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Thresholds and criteria for evaluating and communicating impact significance in environmental statements: 'See no evil, hear no evil, speak no evil'?

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Abstract

The evaluation and communication of the significance of environmental effects remains a critical yet poorly understood component of EIA theory and practice. Following a conceptual overview of the generic dimensions of impact significance in EIA, this paper reports upon the findings of an empirical study of recent environmental impact statements that considers the treatment of significance for impacts concerning landscape ('see no evil') and noise ('hear no evil'), focussing specifically upon the evaluation and communication of impact significance ('speak no evil') in UK practice. Particular attention is given to the use of significance criteria and thresholds, including the development of a typology of approaches applied within the context of noise and landscape/visual impacts. Following a broader discussion of issues surrounding the formulation, application and interpretation of significance criteria, conclusions and recommendations relevant to wider EIA practice are suggested.

Keywords: Impact significance; Thresholds; Criteria; Environmental statements

1. Introduction

A universal and defining purpose of Environmental Impact Assessment (EIA) is to provide an analysis of the potential significant environmental effects associated with major development proposals and to communicate this information to decision-makers and the broader public. Although past research has found that the practice of EIA does not necessarily change the final direction of project authorization decisions (in the sense of whether or not a given proposal should proceed on environmental grounds), critically it appears that information generated during the EIA process *does* serve to influence decisions relating to impact mitigation and project design (Weston, 1995; Wood and Jones, 1997). This in itself serves to highlight the importance of achieving a transparent evaluation and communication of impact significance during the appraisal process so that improvements to the environmental performance of development can be maximised and the practical outcomes of EIA improved.

However, EIA is characteristically an adversarial system within which the ultimate responsibility for providing 'appropriate' environmental information rests with the project proponent, who therefore exerts considerable control over the analysis supplied to the decision-making process. Consequently, EIAs have been strongly criticised as comprising advocacy exercises that are inherently vulnerable to communicative

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distortion, particularly via the use of 'steering mechanisms' that influence and control the interpretation of environmental information and analyses (Killingsworth and Palmer, 1992). Nowhere is this potential for distortion greater than in the language and criteria that are employed to evaluate and communicate the significance of predicted environmental effects.

Despite renewed interest in the treatment of impact significance within the EIA literature (Weston, 2000a,b; Lawrence, 2000; Wood and Becker, 2005; Wood et al., 2007), there has been a paucity of research that critically examines and reflects upon the way in which significance is evaluated and communicated within key EIA documentation, specifically within Environmental Impact Statements (EISs). This is despite the growth of a substantial literature in the field of EIS quality review, which whilst successful in providing aggregated insights on various EIA regimes and selected development sectors, has resulted in little analysis that has been disaggregated according to impact type, feedback that is vital to improve the effectiveness of EIA practice (Badr et al., 2004).

This paper starts by providing a conceptual overview of the generic dimensions of impact significance in EIA and the challenges that these raise with respect to the objectivity and utility of impact analysis. Drawing on an empirical study of post-2000 EISs, the paper then proceeds to consider the treatment of significance for impacts concerning landscape ('see no evil') and noise ('hear no evil'), focussing specifically upon the evaluation and communication of impact significance ('speak no evil') in UK practice. Particular attention is given to the use of criteria and thresholds for assessing impact significance and the role of uncertainty within significance evaluation. Finally, following a broader discussion of issues surrounding the formulation, application and interpretation of significance criteria, conclusions and recommendations for future practice are highlighted.

2. The concept of significance in EIA

The determination of the *significance* of environmental impacts has been identified as the most critical element of EIA (Duinker and Beanlands, 1986; Sadler, 1996), indeed impact assessment legislation, guidelines, and environmental statements themselves all make liberal use of the expression. Yet despite the central importance of significance evaluation and communication, it remains one of the most complex, contentious, and least-understood aspects of EIA systems across the globe.

The objectivity and utility of the information and appraisal typically generated in EIA has been widely criticised (e.g. Lawrence, 1993; Beattie, 1995; Kontic, 2000), and this may be linked to a number of closely interconnected dimensions of impact significance — namely that it is a dynamic, contextual, and political concept, characterised by uncertainty.

Firstly, significance evaluation is an inherently *dynamic* activity, with the nature of significance evolving through the EIA process. As an EIA progresses from project screening (deciding whether or not a development proposal should be subject to EIA), to scoping (determining the focus of the EIA), and through to impact prediction, monitoring and mitigation, the detail and availability of environmental information increases and there are changes in the decision-processes surrounding the evaluation and communication of significance, the decision consequences, and the nature of related uncertainties (Table 1).

The complexity of impact significance is exacerbated by *context*, comprising issues surrounding spatial scale, temporal change, social and ethical values, ecological sensitivity, economic considerations, and institutional arrangements. The spatial context concerns whether the proposal's potential impacts should be considered significant at the local, regional, national, or international scale. The temporal context concerns the relationship with past, present and potential future development that could cumulatively affect the same environment.

Arguably environmental quality is subjectively experienced with the significance of impacts dependent upon the value society places upon a particular environmental receptor at a particular point in time (Weston, 2000b). However, social values are characterised by plurality, not simply in terms of the different perspectives of individuals and agencies regarding the desirability of change, but also with respect to values that surround different ethical positions. For example, the protection of habitat from development may be considered from a purely utilitarian or welfare perspective, from the point of view that the habitat has intrinsic value, or simply that it is morally correct regardless of the consequences (Adger et al., 2004).

The ecological context plays a further role on a site-specific basis in the sense that a small development proposal in an ecologically sensitive environment may be considered to have a more significant impact than a far larger development located in a more 'robust' setting. Similarly, from an economic perspective, a community dominated by high unemployment may be more supportive of controversial development proposals than comparable areas with full employment. Finally

Table 1
Significance evaluation and uncertainty at key stages in the EIA process

EIA process stage	Purpose of significance evaluation	Minor impacts considered significant	Major impacts considered non-significant	Sources of uncertainty
Screening	Identification of development proposals requiring formal EIA	• Competent authority loses credibility. • Costs to the developer of initiating an unnecessary EIA	• Controversy and conflict • Legal challenge • EIA occurs at a later phase of project planning	• Project design, technical processes and timing • Environmental and social receptors potentially affected
Scoping	Preliminary identification of impacts and issues requiring assessment	• Assessment resources subsequently wasted • Voluminous and unwieldy EIS	• Bias to focus of the subsequent assessment • Loss of trust, credibility and reduced legitimacy of the EIA	• Knowledge/understanding of the existing environment • Relevance/availability of environmental information • Future baseline conditions • Detailed project design • Divergence of opinion rekey impacts and valued environmental components • Likelihood of impact occurrence
Impact prediction and EIS production	Feedback to project design for change and/or mitigation. Identification, evaluation and communication of key impacts for the competent authority and the public	• Unnecessary mitigation raises project costs • Causes damage to the public profile of the project and increases opposition • "Overreaction" and possible rejection of feasible projects	• Biased assessment • Loss of credibility for proponent and competent authority • If detected later in the process: – project delays – mitigation "retrofitted" – future legal procedures – project stopped	• Measurement error in assessing baseline conditions • Estimating future baseline changes without the project • Accuracy and/or suitability of predictive methods used • Uncertainty over mitigation performance/ effectiveness • Lexical uncertainty in communication/ interpretation of impact significance
Monitoring/audit and impact management	Evaluation of impact predictions and mitigation effectiveness. Identify further mitigation requirements and focus management resources	• Attempt to mitigate environmental changes that are not related to the project or are costly to correct	• Loss of credibility for proponent and competent authority • Failure to recognise early warning signals • Costly rehabilitation	• Measurement error • Uncertainty in identifying impacts attributable to the project

Source: Adapted from Hilden (1997).

the institutional context defines the formal and informal rules or procedures within which decision-making occurs (Bromley, 1989; Jepperson, 1991) at different points within the EIA process.

The institutional context serves to invest certain rights and responsibilities upon stakeholders, and shapes the degree of power and influence that interest groups exert upon decisions. For instance, in the UK, the formal responsibility for screening development proposals lies with the competent authority, whilst the task of supplying environmental impact information (i.e. the EIS) falls to the developer. The public then have a right to comment upon the EIS and their views should be taken into consideration during project authorization decision-making by the elected representatives. The adversarial nature of EIA involving the entrainment of power and influence, conflicting interests, and values indicates that decision-making in the context of

evaluating impact significance cannot be considered as a purely technical or 'scientific' process, but is characterised by a strong *political* imperative.

The intricacies of significance evaluation are further aggravated by *uncertainty* surrounding the information available for decision-making. During screening, uncertainty will often surround the exact detail of the project proposed, including its precise 'footprint' and the technical processes involved. During scoping there may be uncertainty regarding knowledge and understanding of the existing environment, the relevance of available baseline information, and subsequent divergence of opinion on the key impacts for investigation. As the EIA progresses to impact prediction phase, measurement error and uncertainty surrounding the accuracy and performance of predictive methods compound the problem of interpreting impact significance (Sadler, 1996). Uncertainty can therefore appear in many forms: in the description or measurement of the project or the environment, in the understanding of how the environment will react, and in the assessment of the importance of the anticipated effects. In this paper the emphasis is upon the latter i.e. the evaluation and communication of impact significance as performed in EISs.

3. Research approach

Previous research in the field of EIS review has centred upon the evaluation of predefined, generic criteria, using a subjective grading system in order to devise an aggregate and statistically representative appraisal of practice (e.g. Glasson et al., 1997; Thompson et al., 1997). In this paper, fixed criteria are not employed and a more exploratory approach was applied, the intention being to capture an illustrative 'snapshot' of practice, focussing specifically on the evaluation and communication of impact significance for (i) noise (a highly quantitative impact, characterised by technically oriented approaches to appraisal); and (ii) landscape/visual impacts (which in contrast to noise are conceived as comprising a more qualitative and subjective impact). Overall, the key aim is to determine the broad characteristics of how the issue of impact significance in EIA is evaluated and communicated in practice, to draw out emergent themes, to contrast the approaches employed, and to consider the implications for EIA effectiveness and future practice.

To this end, the research involved a desk-top review of the landscape/visual and noise assessment component of 30 individual UK EISs, all produced since the year 2000 (see Appendix A). It should be noted that the selection of 30 EISs is not intended to provide a statistical sample, but rather was designed to represent a range of development types, consultancies, and locations/environmental settings. Thus the findings should be seen as indicative of UK practice, *not* definitive. To facilitate comparisons and to ensure a systematic evaluation process, a basic review framework was devised to record the nature and dimensions of impact prediction, evaluation, and communication of impact significance within each EIS, in addition to related issues surrounding the treatment of baseline conditions, the relationship to impact mitigation, and the consideration of uncertainty.

4. Landscape/visual assessment and the treatment of impact significance

In accordance with the European EIA Directives, the UK regulations require an EIA to consider the direct and indirect effects of a project proposal upon the landscape[1]. In practice, most EIAs distinguish between *landscape* impacts and *visual* impacts. Landscape impacts relate to "changes in the fabric, character and quality of the landscape" (IEA/LI, 1995), whilst visual impacts may be considered to represent a subset of landscape impacts, focussing upon "changes in the available views of the landscape, and the effects of those changes on people" (IEA/LI, 1995).

Whilst quantification of the more factual or 'objective' dimensions of landscape and visual impacts is possible (e.g. the number of trees removed or the length of hedgerow potentially lost to development), the appraisal of impact significance is strongly characterised by qualitative approaches, with landscape considerations identified as probably the most subjective of all the impacts typically addressed within EIA (Morris and Therivel, 2001). Whilst useful guidance documents exist (e.g. IEMA/LI, 2002; CC, 1993; Swanick, 2002), there are no definitive regulatory thresholds or criteria for the assessment of impact significance, and the exercise of professional judgement is paramount. Thus, as is noted by the IEMA/LI (2002) guidelines: "Significance is not absolute and can only be defined in relation to each development and its location. It is for each assessment to determine the assessment criteria and the significance thresholds, using informed and well reasoned judgement supported by thorough justification for their selection,

[1] For an overview of landscape and visual impact assessment methods and techniques, the reader is referred to Morris and Therivel (2001), IEA/LI (1995), and IEMA/LI (2002).

LANDSCAPE SENSITIVITY	MAGNITUDE OF CHANGE
High Landscape of distinct quality, national, regional or local importance	**High** Notable changes in landscape characteristics
Medium Landscape of moderately valued characteristics	**Medium** Moderate change in localised area
Low Lower and poor quality landscapes which may include damaged or derelict landscape	**Low** Virtually imperceptible change

Fig. 1. Case 8: Magnitude and sensitivity thresholds for landscape receptors.

and explanation as to how the conclusions about significance for each effect assessed have been derived."

4.1. Landscape and visual impact significance criteria in practice

Despite this clear recognition of the role of thresholds and criteria in evaluating and communicating impact significance, in 37% of the EISs reviewed no attempt was made to explain the approach taken to determine landscape or visual impact significance, and the underlying criteria or language terms employed in the assessment were not defined or made explicit. In 13% of cases the assessment indicated the application of broad EIS-wide definitions of significance criteria (typically outlined in the early chapters of the EIS), with no further refinement to reflect the characteristics and dimensions of landscape or visual impacts. More detailed, customised significance criteria were defined in the remaining 50% of the EISs examined, and these form the focus of the ensuing analysis and discussion.

Although different sets of thresholds and criteria are applicable to each of landscape and visual impacts, perhaps unsurprisingly two dimensions of impact significance dominate the customised assessment criteria, namely: (i) the scale or magnitude of the effect; and (ii) the sensitivity of the location/setting or receptor. However, notable variations were evident in the precise manner in which sensitivity and magnitude considerations were defined and in the way subsequent significance determinations were articulated and communicated.

Drawing upon the range of practice exhibited in the EIS sample, a typology comprising three distinct significance assessment approaches has been derived. Each type of approach is defined below and illustrative exemplars drawn from either landscape or visual assessment are provided, followed by a brief synopsis of the relative merits and drawbacks of each generic framework.

4.1.1. Type 1 approach

In the Type 1 approach, separate sets of criteria are defined for both: (i) different levels of impact magnitude; and (ii) varying degrees of receptor sensitivity. These criteria are then brought together in a simple matrix to identify relative degrees or categories of impact significance that are summarised using single language terms (e.g. "Major", "Moderate", "Minor") with no further detail provided.

Six cases were found to use Type 1 significance appraisal frameworks (Cases 8, 16, 26, 27, 29, 30) and Case 8 is shown as an example in Figs. 1 and 2.

Whilst the Type 1 approach has the merit of simplicity, this can come at a considerable cost in terms of the degree of transparency achieved. For instance, in Fig. 1, the level of detail supplied in the descriptors associated with varying levels of sensitivity and magnitude is minimal; fundamentally it is not exactly clear what is meant by, for

		LANDSCAPE SENSITIVITY		
MAGNITUDE OF CHANGE		**Low**	**Medium**	**High**
	High	Moderate impact	Substantial impact	Substantial impact
	Medium	Slight impact	Moderate impact	Substantial impact
	Low	Slight impact	Slight impact	Moderate impact

Fig. 2. Case 8: Significance thresholds for landscape receptors.

Major
Where the extent of the impact on landscape character is large in scale or magnitude as a result of high sensitivity to change or a high intrinsic value and as a consequence the integrity of that asset will be significantly changed. The impact is of national or regional importance, and will be of long term nature (or very severe short term), irreversible and certain or likely to occur.
Moderate
Where the extent of the impact on landscape character is small in scale or magnitude as a result of low sensitivity to change or a low intrinsic value. The impact is of district importance. The impact will be of medium or short-term nature and likely to occur.
Negligible
Where the extent of the impact on landscape character is barely noticeable in scale or magnitude as a result of low sensitivity to change or a low intrinsic value. The impact is of local importance. The impact will be of short-term nature and unlikely to occur.

Fig. 3. Case 6. An example of Type 2 impact significance criteria.

instance, a "moderate" change or "moderate" value, and to whom. Clearly the detail encapsulated in these descriptors could be enhanced, yet the reliance upon a single language term in the final assessment of significance (a definitive characteristic of Type 1 frameworks), indicates that the issue of variance in meaning and interpretation remains deeply entrenched in the approach.

In addition, no attempt is made to further define the final significance categories or their inherent characteristics to incorporate impact dimensions such as timing, duration, permanence, likelihood of occurrence etc. This results in a final significance determination that is not only open to multiple interpretation, but which is inherently simplistic in that it is purely related to impact magnitude and sensitivity, with no further 'benchmarking' to the more detailed context of the proposal, the environmental setting, or the expert assessors professional frame of reference.

4.1.2. Type 2 approach

In contrast to the Type 1 approach, no appraisal matrix is used and there is no formal attempt to draw together various levels and/or combinations of impact magnitude and receptor sensitivity. Instead the emphasis is upon providing more detailed definitions of the final impact significance criteria. Type 2 approaches were found in use in 8 cases in the review of EISs (Cases 6, 18, 20, 21, 22, 24, 25, 28) and for purposes of discussion the example of landscape assessment for Case 6 is considered further (Fig. 3).

In Fig. 3 it can be seen that the definitions of significance provide more detailed insights into the factors that have fed into the assessor's frame of reference, moving beyond the basic considerations of magnitude and sensitivity that characterise the Type 1 approach to include factors such as the value of the landscape, duration of impact, reversibility, and certainty of occurrence. However, the lack of any explicit framework for combining varying degrees of sensitivity and magnitude does serve to reduce transparency in other respects. For instance, in Fig. 3 it can be seen that the approach does not provide an assessment of the significance of a situation in which a landscape judged to be of *moderate sensitivity* is exposed to a *moderate* or *high magnitude* of impact.[2]

4.1.3. Type 3 approach

These combine elements of Type 1 and Type 2 approaches. Sets of criteria are defined for both impact magnitude and receptor sensitivity and these are then combined in an appraisal matrix to identify relative degrees of impact significance. The matrix is accompanied by ancillary definitions of the resulting final significance categories.

Whilst a Type 3 approach is by far the most detailed, they appear to be rare, with only one example (Case 9) identified in the review of 30 EISs. In Case 9, the criteria and categories employed to define both magnitude and sensitivity are provided in diagrammatic form, and to illustrate the approach the example of visual impacts is provided in Fig. 4.

Various permutations and combinations of magnitude and sensitivity are drawn together in a generic matrix (Fig. 5) to illustrate different levels of impact significance (i.e. "very substantial", "substantial", "moderate",

[2] It may be the case that the expert assessor has determined that these particular combinations of circumstances are not relevant to this particular project and environmental setting, although this is not stated in the EIS for Case 6.

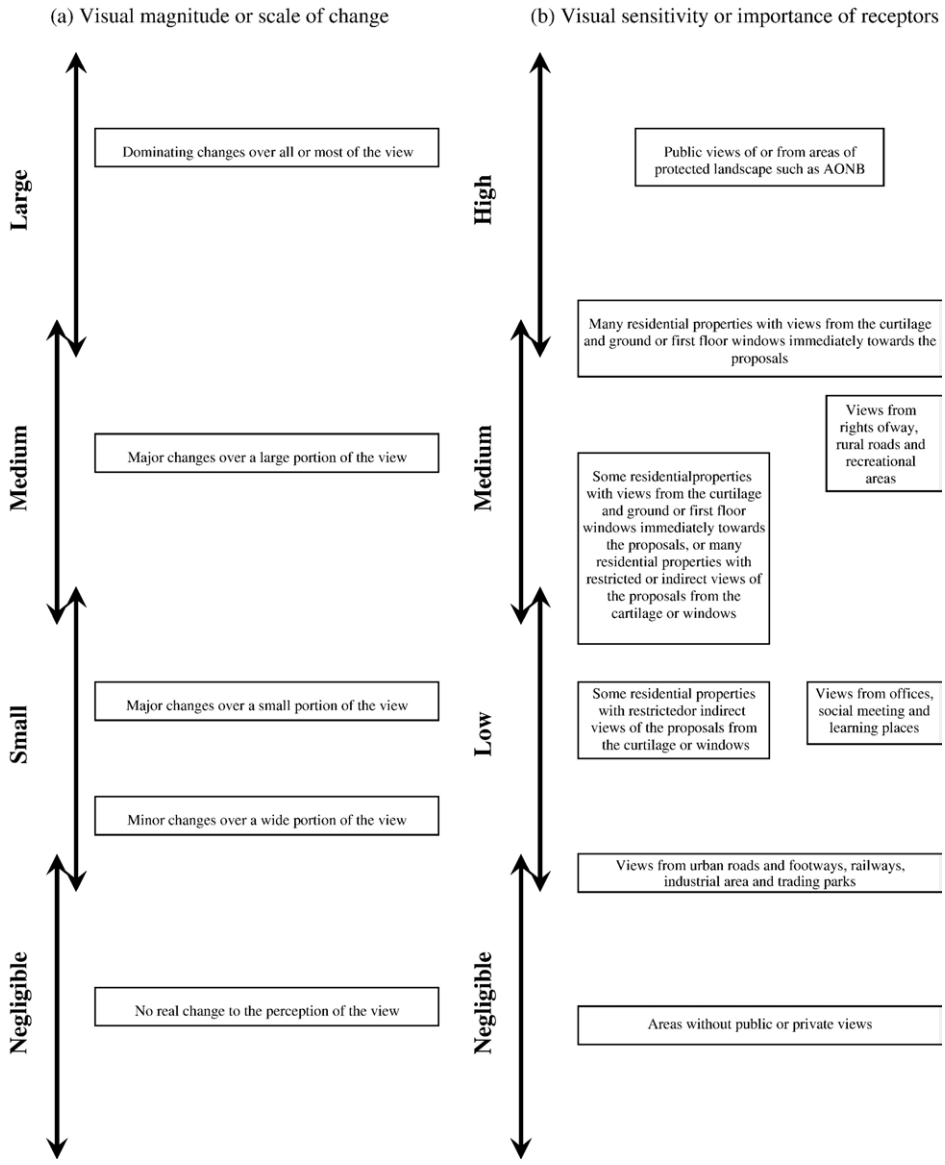

Fig. 4. Case 9: Magnitude and sensitivity thresholds.

"slight" and "none"). This matrix is accompanied by detailed descriptors that are specific to visual significance determinations (Fig. 6).

The level of transparency in the approach is comparatively high, with the sensitivity framework incorporating some useful examples and the descriptors serving to provide a fuller account of decision factors e.g. the temporal dimension of visibility, especially the influence of the seasons. Thus, whilst there is still some potential for semantic confusion (e.g. concerning the precise meaning of terms such as "major change" and "large portion" of the view), it can be argued that Type 3 assessment frameworks do go some way to enhance the transparency of the assessment in the sense that the reader is potentially in a better position to 'calibrate' the language terms used by experts.

5. Noise assessment and the treatment of impact significance

Although the EIA Directives do not explicitly require EIAs to assess noise, most development projects generate noise impacts either during construction, operation, or demolition as part of project decommissioning, and as a

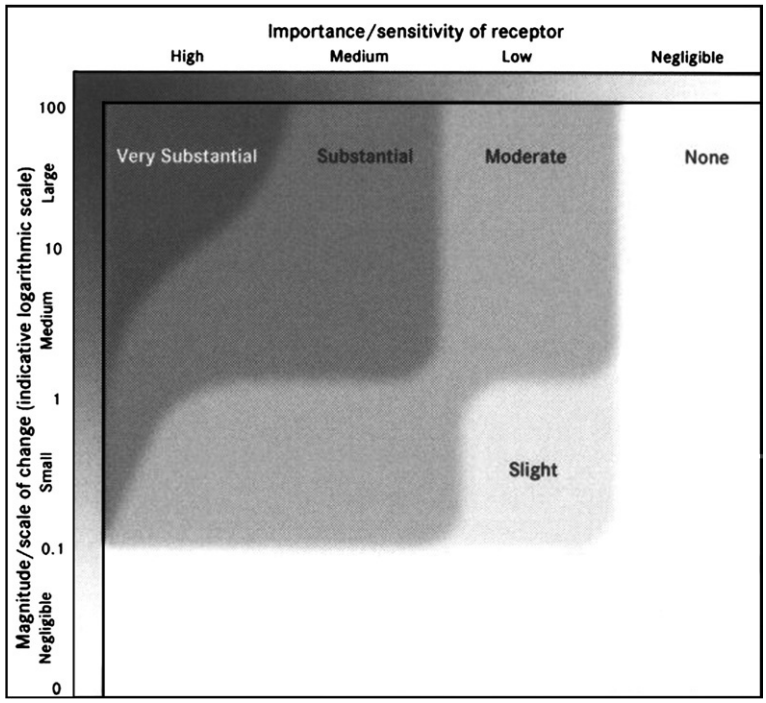

Fig. 5. Case 9: Impact significance matrix.

SIGNIFICANCE	DEFINITION
Very Substantial	The majority of the proposals are clearly visible irrespective of the season. Proposals dominate or substantially obstruct views from the most sensitive receptor types. The main elements of the proposals are clearly visible as a result of proximity, size, the absence of intervening vegetation, topography or structures, or due to the absence of adequate mitigation measures.
Substantial	A substantial part of the proposals is visible whatever the season and represent major changes to views from sensitive and very sensitive receptor types. The visual prominence of the proposals detracts from principal views or dominates changes to views from sensitive receptor types. Views are not significantly moderated by distance, scale seasonal factors or other design and mitigation measures.
Moderate	The majority of the proposals are visible but well moderated by distance, scale or other features. The proposals represent major or dominating changes to views from receptors of low sensitivity, or small changes to views from sensitive and very sensitive receptor types/ Significance increase during winter months.
Slight	Some parts of the proposals remain visible and represent a small change to views from receptors of low sensitivity or more sensitive receptors at a great distance from the site. Visibility possible increases during the winter but not of great significance
Not Significant	Proposals are only partially visible or appear visually insignificant and unaffected by seasonal change. No real change to existing views

Fig. 6. Case 9: Additional significance assessment descriptors.

consequence virtually all EISs in the UK address the topic.

Noise can be quantified on a logarithmic scale of decibels (dB) and a wide range of guidelines and standards that incorporate quantitative noise thresholds and criteria exist.[3] Characteristics of noise that influence the degree of disturbance subjectively experienced include temporal dimensions (e.g. the time of day, frequency of occurrence, duration of exposure); the nature of the noise source (intermittent, continuous, pitch/tone and spectral characteristics); the characteristics and sensitivity of receptors receiving the noise; and the magnitude of any change in noise and the absolute level of noise. In EIA the A weighted noise measurement dB(A) is employed to most closely match the frequency response of the human ear.

5.1. Noise impact significance criteria in practice

Thresholds, criteria and methods drawn from standards and guidelines are widely used to assist the assessment of noise impact significance in EIA, and 93% of the EISs reviewed were found to directly use such approaches. However, in over 60% of these cases, whilst use of the relevant standard is indicated and is indeed typically used to legitimate the assessment conclusions, the underlying criteria and language terms employed for evaluating significance were not clearly defined.

As with landscape and visual impacts, the review of EISs identified a typology of three basic approaches to the assessment of noise impact significance in practice, examples of which are considered subsequently:

(i) Approaches that evaluate and communicate impact significance through the use of *relative noise criteria* i.e. thresholds that relate to the magnitude of the difference between baseline ambient noise levels and the noise generated by the proposed development.
(ii) Approaches that involve the consideration of *absolute noise criteria* i.e. thresholds that relate to the significance of the magnitude of specified *overall* levels of noise that result when ambient baseline noise levels are combined with the anticipated project impacts.
(iii) *Combination approaches* that employ a mixture of both relative and absolute criteria to assess impact significance.

[3] For an introduction and overview of noise impact assessment the reader is referred to Morris and Therivel (2001).

5.1.1. Noise impact significance determinations using relative criteria

Two types of examples of the use of relative criteria for were found in practice, namely (i) British Standard 4142 "Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas" (BSI, 1997); and (ii) customised approaches.

Of the 30 EISs examined, BS 4142 was the most commonly used standard for determining noise impact significance, involving some 23% of cases. In essence, BS4142 describes a method to determine the noise level attributable to the new source (i.e. the proposal), the background (baseline) noise levels, and the likelihood of complaints. To undertake the assessment of the likelihood of complaints involves the subtraction of the measured background noise from the 'rating level' i.e. the source noise level corrected for tone or character. The difference calculated in this way is then compared with the following criteria:

- A difference of around +10 dB or more indicates that complaints are likely;
- A difference of around +5 dB indicates a marginal significance of complaint;
- A difference of −10 dB or less is a positive indication that complaints are unlikely.

A number of points of interest with regards to the use of BS4142 in isolation for noise impact significance considerations in EIA arise. Firstly, whilst the assessment of baseline levels is incorporated in the approach, arguably the sensitivity of receptors is underplayed. For example, in circumstances where baseline noise levels are already high and where receptors are potentially highly sensitive to any additional noise burden, mathematically the method may produce an outcome that suggests complaints are unlikely.

Secondly, issues such as the timing and duration of the noise impacts are not adequately addressed, with the method placing an overriding emphasis upon the magnitude of noise. Whilst BS4142 requires a 5 dB addition to the source noise level if (a) the noise has a tonal component (e.g. it contains a noticeable hiss or hum), or (b) if it is impulse noise (e.g. bang or thump) or if it is irregular or intermittent in nature, it is debatable whether this approach fully captures the potential annoyance caused by the character and quality of the noise impact, particularly given that in many cases of EIA development the impact is likely to be imposed and not voluntarily received.

Thirdly the focus of BS4142 upon complaints means that potentially the emphasis of the assessment lies less

SIGNIFICANCE	DEFINITION
Major Adverse	Noise levels increased to a point where continued residential use of individual properties is inappropriate or where the use of a community building could be inappropriate. Increases in ambient noise levels of 15 dB or more at residential areas.
Moderate Adverse	Increases in ambient noise levels of 5 to 15 dB at residential properties. Increased noise levels requiring mitigation by acoustic insulation of residential properties on a widespread basis. Increases in noise in outdoor recreation areas in close proximity to the junction to levels where continued use may be inappropriate.
Slight Adverse	Increases in noise levels by 3 to 5 dB at residential properties or where acoustic insulation is required for individual properties. Increases in noise of 5 to10 dB at outdoor recreational areas inclose proximity to the motorway.
No Significant Impact	Changes in noise level of less than 3 dB at residential properties. Increases in noise level of less than 5 dB at outdoor recreational areas in close proximity to the junction.
Slight Beneficial	Reductions in noise levels at individual properties to below the threshold for acoustic insulation. Reductions in noise level of 3 to 5 dB at residential areas, community buildings or outdoor recreational areas.
Moderate Beneficial	Reductions of more than 5 to 15 dB in residential areas, community buildings or outdoor recreational areas.
Major Beneficial	Reduction of road traffic noise to a level which does not contribute significantly to the ambient noise in an area.

Fig. 7. Case 14: An example of bespoke noise significance assessment criteria.

upon managing and mitigating impacts to minimise social and environmental effects (as in best practice EIA), but instead the method may be used as a means to legitimise the imposition of impacts up to a maximum level that falls just below the calculated theoretical threshold of complaints.

In five cases (Cases 3, 9, 14, 22, and 25) the EISs employed customised criteria to assess noise impact significance, all of which are based around the use of relative thresholds. Whilst customised approaches remain rooted in a quantitative appraisal of the magnitude of the change in noise, all three cases were considerably more transparent in communicating the role of other factors (most notably the nature and sensitivity of receptors) in influencing judgements on impact significance than was generally found with other approaches in the EISs examined (e.g. see Fig. 7). Thus, in each case, language terms such as "Moderate Adverse" etc. are defined and enable the reader to trace the assessor's frame of reference.

5.1.2. Noise impact significance determinations using absolute criteria

In the sample of EISs examined, two different types of absolute criteria were identified, involving either (i) single thresholds set at a fixed level, including a 55 dB $L_{\mathrm{Aeq\ (1\ h)}}$[4] threshold and a 68 dB $L_{\mathrm{A10\ (18\ h)}}$[5] threshold; or (ii) the use of a steeped sequence of absolute thresholds. For illustrative purposes the following discussion focuses solely upon the former i.e. examples of single level absolute criteria.

The 55 dB threshold has its origins in community surveys to identify daytime threshold levels of noise that should not be exceeded in order to prevent serious noise annoyance (WHO, 1980). Use of the 55 dB threshold is found in Minerals Planning Guidance MPG11 (DoE, 1993), and indeed of the three cases that use this threshold Cases 4 and 20 are both extraction developments, whilst Case 5 is a waste disposal facility for which MPG 11 indicates the guidelines are also relevant. Thus, paragraph 34 of MPG11 recommends that "the daytime nominal limit at noise sensitive properties used as dwellings should normally be 55 dB L_{Aeq}, 1 hour", except in quieter rural areas where this level exceeds existing background noise by more than 10 dB

[4] $L_{\mathrm{Aeq\ (1\ h)}}$ is the equivalent continuous level of sound that contains the same sound energy over 1 h as the actual sound over this period.

[5] $L_{\mathrm{A10\ (18\ h)}}$ is the sound level exceeded for 10% of the measurement period of 18 h.

(A). Interestingly, MPG 11 also recommends that noise limits can be linked to planning conditions. These can then be monitored and enforced, and so in this sense the thresholds serve to feed into decision-making regarding the final management and mitigation of operational noise impacts.

The 68 dB thresholds was found in use with 3 case studies and can be linked to the assessment of traffic related noise effects associated with the operational phase of the development proposals. Case 11 indicates that the 68 dB $L_{A10\ (18\ h)}$ threshold is drawn from Highways Agency guidelines which refer to the level at which residential properties qualify for a noise insulation grant. Thus the EIS states "if this level was reached or exceeded, it would indicate a significant noise nuisance."

All of the above examples of absolute noise criteria represent 'pivot thresholds', in that they serve to identify a critical dividing line between what is considered to be a significant and non-significant impact, although there is no attempt to specify in more detail the relative degree of significance. Pivot thresholds have the advantage of simplicity, ease of application, and arguably facilitate consistency of practice in noise appraisal. However their use in isolation is potentially controversial and can be used to underplay impact significance. For example, the EIS for Case 11 predicts that the highest traffic related noise prediction will result in an increase in noise level of 6 dB to 62.2 dB, and because this falls below the 68 dB threshold it concludes that noise impacts are "considered not to be significant and specific mitigation measures have not been included". Comparison with other EISs reviewed reveals the extent to which this underplays the degree of impact. Thus, CASE 8 also employs the 68 dB absolute threshold, but in tandem with a second relative threshold in a combination approach whereby any increase in baseline noise levels above 3 dB is also used as a means to identify a significant effect.[6]

5.1.3. Noise impact significance determinations using combination approaches

In addition to the example of Case 8, the review of EISs identified one other example of a combination approach, this time associated with the noise assessment of windfarm proposals (Cases 21 and 29). The "Assessment and Rating of Noise from Wind Farms" (ETSU, 1996) is a methodology designed to assess noise impacts through the identification of "indicative noise levels thought to offer a reasonable degree of protection to windfarm neighbours, without placing unreasonable restrictions on windfarm development or adding unduly to the costs and administrative burdens in developers or local authorities" ETSU (1996).

The method sets separate noise limits for day-time and night time periods. For instance, the day-time limits are intended to preserve a property's external amenity, and are derived from the best fit correlation of background noise data collected over specified quieter periods of the day against wind speed data collected concurrently. The limit is then set at 5 dB(A) above the best fit curve over a range of wind speeds between 0–12 m s^{-1}. Where noise levels are low (in the range 30–35 dB(A)) the guidelines recommend that the noise limit be fixed at an absolute level from within the range 35–40 dB(A).

The overall approach is of interest in three main respects. Firstly, the 5 dB figure represents a relative threshold, in effect a 'floating threshold' that is applied over a range of wind conditions over day and night time in order to establish a sequence of absolute thresholds linked to variations in wind speed that occur in the locality. Thus the approach is strong in terms of catering for the dynamic nature of baseline noise conditions. Secondly, it is apparent that principally the method is not intended to be used as a means of retrospectively assessing the significance of noise impacts for a given project, but rather an important objective is to influence the siting and design component of windfarms in a proactive manner such that the potential for significant noise impacts is avoided. Thus, as with MPG11, the approach is encouraging environmental assessment that seeks to influence environmental management outcomes. Thirdly, the approach is unusual in that the impact acceptability is partially considered in the sense that where a dwelling is associated with the development proposal (e.g. the home of a farmer who has a financial stake in the development) and the party concerned is a voluntary recipient of the impacts as opposed to them being imposed, the guidance is relaxed. Thus the EIS for Case 12 indicates that "dwellings associated with the development may be allowed to experience a level of up to 45 dB_{LA90}[7] before noise levels are deemed too high, when background levels are below 30 dB_{LA90}."

[6] It is also interesting to note how an impact of the magnitude anticipated in CASE 11 would be assessed using customised transport noise relative thresholds applied in other cases. Thus an impact of 6 dB would be classed by the criteria in CASE 3 as being of 'moderate impact significance', CASE 9 as a 'moderate impact' and CASE 14 as a 'moderate adverse impact'.

[7] $L_{A90\ (T)}$ is the sound level exceeded for 90% of the measurement period, *T*.

6. Discussion: the formulation, application and interpretation of significance criteria

The preceding analysis has revealed clear evidence of considerable diversity in the way in which expert judgement is formalised with respect to the treatment of significance in EIA, both within and between impact areas. For landscape and visual assessment, over one third of the EISs reviewed made little or no attempt to communicate the approach employed to evaluate impact significance. By implication, the use of expert judgement remains essentially an opaque or 'black box' exercise, with limited explanation or justification for the significance determination. This is despite the recommendations of government guidance which state: "One of the aims of a good environmental statement should be to enable readers to understand for themselves how its conclusions have been reached, and to form their own judgements on the significance of the environmental issues raised by the project" (ODPM, 2000). In cases where more explicit and transparent criteria were employed, the lack of formal or orthodox standards for determining the significance of landscape and visual assessment necessitates the use of customised approaches that were found to vary methodologically. Although the judgement of the expert is potentially more transparent in such customised approaches, issues of consistency and comparability of practice arise and the formulation of criteria is potentially 'unconstrained' and remains open to manipulation, issues that are considered in more detail below.

In contrast to landscape/visual assessment, a range of formal thresholds and criteria are employed for noise impact assessment, although it seems that experts largely fall back on particular established protocols for application with specific development types. Arguably the use of criteria and thresholds drawn from guidance provides the assessment with some degree of standing and a degree of consistency. However, the use of such orthodox approaches in noise assessment can lead to *less* emphasis on the exercise of expert judgement when evaluating impact significance, with the assessor in effect 'hiding' behind quantitative thresholds that focus exclusively upon the magnitude of noise and which have not been refined for the environmental or social context of the proposal, and that may be employed – deliberately or otherwise – to downplay impacts.

That said, the use of standard approaches and their associated thresholds is not always inherently problematic, but rather the specific way in which thresholds are embedded in the assessment approach is key. Thus, it could be argued that the use of criteria associated with MPG 11 for minerals and waste projects or the ETSU approach for windfarms can be positive in circumstances whereby the thresholds are used to influence project design/operation in order to secure an improved environmental management outcome.

For both landscape/visual and noise assessment, a key issue of concern regarding the quality and effectiveness of assessment practice is the high proportion of the EISs that make little or no attempt to define and explain the approach used to evaluate and communicate judgements regarding impact significance. Amongst the EISs reviewed in this paper, customised significance criteria were found to be amongst the most transparent, although the use of such criteria does in itself raise a number of important issues.

Firstly, it should be recognised that even where clear and transparent significance criteria are outlined within the text of an EIS, it does not follow that in reality the expert actually applies the criteria in practice. Rather the significance framework may simply be included to portray a convincing, systematic and objective style, in a cynical attempt to add 'scientific' credence to the assessment.

The use of customised criteria also raises the potential issue that the framework for defining impact significance could be manipulated to the advantage of the project proponent by in effect 'raising the bar' such that, for example, a 'substantial' impact will never be identified and by default the assessment is found to subsequently 'speak no evil'. Thus, whilst the use of natural language terms and customised criteria for evaluating and communicating impact significance may ostensibly serve to improve the transparency of the assessment, the EIS author can still exert influence and control over the reader, based upon what are essentially subjective–technical judgements. Critically therefore, the decision-maker needs to consider carefully not only the meaning of the term as expressed by the expert, but also the validity of the approach taken to apply the adjective to the degree of impact predicted.

Related to the previous point, sharp 'black and white' boundaries between impact significance criteria or categories may also be used that do not reflect the actual 'shades of grey' that are likely to exist in reality e.g. it is a logical fallacy that a noise impact of 4.9 dB should be considered a 'slight' impact but that a 5.0 dB is classed as being of 'moderate' impact significance. EIA has in effect attempted to 'filter out' such fuzziness by portraying an impression of discrete classes of impact. Case 9 (Fig. 4) provides an example of an

approach that attempts to tackle this issue by allowing for a degree of overlap at the boundaries of the assessment categories (i.e. between 'small' and 'medium') that serves to provide a more realistic indication of the gradients of sensitivity and magnitude that exist in reality. Similarly the significance matrix in Case 9 is characterised by 'fuzzy' rather than sharp or crisp boundaries between the categories employed. However, the use of expressions such as 'major', 'moderate' etc. as a means of characterising impact significance does not avoid the problem of lexical uncertainty in that such language terms and associated criteria may themselves be contested — one person's 'slight' impact is quite possibly another's 'substantial'. In addition, whilst it is not unusual for significance assessment in EISs to attempt to incorporate consideration of receptor sensitivity in assessing impacts upon different parties, no evidence was found of stakeholder consultation or community involvement feeding into the design or application of the significance assessment framework employed.

It has been widely argued that the significance of an impact intrinsically reflects the value basis of the party that is formulating a judgement or opinion (Weston, 2000a; Wilkins, 2003) and that in an adversarial EIA system, stakeholders will simply act in a political manner to support a given position, thus effectively rendering futile any attempt to incorporate a broader range of inputs into significance appraisal criteria. Here it is suggested that when considering the role of values in EIA decision-making processes, a nuanced yet importance distinction should be drawn between concepts of impact significance and impact *acceptability*, and that stakeholders, including the lay public, are able to differentiate and separate these two concepts in formulating judgements. Research by Wood et al. (2007) into stakeholder assessments of the significance of visual impacts related to a windfarm proposal provides a useful illustration of this point. In this study, local residents who indicated a positive perspective towards windpower were found to evaluate impact significance as *more severe* yet simultaneously *more acceptable* than the residents who expressed indifference towards windpower. Thus the pro-windfarm portion of the local community clearly recognised the visual impacts as significant, but reflecting their values and belief systems, they were prepared to accept the impacts even though they would be in effect imposed upon them if the development proceeded. Such evidence suggests that there is potential scope for incorporating a broader range of stakeholder inputs in order to calibrate criteria and language terms for significance appraisal, whilst simultaneously enhancing the legitimacy of the basis of the judgements expressed in EIS documentation.

Whilst the issue of lexical uncertainty clearly raises serious challenges with regards to the interpretation of assessment criteria, the complexity of impact significance determinations is further compounded by *other* sources of uncertainty in the EIA processes, particularly uncertainty associated with baseline conditions, impact predictions and mitigation (see Table 1).

The baseline environment is characteristically dynamic and yet EIA fieldwork is often carried out under circumstances of limited time and resources, and may not be conducted at the optimum time of the year. For example, consideration of seasonal differences for landscape and visual impact assessment occurred in only 20% of the cases reviewed. Evidence that explicit consideration has been given to the nature and implications of future baseline conditions (i.e. the future without the project) is even more illusive, occurring in just 3 cases for landscape and visual assessment and 4 cases for noise.

The degree of uncertainty associated with impact predictions and the effectiveness of mitigation measures is similarly underplayed in EIA and is not given adequate consideration in significance evaluation. Thus, for landscape and visual assessment, only 23% of the cases examined included some consideration of the level of uncertainty associated with the impact prediction method employed, although the corresponding figure for more quantitative based noise assessment is higher at 33%. Precautionary or worst case scenarios were used as the basis of the assessment in 33% of noise assessment cases, falling to just 16% for landscape and visual assessment. Furthermore, some 27% of noise assessments and 37% of landscape/visual assessment focussed entirely upon the significance assessment of residual impacts despite the potential for uncertainty surrounding the effectiveness of mitigation measures.

7. Conclusions and recommendations

A critical role of EIA is to communicate the significance of the potential impacts arising from development proposals to a range of stakeholders including the elected project authorization decision-makers, regulators/statutory consultees, and the wider public. To remain useful to these parties and to maintain credibility and legitimacy in the face of the exercise of judgement that is embodied within the EIA process, the EIS itself needs to be characterised by clarity and transparency, most notably with regards to the approach

used to evaluate and communicate impact significance within the assessment.

With noise assessment typically employing orthodox standards and significance assessment frameworks that are not refined to the particular local circumstances of the project and environmental setting, and with over one third of the landscape and visual cases examined failing to define the terms used for evaluating and communicating impact significance, there undoubtedly appears to be scope for improvement in practice. Drawing on insights gained from findings that are specific to noise and landscape/visual assessment, a number of preliminary conclusions and recommendations that are of wider relevance for EIA practitioners are proposed below:

(i) Develop a more inclusive approach to the determination of significance assessment frameworks or criteria that are refined for the social and environmental decision-making context.

Clearly there is potential for the process of significance evaluation and communication to be highly contentious and conflictual, with divergence in what might be considered to be significant between the different actors involved, be they regulators and statutory consultees, the lay public, special interest groups and NGOs, or the project proponent and their associated consultants. The use of explicit significance criteria and evaluation frameworks serves to improve transparency, although as has been demonstrated, the development of effective criteria is by no means a simple task and current approaches have been seen to contain limitations and omissions. Drawing upon the typology of significance suggested by Canter and Canty (1993), the findings in this paper suggest that UK practice is dominated by codified or institutional perspectives and technical or professional substantive judgements of significance, at the expense of broader public interest or community based considerations.

Innes (1998) recognises that information has more influence in decision-making when it becomes embedded in understanding, practices and norms rather than when it is used purely as evidence, and argues that the actual process of producing information is crucial, requiring deliberation to develop shared meanings through communicative planning. One way forward for EIA practice, not without considerable challenges, would be to seek to devise a significance appraisal framework and associated criteria in conjunction with a range of stakeholders, in a process of dialogue ideally conducted early in the scoping phase of the EIA. Such as process would serve to enhance the credibility and legitimacy of significance appraisal frameworks and the involvement of a broader array of stakeholders could improve the incorporation of socially derived, context informed, value-judgements.

Alternatively, more inclusive assessment techniques such as the Quality of Life Capital approach (Morris and Therivel, 2001) could be more widely employed, whereby the emphasis shifts from the determination of significance relating to standard EIA impact 'themes' (noise, landscape, water quality, air quality etc.) to focus instead upon the benefits that different groups perceive to be provided by the baseline environmental situation, and the extent to which these might be substituted or improved through project design alternatives.

Technical analysis in the form of environmental simulations also offer potential for more open and collaborative approaches whereby stakeholder inputs are fed back into project design in an iterative manner. Such an approach can be particularly effective when simulations are 'user friendly' and easy to interpret amongst a wide and diverse audience, as can be the case with landscape and visual impact models and computer animations (Wood et al., 2007). At its fullest extent such an approach can even preclude the need for the creation of thresholds or criteria for significance evaluation; instead the collaborative process is informed by the technical analysis (e.g. simulations) and results in a more unified approach to the management of significance determinations.

In circumstances where project proponents argue that confidentiality constraints preclude engagement with the broader public(s) during scoping, the effectiveness of EISs could still be improved by working in partnership with the competent authority and the statutory consultees in order to define significance assessment criteria at the outset that supplement and extend technical and professional substantive judgements to include an explicit link with decision-making consequences. For example, in defining the significance of ecological impacts as "major", in addition to technical factors the EIS for Case 20 states: "Impacts of Major significance represent important, possibly key considerations in the decision making process. They are serious constraints to development and should be avoided except in proven circumstances of national or regional need. High levels of mitigation or compensation should be provided."

Finally, wherever possible, when formulating thresholds and criteria in a more negotiative style, the emphasis should be upon their use as means to improve environmental management outcomes.

(ii) Move beyond magnitude of impact and value/sensitivity of receptors.

At present, the significance criteria and thresholds applied in practice are heavily dominated by an assessment of the magnitude of the impact and the value or sensitivity of the affected resources. Whilst a more inclusive approach to the formulation of significance thresholds and criteria may broaden their basis, other 'standard' dimensions of impact significance could also benefit from more consistent and explicit treatment, notably the timing of impacts, duration, reversibility, and their cumulative potential. When there are no significant impacts, this need to be justified and explained and should not be assumed as obvious.

(iii) Give greater attention to links between baseline considerations, mitigation and the assessment of the significance of residual impacts.

The characterisation of baseline conditions is a critical starting point for assessing impacts and in theory provides the benchmark against which assessments of the significance of predicted environmental change are considered. Implications of the dynamic nature of baseline conditions is given limited treatment in practice and improvements in consideration of future baseline conditions in the absence of the project should also be made, particularly when there may be a long lag time between project approval and subsequent development and operation stages of a project.

Generally the consideration of residual impacts was given cursory treatment in the EISs examined in this paper. Some significance assessment frameworks focus entirely upon the residual impacts, but this assumes that mitigation will be successful and may be equally unhelpful; for instance, a tree planting scheme designed to reduce visual impacts may simply fail, and hence the impacts remain unmitigated. To provide a full picture to decision-makers, the impact significance criteria should be applied to both the unmitigated impacts and the residual impacts.

(iv) Improve treatment of uncertainty and fully identify assessment limitations.

Significance assessment frameworks can impart a greater sense of certainty than is genuinely warranted and there is need to acknowledge the various sources of uncertainty, including the degree of confidence in predictions, the likely success of mitigation, and the level of confidence in the final judgement of significance.

Under conditions of uncertainty the adoption of a precautionary approach to significance determination offers a simple yet effective way forward, whilst more sophisticated methodologies such as fuzzy set analysis (Wood et al., 2007) provide the means to more fully understand the lexical uncertainty associated with context specific significance determinations.

The environmental assessment regulations require an EIS to provide a statement of any difficulties encountered in the assessment and overall this issue does not appear to be given sufficient attention in the UK.

(v) Ensure comparability of significance assessment between impacts.

The issue of orthodox bias in the assessment approaches typically associated with different impact themes can make multidisciplinary consensus in the EIA problematic (Sadler, 1996) and reduces the potential for promoting interdisciplinary solutions to environmental problems. Thus, whilst the multidisciplinary nature of EIA is largely seen as strength, it was apparent in reviewing the EISs that EIA managers appear to encounter problems in drawing material together from various disciplines in terms of a consistent EIS report that contains a systematic and comparable treatment of significance. For example, it is not uncommon to find that an EIS incorporates a significance assessment methodology statement early on, but that the approach is not adhered to for all impact areas, with different language terms and fundamentally different methodologies subsequently applied. Clearly, in circumstances whereby one impact may be 'traded off' against another there is a need to be able to make meaningful comparisons based around relative impact significance. For instance, continuing with the example of noise and landscape, a situation could occur whereby a large earth bund may be suggested by as a mitigation measure to reduce the significance of noise impacts, but this may in turn increase the level of significance attributed to landscape and visual impacts associated with the development.

From the above recommendations it should be clear that the challenges for EIA and impact significance determinations do not lie simply in the realms of improved science and the pursuit of unfailing objective expert opinion, but rather that clarity of communication of the assessment to decision-makers and the broader stakeholder community is a vital ingredient of success. Thus, rather than conceiving of impact significance determination as a simple case of objectivity versus subjectivity, more realistically it becomes an issue of "how well subjective judgements are substantiated" (Lawrence, 1993). As has demonstrated, there is currently scope for much improvement in EIA practice in the UK in this regard.

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Appendix A. Environmental Impact Statements Reviewed

Case no.	Title	Date
1	Southend-on-Sea Flood Defence Improvements: Pier to Thorpe Avenue	12/2000
2	Land at Temple Quay North (mixed use urban development)	05/2001
3	Dibden Terminal (container port development)	09/2000
4	Land at Denge Pit (aggregates extraction)	03/2001
5	Green Waste Composting Facility, Longham Quarry	11/2001
6	Proposed New Sports Centre, Wycombe Abbey School	04/2002
7	Bulcote Farm Minerals Extraction and Restoration	07/2002
8	Buckton Fields (mixed use urban development)	07/2000
9	UK Heritage and Technology Centre, Brooklands	12/2002
10	Colthrop Mill (distribution and industrial premises)	05/2001
11	Crewe Green Link South Weston Gate Roundabout to A500 Bypass	11/2001
12	LLethercynon Wind Energy Project	03/2000
13	Lots Road (residential development)	2002
14	M4 Junction 11 Upgrade	08/2002
15	Silk Stream Flood Alleviation Scheme	04/2000
16	Spa Green Quarry Redevelopment	02/2001
17	Drigg PCM Retrieval Project	04/2000
18	The Redevelopment of the Manor Farm Sewage Treatment Works	10/2000
19	Shepherd's Grove Waste Composting Facility	05/2001
20	Lodge Farm New Rugby Clay Extraction	2002
21	A380 Kingskerswell Bypass	11/2004
22	St Anne's Wharf, Norwich (mixed use redevelopment)	02/2003
23	Beechen Lane Lyndhurst (residential development)	01/2003
24	Petersfinger Park and Ride	01/2006
25	Hartland Park (storage and distribution centre)	01/2005
26	Thames Gateway Water Treatment Plant	06/2004
27	Aircrete Blockmaking Facility, Inghtham	12/2004
28	Airdrie–Bathgate Rail Link Project	05/2006
29	Lochluichart Windfarm	11/2005
30	Felindre to Tirley Natural Gas Pipeline	08/2006

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