# IMPACT ASSESSMENT GUIDE


## Summary

The environmental assessment process provides a consistent approach to the assessment of changes and evaluation of impacts. This process is used to determine the impact of developments and the procedures for Environmental Impact Assessment (EIA) are now well established and applied internationally. For developments, it is important to consider both local and estuary wide impacts. Furthermore if may be necessary to identify other ongoing changes in the system and the sensitivity of particular features (notably habitats) to such change. This can be quite difficult to disentangle and approach in a consistent manner. For this reason it helps to follow a systematic procedure that clearly outlines the rationale, which supports decisions on the nature of an environmental impact. A framework based on four key stages has been provided:

- ***Identify*** the environmental changes from proposed activities and the features of interest/receptors that could be affected.
- ***Understand*** the nature of the environmental changes in terms of their exposure characteristics, the natural background system, and establish the sensitivity characteristics of specific features.
- ***Evaluate*** the vulnerability of the features as a basis for assessing the nature of the impact and its significance.
- ***Manage*** any impacts, which are found to be significant and require implementation of impact reduction measures.

The steps required at each stage are summarised in Figure 1, and described more fully in the Sections that follow. This approach to the evaluation of impacts reflects the advice to be found in a number of guidance documents and regulations, including the criteria listed in Annex III of the EC Environmental Assessment Directive (97/11/EC). The impact evaluation particularly draws on the assessment process developed to provide advice on operations within European marine sites (EN, 1998; EC, 2000) and an approach to Environmental Risk Assessment (ABP Research, 1997), which is based upon a UK guide to risk assessment for environmental protection (Department of Environment, 1995).

The environmental assessment process provides a consistent approach to the assessment of changes and evaluation of impacts. Such an assessment should make use of the best available information derived from a wide range of sources, including consultation, literature review, surveys, numerical modelling and historical analysis, and using informed scientific interpretation and judgement based on past experience. There is inevitably an element of subjectivity in this process, which relies on the experience of those undertaking the assessment. This approach provides a clear delineation of the:

- Processes of change;
- Magnitude of environmental change in terms of an exposure;
- Response of particular features to an environmental change in terms of its sensitivity;
- Vulnerability of the feature to change which is an expression of risk of an impact;
- Significance of the impact.

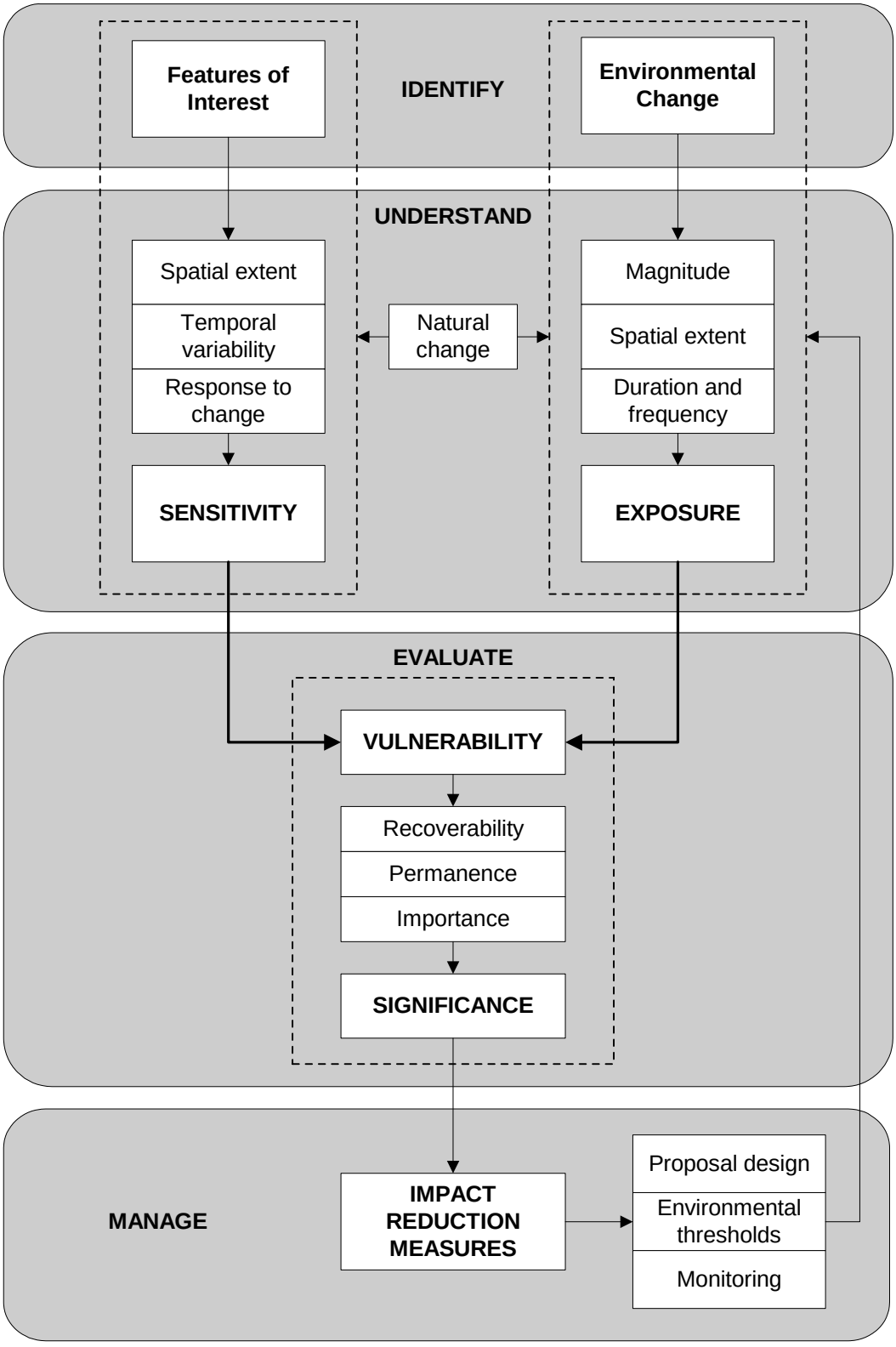


**Figure 1.** **Flow diagram for impact assessment process**

Even when some or all of these aspects can only be assessed subjectively, it has the advantage of making the assumptions explicit.

The process provides a valuable means of establishing a consistent approach amongst planners, developers, regulators, conservation agencies, and interested bodies. Such tools allow a project assessment to be reviewed by all relevant or interested parties, who can then make their own assessment of the likely impacts and consequences of the proposed development. In this way, assessments can be compared and attention can be focused on those areas where there is disagreement.

### Identifying Features of interest and ENVIRONMENTAL Changes

The issues that need to be addressed within the marine environment will depend on the nature of the estuary and the type of development or activity proposed. A typical list is given in Box 1.

**Box 1. Issues**

*Physical processes* – waves, tides, water levels, salinity/temperature, sediment transport (erosion and accretion), morphology

*Water and sediment quality* – suspended load, turbidity, dissolved oxygen, nutrification, toxic contamination, and eutrophication

*Habitats* – subtidal, intertidal, transitional and terrestrial

*Flora and fauna* – benthic ecology, migratory and estuarine fisheries, shellfish, pelagic communities, algae (including seaweed), saltmarsh, mangrove, birds

*Infrastructure* – navigation channels, bridges, pipes, cables, coastal defences

*Activities* – fisheries, dredging, shipping, recreation, bathing.

These may include physical processes, water and sediment quality, habitats and the flora and fauna they support, as well as the infrastructure and activities to be found in the estuary. The first two of these are key issues because they are used as surrogates in the management of the marine environment to identify potential problems. They have no tangible importance in their own right but rather a consequential importance for many of the habitats, structures and activities that are found in the marine environment. The assessment must therefore distinguish between processes, which may be altered, and result in environmental change and the resultant impacts on features of interest[1].

The environmental changes can therefore be considered as contributory factors to a potential impact on a feature of interest. Some features may be affected by a number of environmental changes and hence there may be the need to consider the cumulative effect of a range of changes.

Features of interest are invariably a reflection of local interests as well as a consequence of national or international agreements or conventions. For instance it may be that shipping access is of strategic importance to the nations trade, whereas, sea defences are locally important to protect people and property from flooding. Equally, habitats may be of varying importance and subject to differing levels of recognition and protection. The features of interest can usually be further sub-divided. For example, fish can be considered in terms of the requirements of estuarine and migratory fish, and the feeding, spawning and nursery areas that support them.

[1] Hence, changes to coastal processes or water/sediment quality are not considered as impacts *per se,* but are investigated in order to predict the scale of environmental changes and the subsequent effect of these changes on features of interest.

As priorities will vary from one site to another, it is fundamentally important to consult locally as well as with the regulatory bodies to determine the issues and features of interest that are of primary concern. This is usually achieved by preparing a scoping study that sets out in outline the nature of the development or activity proposed and identifies what features might be affected and the scope of environmental assessment. The consultation process is then used to focus in on the primary issues and identify issues that may have initially been overlooked. This exercise sets the scope for the subsequent assessment work and can usefully provide an agreed basis for undertaking formal environmental impact assessments.

### Understanding Features of Interest and Changes Caused by Proposal Activities

The evaluation of potential impacts requires an understanding of both the features of interest under consideration and the changes in the marine environment as a result of the proposals. Depending on the scale of the proposed development or activity, this may be as simple as a brief review and desk study of the impacts, or may entail extensive field data collection, modelling, analysis, and even primary research, to establish sufficient information to satisfactorily complete an assessment. The existing literature and previous studies are invariably an important starting point to define the current state of knowledge and hence possible limitations and gaps in information, highlighting where additional investigations need to be carried out. Consultation can also help. This can be used to obtain information from experts and specialists but also most importantly from locals who may have specific knowledge of the area and how it has changed over the years. It can sometimes be difficult to rationalise such anecdotal evidence but it is invariably worthwhile for two reasons:

- It can help to ensure that important features or processes are not missed; and
- When presenting the findings of an assessment, incorporating the local perspective can help others (such as the general public) to understand the results.

The information gained can provide an important input into understanding how the system works and feeds into the overall synthesis of different forms of data, information and techniques. The type of studies that might be undertaken and the way in which these can be drawn together by developing a conceptual model of system behaviour are described in the Chapter 4 of Understanding & Managing Change in Estuaries. The resultant understanding informs the process of determining the sensitivity and importance of the features of interest and the nature of environmental change occurring as a result of the proposed activities. These steps are necessary in order to evaluate the significance of any impacts.

### Determining the Nature of Environmental Change

The magnitude of a change resulting from the proposal activities should be considered in spatial and temporal terms and represents an exposure to features of interest such as habitats and species. It will usually be necessary to quantify the magnitude of change using a level or concentration. In other cases a more subjective estimate of the order of change may be necessary. Importantly, the magnitude of change should be considered against the background environmental conditions in the study area. This, necessarily includes the likely consequences of any ongoing changes (natural or otherwise) such as sea level rise, changes in shipping patterns, and population trends (e.g. fish and bird populations). Environmental changes that typically need to be investigated may include:

- Habitat loss (intertidal, subtidal and terrestrial).
- Physical disturbance (noise and light).
- Erosion and accretion.
- Flow speeds.
- Water levels.

- Emersion and exposure of habitat.
- Wave climate.
- Salinity and temperature.
- Suspended sediment concentrations.
- Turbidity and light penetration.
- Toxic contamination (e.g. heavy metals).
- Dissolved oxygen.

The description of the environmental change as an exposure should incorporate knowledge of the duration, frequency and seasonality of the initiating construction activity. However, where features of interest vary with time (e.g. seasonal nature, or limited life-span) then it may be necessary to consider a range of possible interactions, particularly if the timing of the construction activity is unknown or could change.

It may be useful to apply standard terminology to the description of activities and environmental changes, although each definition would need to be qualified with supporting data. For example:

- ***Development activities***: short-term, long-term, infrequent, frequent.
- ***Spatial extent of change***: immediate, local and estuary-wide

The process of considering the magnitude of change can be usefully informed by comparison with the assessment and monitoring results of previous developments or operations. Invariably, judgements are informed on the basis of specialist knowledge and experience in applying the above approach to comparable projects in estuary environments.

**Determining the Sensitivity of the Features of Interest**

Sensitivity can be described as the intolerance of a habitat, community or individual of a species to an environmental change and essentially considers the response characteristics of the feature. Thus, if a single or combination of environmental changes is likely to elicit a response in the feature under assessment, then that feature can be considered to be sensitive to some degree.

Where scientific information is available, the response characteristics of a feature to an environmental change (i.e. suspended sediment, dissolved oxygen and/or contamination) should be expressed numerically. Dose-response characteristics can be investigated with reference to scientific literature and specific environmental databases.

The sensitivity stage of the evaluation provides the benchmark against which the changes and level of exposure can be compared to evaluate the vulnerability. In some cases it may be applicable to compare the anticipated change or exposure against either baseline conditions or other relevant thresholds such as quality criteria (i.e. water quality or rates of deposition) where specific response characteristics are not well understood.

The sensitivity assessment is based upon an understanding of the requirements of the features of interest developed by a review of scientific and other relevant literature and past experience of sensitivity of marine habitats and species to similar developments and operations both locally and elsewhere. The assessment can also be informed by specific guidance (ABP Research, 1999), databases such as MarLIN (ref: http://www.marlin.ac.uk/), water and sediment quality guidelines[2], or advice from conservation agencies.

[2] Which derive from syntheses of information on toxic and non-toxic contamination and its biological effect.

Initially the assessment of sensitivity will tend to focus at the habitat level; that is the sensitivity of the form and evolution of the estuary system and its subtidal and intertidal habitats to change. More specific assessments may then be needed at the community or individual species level. For example, fish sensitivity can be considered in terms of the ability to cope with changes that cause loss or damage of spawning, nursery and feeding areas (i.e. habitat) and changes which damage, disturb or contaminate whole fish communities, populations, or individual species.

## Impact Evaluation

### *Assessment of Vulnerability and Nature of Impact*

The vulnerability of the feature of interest is essentially the comparison of the anticipated exposure with the features sensitivity or response characteristics. Where the exposure and sensitivity characteristics overlap then vulnerability exists and an adverse affect may occur. Where an exposure or change occurs for which the receptor is not sensitive then no direct impact can occur. The degree of overlap of the exposure and sensitivity characteristics will be a measure of the certainty of a response and hence an impact.

Both the exposure and sensitivity can be expressed in terms of a magnitude, which includes a measure of uncertainty. Uncertainty in the exposure characteristics may be a function of model uncertainty (including parameter variability), alternative development scenarios, and temporal variability. Uncertainty in the sensitivity may derive from variability in response characteristics of habitats and species and extrapolation of field and test conditions to the specific environment under investigation.

The assessment of vulnerability can be considered to represent the potential for an adverse response in the feature of interest. For some features there may be a number of contributory factors or environmental changes that create vulnerability (such as raised suspended sediment and lowered dissolved oxygen).

To assess how the vulnerability will manifest as an actual impact on the feature requires knowledge of other factors such as the spatial extent of feature affected and the potential for recoverability.

The assessment of recoverability considers the adaptability of habitats, communities and species, or their ability to return to former status once background conditions return. It will be important to evaluate the nature of the impact in terms of the duration required for recoverability. This can be expressed in terms of its permanency (temporary or permanent).

Experience from consultation on development projects suggests that the permanency of an impact can be a major factor in determining the significance of an impact.

This stage of an assessment should conclude on the actual nature of the potential impact. This description could be in terms of quantifying a loss of species population or habitat area or physical response characteristics.

### *Assessment of Significance*

For purposes of highlighting important impacts that require implementation of impact reduction measures such as changes to proposal design, monitoring and/or other management controls it is important to identify the anticipated significance of each impact.

Estimating and categorising the significance of an impact is the stage that probably incorporates the greatest degree of subjectivity in an evaluation. A feature of interest may be vulnerable to environmental changes such that an impact is likely to be realised, but whether this potential impact is 'significant' may depend on factors, such as the permanency of the impact, its relative 'importance' (either to the ecosystem or in terms of statutory designations), the scale of habitat/population/feature affected and potential for secondary impacts or the perceived tolerability of the stakeholder to risk. Similarly, a low risk of impact to a rare/protected species or habitat or a component of the ecosystem that is important for the overall ecosystem function could represent a potentially significant impact that may need controlling actions to be incorporated.

The assessment of significance can be heavily dependant on the values that stakeholders place on features and this may clearly vary according to the stakeholder. For those carrying out impact assessments, it is important to be objective and where possible adopt thresholds to significance based on scientific rationale.

One guiding method to evaluating the significance of an impact can be to assign a level of relative importance to a particular feature. This is a measure of its value in terms of its ecological/nature conservation value (as indicated by international, national or local designations and other supplementary information), or its social, economic or commercial value. For example, the commercial fisheries may be considered to be of local importance whereas a particular species of fish may be of regional/national importance and may be protected by law.

It must however be recognised that just because a feature is not designated under international, national or local legislation does not mean it has little or no nature conservation importance, particularly when considering the function and ecology of the whole system.

The impact significance should be described in terms of whether it is beneficial or adverse and on a scale that includes insignificant, minor, moderate and major significance.

As a guide, it is normal practice to examine any impact of moderate through to major significance, to see if some form of impact reduction measure can be incorporated.

**Impact Reduction Measures**

As a project is developed, it may become apparent that some impacts are likely to be significant and may be considered to pose an unacceptable risk. This invokes an iterative process to determine whether the impact can be designed-out, by changing the works in some way, or by identifying some form of mitigating measure that would lessen the impact. Such measures can take the form of monitoring and control, constraints and conditions on the activity or construction process, or compensating enhancements. A particular form of control is the use of 'environmental thresholds' against which the changes resulting from the activity can be monitored and managed.

The use of environmental thresholds allows the construction process to be monitored and managed for compliance and avoids the need to define exactly how the work should be done in advance (ABP Research, 2000; Oresund Konsortiet, 1998).

An environmental threshold is a trigger point above which additional monitoring or remedial/corrective action takes place to ensure that the appropriate environmental conditions are maintained. The role of the thresholds is to provide a basis upon which management decisions can be made. Monitoring will identify how thresholds are complied with and the levels at which corrective action should be implemented. The initial derivation

of threshold levels should be based upon statutory quality compliance levels and known environmental sensitivity.

Hence, the approach is to provide a feedback into the management of specific operations. Corrective actions can be based upon a tiered level of response to ensure that appropriate conditions in the water column and the surrounding habitats are maintained.

**References**

ABP Research, 1997, A guide to the environmental risk assessment package (ERA), ABP Research, Southampton, Report No: R.717

ABP Research, 1999, Good practice guide for ports and harbours operating within or near UK European marine sites, English Nature, Peterborough, pp120

ABP Research, 2000, Environmental Thresholds, ABP Research & Consultancy Ltd, Southampton, UK Report No: R.865

Department of Environment, 1995, A guide of risk assessment and risk management for environmental protection, HMSO, London

EC, 2000, Managing Natura 2000 sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, Office for Official Publications of the European Commission, Luxembourg, pp69

EN, 1998, Natura 2000 European marine sites: guidance relating to statutory conservation objectives and operations which may cause deterioration or disturbance, English Nature, Peterborough

Oresund Konsortiet, 1998, The Oresund Link: assessment of impacts on the marine environment of the Oresund Link.