value, sensitivity/fragility and recoverability of the relevant receptor(s). It therefore requires an evaluation of these receptor attributes – which should have been carried out in the baseline evaluation.

Impact prediction is often poorly addressed, perhaps because it is the most difficult step in EIA. Direct impacts are usually relatively easy to identify, but accurate prediction of indirect and **cumulative impacts** can be much more problematic. Guidance on assessing these (and impact interactions) is provided in CEAA (1999) and EC (1999).

Whatever methods are employed, impact prediction is not an exact science. There are bound to be uncertainties (that can sometimes be expressed as ranges) which should be clearly stated in the EIS.

1.2.4 Mitigation

Mitigation measures aim to avoid, minimise, remedy or compensate (in that sequence) for the predicted adverse impacts of the project. They can include:

- selection of alternative production techniques, and/or locations or alignments (of linear projects);
- modification of the methods and timing of construction;
- modification of design features, including site boundaries and features, e.g. landscaping;
- minimisation of operational impacts (e.g. pollution and waste);
- specific measures, perhaps outside the development site, to minimise particular impacts;
- measures to compensate for losses, e.g. of amenity or habitat features.

Much of the environmental damage caused by developments occurs during the **construction phase**, and a problem is that construction is usually contracted to a construction company who will not have participated in the EIA process, and over whom the developer may have little control (Wathern 1999). Consequently, there is a need to provide a Construction Environmental Management Plan, ideally as part of an overall project Environmental Management Plan (see §1.5). In addition, because project specifications frequently change between publication of the EIS and the start or completion of construction (often for unforeseeable reasons) developers sometimes employ site environmental managers to ensure (a) that such modifications take account of environmental considerations, and (b) that construction phase mitigation measures are carried out.

Different mitigation measures will be needed in relation to specific impacts on different environmental components and receptors. The EIS should provide detailed prescriptions for proposed measures for each impact, indicate how they

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would actually be put in place, and propose how they might be modified if unforeseen post-project impacts arise. A primary consideration is the likely significance of post-mitigation **residual impacts**, and care is needed to ensure that a mitigation measure does not generate new impacts, perhaps on receptors in other environmental components.

Best practice dictates that the **precautionary principle** (advocated in EU and UK environmental policy) should be applied, i.e. that mitigation should be based on the possibility of a significant impact even though there may not be conclusive evidence that it will occur. Similarly, on the basis of the EU principles that preventive action is preferable to remedial measures, and that environmental damage should be rectified at source (see §1.3) the best mitigation measures should involve modifications to the project rather than containment or repair at receptor sites, or compensatory measures such as habitat creation – which should normally be considered only as a last resort (see §11.8.4).

In addition to mitigation, government guidelines suggest that opportunities for **environmental enhancement** (improvement of current environmental conditions and features) should be sought in EIA. For instance, this is one of the duties of the Environment Agency, especially in relation to coastal and flood defences (Defra 2005).

1.2.5 Presentation of findings and proposals in the EIS

The information presented in the EIS must be clear and, at least in the non-technical summary, should be in a form that can be understood by “non-experts” without compromising its integrity. It should also be “transparent”, e.g. in relation to limitations and uncertainties. Presentation methods vary between components, but can include the use of maps, graphs/charts, tables and photographs.

The EIS must be an integrated document, and this will necessitate assessing the component in relation to others, e.g. to evaluate its relative importance, and ensure that potential conflicts of interest have been addressed (see §1.5).

1.2.6 Monitoring

Monitoring can be defined as the continuous assessment of environmental or socio-economic variables by the systematic collection of specific data in space and time. It can be strictly continuous, e.g. using recording instruments, but more commonly involves periodic repeat data collection, usually by the same or similar methods as in baseline surveys. Monitoring in EIA can include

- **Baseline monitoring** – which may be carried out over seasons or years to quantify ranges of natural variation and/or directions and rates of change, that are relevant to impact prediction and mitigation. This can avoid the frequent criticism that baseline studies are only “snapshots” in time. However, time constraints in EIA usually preclude lengthy survey programmes, and assessments of long-term trends normally have to rely on existing data.

- **Compliance monitoring** – which aims to check that specific conditions and standards are met, e.g. in relation to emissions of pollutants.
- **Impact and mitigation monitoring** – which aims to compare predicted and actual (residual) impacts, and hence to determine the effectiveness of mitigation measures.

Unless otherwise specified, “monitoring” in EIA normally refers to impact and mitigation monitoring, which is also sometimes called auditing. There is often considerable uncertainty associated with impacts and mitigation measures, and it is responsible best practice to undertake monitoring during both the construction and post-development phases of a project. Monitoring is essential to learn from both successes and failures. For example:

- It is the only mechanism for comparing predicted and actual impacts, and hence of checking whether mitigation measures have been put in place, testing their effectiveness, and evaluating the efficiency of the project management programme;
- If mitigation measures are amenable to modification, it should still be possible to reduce residual impacts identified during monitoring (feedback loop in Figure 1.1);
- It can provide information about responses of particular receptors to impacts;
- It is the only means of EIA/EIS evaluation and of identifying mistakes that may be rectified in future EIAs. For example, it will provide information that can be used to assess the adequacy of survey and predictive methods, and how they may be improved. Thus, a principal aim of monitoring should be to contribute to a cumulative database that can facilitate the improvement of future EIAs (Clark 1996).

Three requirements are essential for successful monitoring: (a) baseline data that are good enough to detect residual impacts; (b) funding to carry out the monitoring survey work; and (c) sufficient contingency funds to enable modifications to mitigation measures to be made, or faults to be rectified, if necessary.

Monitoring is not strictly part of the EIA process, is not statutory in the UK, and can be expensive. Consequently, in spite of government guidance that it should be undertaken (e.g. Defra 2005) lack of monitoring is a serious deficiency in current EIA practice (SNH 2005).

1.3 The current status of EIA

Since the first EIA system was established in the USA in 1970, EIA systems have been set up worldwide and have become a powerful environmental safeguard in the project planning process. In Europe, EU Directives 85/337/EEC, 97/11/EC and 2003/35/EC (EC 1985, 1997, 2003) set the legal basis for individual member states’ EIA regulations. More than 300 EISs are currently prepared annually in the UK alone.

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Several important internationally-accepted principles underlie the recent rapid growth in EIA and *strategic environmental assessment* (SEA) (see §1.6). The World Commission on Environment and Development espoused the principle of **sustainable development** in its report of 1987 (WCED 1987), and this was further elucidated at the UN Conference on Environment and Development (UNCED 1992) – the “Rio Earth Summit”. EIA is an example of this evolving worldwide emphasis on preventive, holistic approaches to environmental protection and promotion of sustainable development (see Chapter 16).

EU Directives 85/337/EEC and 97/11/EC require that, for a specified list of project types (Annex I of Directive 97/11), EIA *must* be carried out. EIA *may* be carried out for projects in another list (Annex II), depending on the characteristics and location of the project, and the characteristics of the potential impacts (Annex III). The required contents of the EIS are given in Annex IV. These are:

1. Description of the project, including in particular:
 - a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases;
 - a description of the main characteristics of the production processes, for instance, nature and quantity of the materials used;
 - an estimate, by type and quantity, of expected residues and emissions resulting from the operation of the proposed project.
2. An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.
3. A description of the aspects of the environment likely to be significantly affected by the proposed project including, in particular, population, fauna and flora, soil, water, air and climate, material assets (including the architectural and archaeological heritage), landscape and the inter-relationship between the above factors.
4. A description of the likely significant effects of the proposed project on the environment resulting from:
 - the existence of the project;
 - the use of natural resources;
 - the emission of pollutants, the creation of nuisances and the elimination of waste; and
 - the description by the developer of the forecasting methods used to assess the effects on the environment.
5. A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.
6. A non-technical summary of the information provided under the above headings.
7. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

Directive 97/11/EC (EC 1997), which became operational on 14 March 1999, expanded the requirements of Directive 85/337/EEC by:

- requiring EIA for a wider range of projects, and upgrading of some Annex II projects to Annex I status;
- giving criteria (including the concept of “**sensitive environments**” and a list of specified types of sensitive environments) for choosing which Annex II projects require EIA;
- strengthening the procedural requirements concerning transboundary impacts (where pollution from one country affects another country);
- requiring developers to include an outline of the main alternatives that they studied and explain the reasons for the final choice between alternatives;
- allowing developers to request an opinion from the **competent authority** on the scope of an EIA;
- requiring competent authorities to make public the main reasons on which project decisions are based and the main mitigation measures required.

The *Public Participation Directive* 2003/35/EC (EC 2003) aims to contribute to the implementation of the obligations arising under the Aarhus Convention, by improving public participation and providing for access to justice through EIA. It provides more detailed requirements for how the public and other Member States should be informed about EIA. It also sets new requirements that allow members of the public with a sufficient interest or whose rights have been impaired through a planning decision to have access to a legal review procedure.

In the UK, EIA Directives are implemented by about 40 regulations – mainly Statutory Instruments (SIs). The core regulations are the *Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations* 1999 (HMSO 1999) and the equivalent regulations in Scotland (SE 1999a). The requirements of each regulation differ slightly, but all are essentially variants of the core regulations. Schedules 3 and 4 of the regulations are particularly relevant to this book.

English government guidance on the EIA procedures is given in ODPM (2000). Guidance on the preparation of EISs is given in DoE (1995), DETR (1999) and two consultation documents DCLG (2006a, 2006b). Information about legal issues related to EIA is at DCLG (undated). Scottish guidance is given by SE (1999b) and SNH (2005). EU guidance on EIA is available at <http://ec.europa.eu/environment/eia/home.htm>. EIA procedures are further discussed in Glasson *et al.* (2005), which also presents a wide range of further literature on the topic.

EIA is also being carried out informally in situations where it is not mandatory, but where developers feel that its structured approach would help in project management or in speeding up the planning process (Hughes & Wood 1996). Moreover, authorities such as the Environment Agency frequently produce or require informal **environmental appraisals** for projects not requiring statutory EIA. The principles and procedures described in this book also apply to such informal assessments.

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In addition to the specific EIA legislation, a wide range of legislation affects the assessment of individual environmental components, key examples of which are referred to in the relevant chapters of this book.

1.4 Book structure

The book is divided into two main parts.

Part I discusses EIA methods for a range of environmental components. **Table 1.3** shows how the chapters correspond to the components itemised for particular attention in the EU and UK legislation. The book includes some components not specifically listed in the regulations but often discussed in practice, namely noise, transport, geology and geomorphology. Chapters 2 and 3 deal with socio-economic impacts. Chapters 4–7 deal with impacts that are partly socio-economic and partly physical: noise; landscape; transport; and heritage. “Physical” environmental components are covered as follows: air and climate in Chapter 8; soils, geology and geomorphology in Chapter 9 (which also covers impacts on agriculture); and water in Chapter 10. “Flora and fauna” is covered in Chapter 11 in terms of the ecology of terrestrial and freshwater ecosystems; but because of the particular importance of coastal geomorphology and its close relationship with coastal ecology, these two components are considered together in Chapter 12.

All of these chapters are all similar in structure; each includes the main EIA steps for the assessment of an environmental component (as outlined in §1.2). The main chapter sections are:

Table 1.3 The book’s coverage of the environmental components listed in Annex IV of Directive 97/11/EC and Schedule 4 of the UK regulations

<i>Environmental component</i>	<i>Chapter number and title</i>
Population	2. Economic impacts 3. Social impacts 4. Noise 5. Transport
Landscape	6. Landscape
Material assets and the cultural heritage	2. Economic impacts 3. Social impacts 7. Heritage
Air, climatic factors	8. Air quality and climate
Soil	9. Soils, geology and geomorphology
Water	10. Water
Fauna and flora	11. Ecology 12. Coastal ecology and geomorphology

- introduction;
- definitions and concepts;
- legislative background and interest groups;
- scoping and baseline studies;
- impact prediction;
- mitigation;
- monitoring.

Part II of the book considers some “cross-cutting” EIA methods: risk assessment and management in Chapter 13; GIS in Chapter 14; Quality of Life Capital in Chapter 15; and sustainability appraisal in Chapter 16. These techniques can often be applied to, and/or facilitate integration between, the environmental components discussed in the first part. These chapters are necessarily somewhat different and individual in structure.

There are four **Appendices**: Appendix A lists acronyms, internet addresses, chemical symbols and quantitative units used in the text. Appendix B lists (and outlines the roles of) UK environment, conservation and heritage organisations; and Appendices C and D supplement the ecological information given in Chapters 11 and 12. Lastly, there is an extensive **Glossary** which is referred to in the chapters and appendices by highlighting the relevant terms in bold italics.

The subjects covered cannot all be discussed in depth in a book of this size. Each chapter aims to provide an overview of the subject. However: (a) the subjects are large and complex, so only brief mention can be made of many aspects including specific methods; and (b) the wide range of subjects covered by the different chapters means that a reader is likely to be familiar with some but not others. These problems are addressed in three ways.

1. Each chapter’s “concepts and definitions” section provides some background information for the benefit of readers who have little or no knowledge of the subject.
2. Terms that will not be familiar to some readers are defined in the glossary rather than within chapters. This reduces repetition in different chapters, which is also why the glossary contains some references.
3. The chapters aim to act as springboards for further reading by making frequent reference to other published material in which additional information is available.

1.5 Integration of component assessments

Although the chapters in this book are presented as separate entities, in practice the individual environmental component assessments should be integrated, and be part of the wider process of project planning. Clearly, an EIA must involve a **team of experts** on the various components, and in many cases on different aspects of a given component. As indicated in Figure 1.1, close coordination is needed to avoid duplication of effort, while ensuring that important aspects are not omitted. This is particularly important for inter-related components such as

soils, geology, air, water and ecology. In addition, the EIS must be an integrated document in which relationships between components are clearly explained. The use of GIS (Chapter 14) can facilitate the integration and comparison of data on different components.

It follows that there must be an **EIA coordinator** who will ensure that (a) cross-component consultation is carried out throughout the EIA process, and (b) appraisals are conducted to consider aspects such as components' relative importances, the relative significance of different impacts, interactions between impacts, possible conflicts of interest, and distributional effects. For example:

- One sector of the community, or part of the impact area, may be particularly affected by multiple developments, or by the concentration of a project's impacts. For instance, lower socio-economic groups are more likely to suffer from traffic accidents, air pollution and noise (Lucas and Simpson 2000). Identification of the groups/areas most strongly affected can be facilitated by use of GIS or simply by a table listing receptors (e.g. particular socio-economic groups, sensitive sites) on one axis, and the main impacts of a project on the other axis. A more equitable distribution of impacts may then be sought, or strongly affected groups may be compensated in some way.
- It is important to ensure that mitigation measures proposed for different environmental components are consistent with those for other components, and do not themselves cause negative impacts. For instance, tree plantings which reduce visual impacts could have beneficial side-effects for noise, but could intrude on archaeological remains.

An initial assessment of the relative importance of environmental components can be made by means of a scorecard, in which each component is entered as a "subject" (Tables 1.1 and 1.2). More sophisticated appraisals can include the use of scenarios and **sensitivity analysis** of the effects (on an appraisal) of varying the projected values of important variables. Another useful tool is the use of an **audit trail**, which can be particularly beneficial if further EIA analysis is needed because the project changes substantially between the time when it is approved and when it is built. Ideally, final assessment should result in the preparation of a list of proposed planning conditions/obligations and an *Environmental Management Plan* (EMP) for the proposed development, to be included in the EIS or presented in a separate document (Brew and Lee 1996).

1.6 The broader context and the future of EIA methods

Projects are not planned, built, operated and decommissioned in isolation, but within regional, national and international processes of change which include other projects, programmes, plans and policies. The aim of assessing cumulative impacts (§1.2.3) is to take these into account as far as possible in relation to a single development project. However, some projects are so inextricably related to other projects, or their impacts are so clearly linked, that a joint EIA of these

projects should be carried out. For instance if a gas-fired power station requires the construction of a new pipeline and gas reception/processing facility to receive the gas, and transmission lines to carry the resulting electricity, these projects should be considered together in an EIA, despite the fact that each requires EIA under different regulations.

Other projects are “growth-inducing”, i.e. necessary precursors to other projects. For instance a new motorway may, directly or indirectly, trigger the construction of motorway service stations, hypermarkets or new towns; or the infrastructure provided for one project may make a site more attractive, or may present economies of scale, for further development. Although it is probably not feasible to consider induced impacts in detail in an EIA, the EIA should at least acknowledge the possibility of these further developments.

The broadening of EIA’s remit to encompass other projects may allow trade-offs to be made between impacts and between projects. For instance, an environmentally beneficial “**shadow project**” may be proposed to compensate for the negative impacts of a development project. An example of this is the “creation” of a new waterfowl feeding ground on coastal grassland as compensation for the loss of tidal mudflat feeding grounds caused by the Cardiff Bay Barrage. However, shadow projects need to be treated with caution. For instance, it can be argued that the provision of a coastal grassland area does not effectively compensate for the loss of tidal mudflats because it is a different habitat supporting different wildlife communities. Compensatory like-for-like creation of valuable habitats is generally much more difficult (see §11.8.4).

Project EIAs also need to be set in the context of **strategic environmental assessment** (SEA) of sectoral or spatial policies, plans and programmes. SEAs can, in theory, reduce the time and cost of EIA, and even eliminate the need for certain types of EIA (Bass 1998), although not much evidence of this currently exists. SEA can also provide background information about the local policy context, baseline environmental conditions, and existing environmental problems in the project area. It has been required in Europe since 2004 as a result of the “SEA Directive” (EC 2001). The UK Government has published guidance on how to carry out SEAs (ODPM 2005).

EIA and SEA should be, and are increasingly being, linked to other related techniques. For example:

- Project design is increasingly being influenced by environmental concerns. There is increasing awareness of the need to minimise resource use in building construction and use, and greater application of techniques such as passive solar heating, photovoltaics and greywater recycling, and of innovative construction methods such as straw bale and earth-sheltered housing and self-build schemes. Tighter building regulations, and the Code for Sustainable Homes and BREEAM (see Chapter 16) are contributing to this.
- **Appropriate assessment** (or Habitats Regulations Assessment) is required where a project may have a significant “in combination” impact on the integrity of a European or Ramsar site (see Table D.1). Appropriate assessment of

projects has been carried out for more than 20 years in response to the Habitats Directive (EC 1992), but appropriate assessment of plans in the UK was only triggered by a European Court of Justice (2005) ruling. Appropriate assessment of plans is identifying wider scale and more diffuse impacts than appropriate assessments of projects alone, for instance the impacts of diffuse air pollution or recreational disturbance on sensitive sites and species. This is likely to affect future appropriate assessments and EIS of projects.

- There is increasing use of environmental risk assessment (ERA) and risk management (Chapter 13). This also employs statistical modelling, and techniques such as **event tree analysis** (§13.4.1) which is a form of flowchart analysis. ERA is particularly relevant to the prediction of impacts from accidents, and is embodied, for example, in the *Control of Major Accident Hazards (COMAH) Regulations* (SI 1999/743) which implement the EU COMAH Directive 96/82/EC on the control of major accident hazards involving dangerous substances (see HSE and EA/SEPA 1999).
- The Quality of Life Capital approach (CC *et al.* 1997) discussed in Chapter 15, can be used to develop management plans for areas of various sizes, based on an analysis of the benefits and disbenefits that they provide: it is likely to provide a particularly useful early input to the project design process.
- Integrated pollution prevention and control (IPPC) legislation and techniques bring together analyses of the impacts of new developments on air, water and soils.
- Village/community mapping exercises can help to identify features that are particularly valued by local residents.
- Life cycle analyses can help to identify the impacts of buildings from the production of the materials used to build them through to their ultimate dismantling and disposal.
- At the global level, environmental policy is experiencing a general move away from a narrow emphasis on the protection of current environmental resources, and towards a broader promotion of sustainability, although this is not without its critics (see Chapter 16). Sustainability checklists can be used by development control officers to ensure that all developments – not just those for which EIA is required – minimise their environmental impacts.

New tools, techniques and approaches are being developed which complement and support the EIA process. For example:

- Mapping software and geographical information systems (GIS) (Chapter 14) now allow much more effective analysis and presentation of information than in the past;
- There is a rapid expansion in the range and availability of information databases, including remote sensed data and other digital data suitable for GIS;
- The internet now provides ready access to a wealth of information, including legislation, other publications, databases and software;

- In ecology and landscape analysis, although legislation and government guidelines still focus on protecting designated areas, there is a shift from “save the best and leave the rest” to consideration of the “wider countryside” and characterisation of areas, with the aim of promoting their uniqueness and joint diversity (CC & EN 1998, Defra 2007);
- More emphasis is being placed on environmental enhancement, not just mitigation of negative impacts;
- Although monitoring is still not mandatory, it is being encouraged in government guidelines;
- Evolving approaches to public participation – particularly in developing Sustainable Community Strategies and in community mapping exercises – allow local residents’ views to be better understood and taken into consideration in EIA.

Finally, concern about wider distributional impacts – for instance about whether some countries are “importing” sustainability at the cost of making environmental conditions in other countries unsustainable – is likely to lead to more evolved forms of public participation and political negotiations, and ultimately to a more equitable approach to development and the environment.

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