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A conceptualisation framework for building consensus on environmental sensitivity

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ABSTRACT

Examination of the intrinsic attributes of a system that render it more or less sensitive to potential stressors provides further insight into the baseline environment. In impact assessment, sensitivity of environmental receptors can be conceptualised on the basis of their: a) quality status according to statutory indicators and associated thresholds or targets; b) statutory protection; or c) inherent risk. Where none of these considerations are pertinent, subjective value judgments can be applied to determine sensitivity. This pragmatic conceptual framework formed the basis of a stakeholder consultation process for harmonising degrees of sensitivity of a number of environmental criteria. Harmonisation was sought to facilitate their comparative and combined analysis. Overall, full or wide agreement was reached on relative sensitivity values for the large majority of the reviewed criteria. Consensus was easier to reach on some themes (e.g. biodiversity, water and cultural heritage) than others (e.g. population and soils). As anticipated, existing statutory measures shaped the outcomes but, ultimately, knowledge-based values prevailed. The agreed relative sensitivities warrant extensive consultation but the conceptual framework provides a basis for increasing stakeholder consensus and objectivity of baseline assessments. This, in turn, can contribute to improving the evidence-base for characterising the significance of potential impacts.

1. Introduction

Environmental sensitivity describes the susceptibility of natural resources (e.g. habitats, water bodies) to human-induced changes such as land-use modifications that may cause their degradation (Toro et al., 2012; Yoo et al., 2014). Although a system-approach that examines all interactions between receptors and stressors is desirable (Adger, 2006), analysing the system's or region's characteristics that make it susceptible to change provides a valuable starting-point in impact assessment processes. The amended Environmental Impact Assessment (EIA) Directive warns about the potential for significant effects when proposing developments in environmentally *sensitive* locations (EC, 2014, article 28). Similarly, the Strategic Environmental Assessment (SEA) Directive refers to the *vulnerability* of the area likely to be affected when identifying and characterising potential impacts (EC, 2001; Annex II, 2). In impact assessment, sensitivity analysis is commonly centred on biophysical components, and framed around the concepts of susceptibility and resilience. It focuses on the capacity of given environmental criteria to absorb anthropogenic change and remain in the same state (Adger, 2006; Carpenter et al., 2001; Toro et al., 2012). In common terms, the higher the sensitivity of the receiving environment or environmental receptor, the less resilient it is - i.e. the less capable to cope with human-induced change. Sensitivity analysis provides further insight into the baseline environment by adding an additional sensitivity/vulnerability dimension to the purely technical factoring of characteristics. Sensitivity analysis not only supports informed planning and decision-making but also efficient response to natural disasters and accidents by highlighting focus areas for action (e.g. Aps et al., 2016). In the context of SEA, sensitivity analysis can serve as a critical foundation for sectoral planning discussions and for developing alternatives that avoid or minimise potentially incompatible land-uses and unsustainable developments. They can also contribute to evaluation of impact significance by setting a threshold above which change is unacceptable (Ehrlich and Ross, 2015) – unless that change helps to revert or reduce sensitivity.

It is acknowledged that the evaluation of impacts and, indeed, any decisions based on impact assessment results have a subjective dimension associated with the varying awareness and opinions of those involved in the process (Antunes et al., 2001; Hegmann and

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Yarranton, 2011). Impact significance is influenced by the importance or value that experts and stakeholders may place on the environmental resource (Duinker and Beanlands, 1986; Ehrlich and Ross, 2015). The same holds true in sensitivity analysis. Yet, as Adger (2006) emphasises, such subjective social values and contexts need to be incorporated in order to capture differentiations in sectoral and local perceptions. Interdisciplinary expert knowledge and perceptions can also further the evidence- and experience-base (Dietz and Stern, 2008; Gupta, 2008). However, when developing systematic and replicable methods that contribute to impact assessment transparency, objectivity and comparability, the inclusion of such social and expert values requires consented standardisation.

2. Conceptualisation of environmental sensitivity

Comprehensive analysis of environmental sensitivity requires harmonisation of relative sensitivity values to enable their comparative and, indeed, combined assessment (Wang et al., 2008; Yoo et al., 2014). The overall degree of sensitivity of an area, which can be rendered as a sensitivity index, can be obtained through aggregation of harmonised individual indicator values occurring in that area (e.g. Antunes et al., 2001; González et al., 2011a; Marull et al., 2007).

There are currently no globally accepted metrics for standardisation of neither indicators nor sensitivity. Nevertheless, standardisation of indicator values according to compliance scales enables contrasting relative sensitivities (González et al., 2013). Such compliance scales may relate to statutory thresholds, targets or presence/absence of certain criteria. On this basis, existing statutory measures provide a sound working framework for conceptualising intrinsic sensitivity in relation to:

- quality status according to statutory indicators, and associated thresholds or targets (e.g. a poor quality status water body, determined by chemical and biological indicators, would have acquired sensitivity to further point source pollution; it would be harder to maintain or improve its status and achieve quality targets while coping with such additional stressor);
- statutory protection (e.g. a water catchment containing a protected species or designation would be naturally susceptible to any land-use entailing hydrological changes that may affect their conservation); or
- inherent risk (e.g. flood risk areas would be unable to sustain development without remedial action).

In light of the above considerations, the lower/higher the quality status of an environmental criterion or the greater its degree of protection, the greater its sensitivity and potential for land-use conflicts. Similarly, the higher the risk, the more susceptible and the less suitable the land may be for certain developments. Despite the potential to harmonise environmental sensitivity on the basis of existing statutory protection and conservation measures, these are currently not established for certain environmental criteria, such as landscape or soils. To address this gap, value judgments may be required to determine sensitivity (Hegmann and Yarranton, 2011). Therefore, environmental sensitivity can be understood as intrinsic (e.g. water quality defined by objective and measurable parameters) or perceived (e.g. subjective visual amenity values).

It is widely acknowledged that value judgments are subjective and commonly linked to individual expertise, knowledge and opinion of those involved in the consultation process (González et al., 2011b; Lawrence, 2007; Toro et al., 2012). For example, experts may have a research- or knowledge-led bias (Boonstra et al., 2015), while the subjectivity of public input (a mandatory requirement in SEA under the Aarhus Convention and Directive 2003/35/EC on public participation - EC, 2003) is linked to awareness levels and/or personal values or concerns (Cox, 2013). However, it has also been acknowledged that social values play a significant role in determining significance (Ehrlich and Ross, 2015) which, arguably, encompasses the perceived susceptibility of the receiving environment or environmental resource. For a robust sensitivity determination, value judgments should be defined in consultation with experts and stakeholders to explore commonly diverging opinions, exchange knowledge and acquire a wider appreciation. This will facilitate making subjective yet informed judgments (Ehrlich and Ross, 2015). In all cases, a participative and structured exchange of perceptions facilitates collaborative learning, and the opportunity to improve the knowledge-base (Fraser et al., 2006; Letsela et al., 2010; Morgan and Matlock, 2008). Such exchange may facilitate reaching a common ground on relative sensitivity values.

Although consensus most commonly implies full and unanimous agreement, it can also be understood as a way to reach agreement whereby discussions lead to general conformity. In this context, consensus has been seen as equivalent to group decision-making (Cabrerizo et al., 2015). Full consensus is considered to be an unrealistic achievement (Herrera-Viedma et al., 2014) due to the varying perceptions and diverging opinions of those involved. Yet, several studies have shown to reach widespread agreement between multiple actors, often bridging research and practice views (e.g. Bojórquez-Tapia et al., 2001; Fletcher et al., 2014; González et al., 2011b). As impact assessment informs decision-making, reaching consensus or, at a minimum, widespread agreement on environmental sensitivity is desirable for a robust and reliable knowledge- and evidence-base.

The objective of this paper is to discuss participative consensus building on environmental sensitivity by means of a pragmatic conceptualisation framework. The paper examines stakeholder feedback on relative degrees of intrinsic/perceived sensitivity. More specifically, it comparatively explores the feedback in order to determine the reasons or possible causal justifications facilitating or hindering the achievement of wide agreement for various thematic criteria. In doing this, it also considers the effectiveness of the proposed conceptualisation framework in building general conformity.

3. Methodology

3.1. Environmental Sensitivity Mapping Webtool

An Environmental Sensitivity Mapping (AIRO, 2016) Webtool, using Geographic Information Systems (GIS) technology, has been developed in the Republic of Ireland (Ireland from here on) to support SEA (Fig. 1). The methodological approach is based on the premise that the environmental sensitivity of the study area needs to be examined to anticipate, identify and characterise potential impacts, as per SEA Directive requirements (EC, 2001). Therefore, it focuses on the analytical starting-point, examining the characteristics of the plan/programme area that make it susceptible and, therefore, likely to be affected by proposed plan/programme actions. The end aim of the Webtool is to provide an operational framework to assist practitioners (e.g. Local Authority planners, consultants) in undertaking SEA by enabling a systematic and rapid spatial examination of environmental sensitivities and potential for land-use conflicts that ultimately supports informed decision-making. The provision of an early 'warning' for potential impacts takes into account: a) the geographic location and extension of the affected area and its environmental characteristics, b) the intrinsic/perceived sensitivity of the overlapping environmental criteria

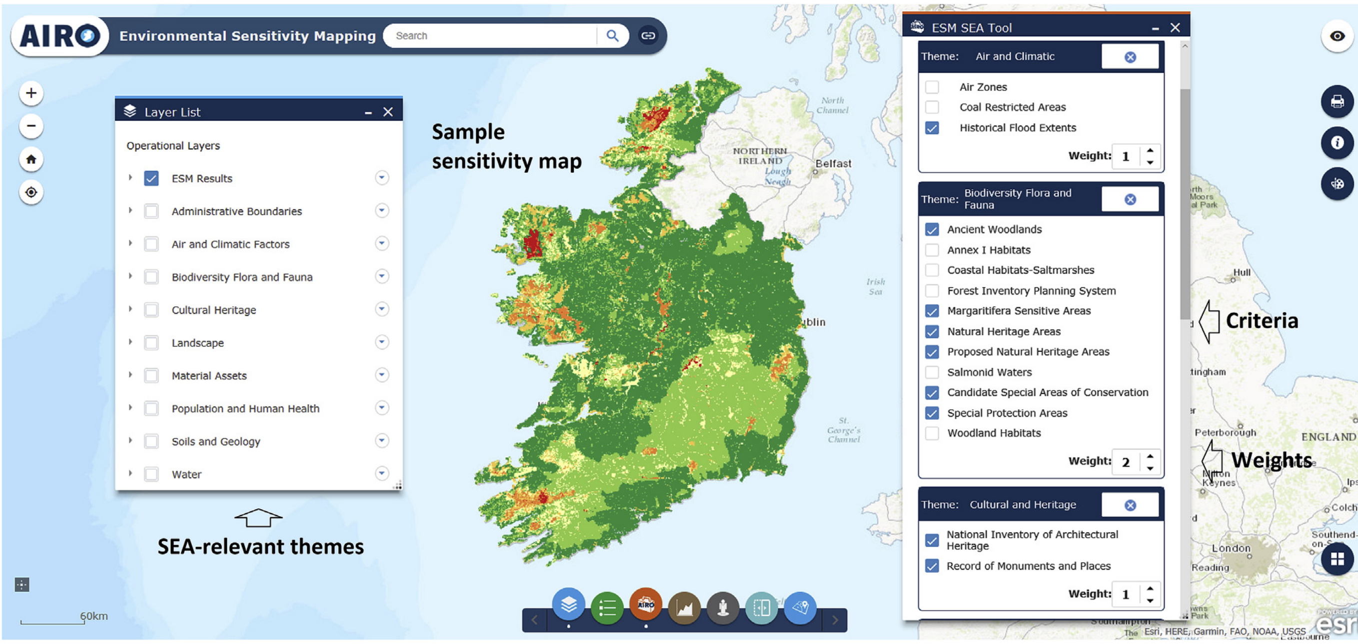

Fig. 1. Screenshot of the Environmental Sensitivity Mapping (ESM) Webtool illustrating Strategic Environmental Assessment (SEA) themes, associated datasets/criteria and weight selection options. The environmental sensitivity map provides an example of the outputs that can be generated in the Webtool.

within the area; and c) the significance assigned to such criteria. To achieve this, SEA-relevant environmental criteria (i.e. spatial datasets) were gathered, sensitivity scores were assigned to them in consultation with experts and stakeholders, and a weighting option of SEA themes was included in the Webtool to factor in scoping priorities or, alternatively, individual concerns and thus facilitate public participation (Fig. 1). It supports the notion that impact significance can be associated with the importance or value that experts and stakeholders may place on the environmental resource (Duinker and Beanlands, 1986; Ehrlich and Ross, 2015).

Sensitivity scores are the foundation of the ESM; they set the harmonised values by which the spatial datasets are combined and added together to produce sensitivity maps. Given their fixed nature (i.e. they cannot be modified by the Webtool user), necessary to facilitate a combined analysis, it was imperative to reach consensus on their relative values.

3.2. Harmonising sensitivity

In order to achieve harmonisation of sensitivity scores, two national workshops were held complemented with one-to-one consultation. The consultation process engaged 43 practitioners, researchers and governmental representatives (referred to as stakeholders from hereon). They were identified and invited to participate on the basis of their expertise and roles, which ranged from undertaking SEAs and preparing sectoral plans and strategies, to gathering and/or creating SEA-relevant spatial datasets, and to reviewing SEA environmental reports to inform decision-making.

A semi-structured approach was adopted to conceptualise sensitivity and to accordingly assign relative scores to the spatial datasets. This enabled accounting for statutory measures and risk, as well as for expert opinion (Fig. 2).

The approach included two complementary workshops. The first workshop discussed the importance of reaching consensus on the harmonised sensitivity values and agreed the adoption of a sensitivity scale. A number of sensitivity scales were presented, all with the starting point of 1 (referring to low sensitivity), and ranging from 3 to 10 (high). The range of scores was discussed and it was ultimately agreed that a simple, narrow scale (i.e. 1 to 3 representing low, moderate and high) would avoid confusion and unnecessary breakdown of values. Also as part of the first workshop, preliminary scores on the relative degrees of sensitivity for 29 of 54 environmental datasets were put forward by the project team to the workshop participants (a and b entries in Table 2). The participants were evenly grouped by SEA themes on the basis of their expertise to facilitate a focused knowledge-based review of preliminary scores. Four thematic groups were formed: 1) Biodiversity, flora, fauna and landscape (including representatives from the National Parks and Wildlife Service – NPWS and BirdWatch Ireland, as well as Local Authority heritage officers); 2) water, air and climate (including the Environmental Protection Agency - EPA, the Office of Public Works and hydrogeology consultants); 3) soils, geology and cultural heritage (with experts from the Department of Environment, Heritage and Local Government, and Teagasc - the Agriculture and Food Development Authority); and 4) population and material assets (including representatives from the National Roads Authority, Sustainable Energy Authority of Ireland and planners from the Regional Assemblies).

The spatial datasets were selected on the basis of their SEA-relevance and public accessibility. In Ireland, comprehensive datasets are currently unavailable for certain SEA themes (e.g. landscape, human health), which precluded their appropriate consideration in the consultation process and, subsequently, in the Webtool. The preliminary scores were based on statutory thresholds, targets, designations and risk, where applicable. The applied harmonisation rules assume that the greater the sensitivity of an environmental criterion, the higher the score assigned to it. The spatial datasets for which such legislative measures were not available to capture intrinsic sensitivity were not assigned any preliminary scores and, therefore, were fully open to discussion. During the first workshop, each SEA theme group was asked to revise the preliminary scores pertinent to their theme, and provide expert input for their adjustment. The revised scores together with value judgments for the remainder of the datasets were gathered

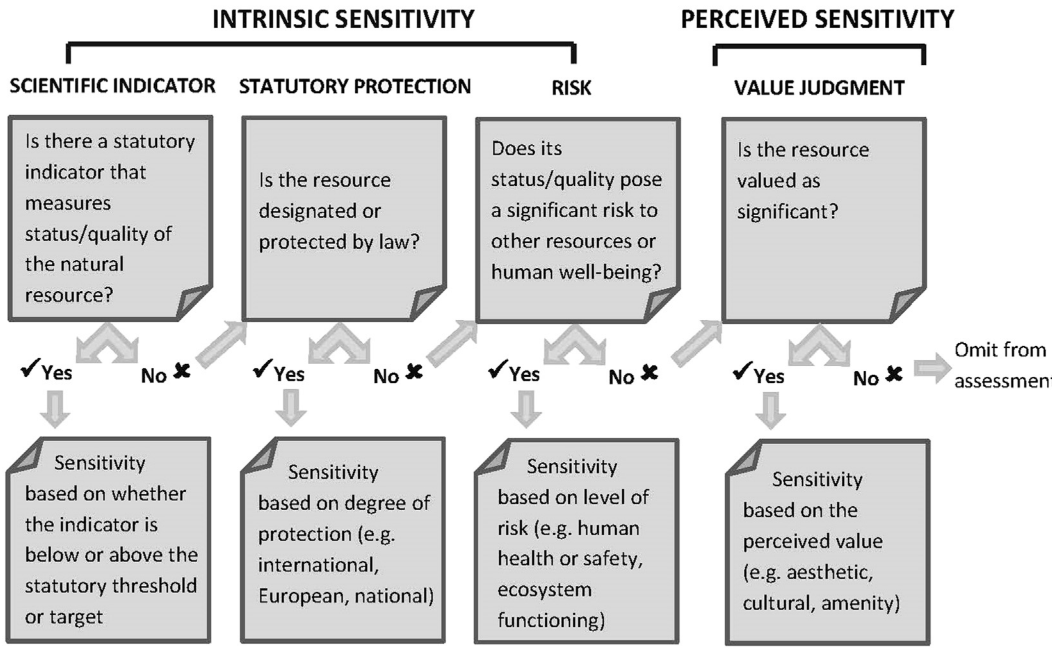

Fig. 2. Conceptualisation framework for establishing relative degrees of environmental sensitivity.

and revisited at a second workshop. The second workshop included a similar range of expertise, as the same organisations and individuals were invited, yet a number of different representatives attended for certain organisations. During this workshop, the scores agreed at the first workshop by each thematic group were open to general debate. The objective was to provide the opportunity for interdisciplinary and cross-disciplinary review of the sensitivity scores and, thereby, for reaching wider consensus. Where diverging opinions were voiced, supporting and opposing views were counted. Discussion on a number of criteria (e.g. geology, soils) were followed with one-to-one consultation given the absence of experts in these areas at the workshops.

4. Results and discussion

A significant number of preliminary scores assigned by the project team on the basis of the proposed conceptualisation framework (Fig. 2) were largely retained throughout consultation, but the majority were subject to debate (Table 1). In some thematic areas (e.g. biodiversity) consensus or wide agreement was reached, while in others (e.g. population) divergences in value judgments resulted in no definite scores being assigned to certain criteria.

4.1. Biodiversity and landscape

Biodiversity, flora and fauna spatial datasets are collated at national level by regulatory bodies (such as the NPWS in the case of Ireland), under the requirements of the Habitats Directive (EC, 1992). Given the degree of protection of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) pertaining the Natura 2000 network, their preliminary high score was supported and maintained throughout the consultation (Table 2). In contrast, there were opposing opinions on the relative sensitivity of Natural Heritage Areas (NHAs), due to their national protection under the Wildlife Act (Govt. Ireland, 2000a). At the first workshop, the thematic group agreed with the moderate preliminary score. During the open debate at the second workshop, a significant minority of participating biodiversity experts (3/7) emphasised that their national rather than European designation implies a lower degree of protection. However, a NPWS representative determined that despite the national nature of the designation, these areas deserve the same level of protection as SACs and SPAs and, therefore, should be assigned the same sensitivity score. Proposed NHAs were correspondingly considered to have moderate sensitivity given that they are pending formal designation. Interestingly, the scores for other biodiversity criteria under national statutory protection (e.g.

Table 1
Summary of workshop results on the review of sensitivity scores for environmental criteria.

Strategic Environmental Assessment (SEA) theme	Total Criteria	Preliminary scores	First Workshop		Second Workshop		Overall		
			Maintained	Adjusted	Maintained	Adjusted	Agreed	Widely agreed	Disagreed
Population and Human Health	6	3	0	3	3	0	3	0	3
Biodiversity, Flora and Fauna	11	10	6	4	9	1	10	1	0
Water	13	11	5	6	7	4	12	1	0
Soils and Geology	8	2	0	2	2	0	1	4	3
Air and Climatic Factors	4	1	0	1	0	1	2	1	1
Landscape	2	0	0	0	0	0	2	0	0
Cultural Heritage	2	2	2	0	2	0	2	0	0
Material Assets	8	0	0	0	0	0	0	0	8
Total	54	29	13	16	23	6	32	7	15

Table 2
Environmental criteria reviewed and sensitivity scores agreed during the consultation process.

Criteria and Final Sensitivity scores where 1 = Low, 2 = Moderate, 3 = High		Basis of the Score/Comments
Population and Human Health		
Percentage population change		
• Decreasing	[c]	Omitted as sensitivity criteria
• Increasing		
Population density (inhabitants/m²)		
• High	[c]	Omitted as sensitivity criteria
• Low		
Total population	[c]	Omitted as sensitivity criteria
WFD RPA Ground drinking water	3[b]	Statutory: Protection priority
WFD RPA Lakes drinking water	3[b]	Statutory: Protection priority
WFD RPA River drinking water	3[b]	Statutory: Protection priority
Biodiversity, Flora and Fauna		
Ancient woodlands		
• Ancient woodland	3[b]	Value judgment: Protection priority
• Possible ancient woodland	3[b]	
• Long-established woodland	2[b]	
Article 17 habitats (Habitats Directive)	3[a]	Statutory: Legal protection and indicator of environmental quality
Coastal habitats (saltmarshes)	2[b]	Statutory: Protection priority and environmental quality
Forest Inventory and Planning System		
• Deciduous	2[c]	Value judgment: Environmental quality
• Coniferous	1[c]	
Margaritifera sensitive areas		
• Catchments of SAC populations listed in Statutory Instrument 296 of 2009	3[a]	Statutory: Legal protection and indicator of environmental quality
• Catchments of other extant populations	3[a]	
• Catchments with previous records but current status unknown	2[a]	
Natural Heritage Areas	3[b]	Statutory: Legal protection
Proposed Natural Heritage Areas	2[a]	Statutory: Protection priority
Salmonid rivers	3[a]	Statutory: Legal protection
Special Areas of Conservation (SAC)	3[a]	Statutory: Legal protection
Special Protection Areas (SPA)	3[a]	Statutory: Legal protection
Woodland habitats	2[b]	Value judgment: Environmental quality
Water		
Aquifer vulnerability		
• High/Extreme/Rock near surface	3[a]	Value judgment: Environmental quality
• Moderate	2[a]	
• Low/Water	1[a]	
Aquifer categorisation		
• Pure limestones that are designated as karst aquifers	3[c]	Value judgment: Environmental quality
• Pure limestones that are not designated as karstic aquifers, impure limestones and Precambrian marbles	2[c]	
• Non-carbonate rocks	1[c]	
Groundwater source protection areas	3[b]	Statutory: Protection priority
RPA Nutrient sensitive areas (Lakes)	3[a]	Statutory: Protection priority
RPA Nutrient sensitive areas (Rivers)	3[a]	Statutory: Protection priority
RPA Recreational waters (Lakes)	3[b]	Statutory: Protection priority
RPA Recreational waters (Coastal/Rivers)	3[b]	Statutory: Protection priority
RPA Water dependant habitats (SACs)	3[a]	Statutory: Protection priority
RPA Water dependant habitats (SPAs)	3[a]	Statutory: Protection priority
Wetlands	2[c]	Statutory: Protection priority
WFD Groundwater status		
• Good	1[b]	Statutory: Environmental quality
• Poor	2[b]	
WFD Lake status		
• High	2[b]	Statutory: Environmental quality
• Pass/Good/Moderate	1[b]	
• Poor/Bad	2[b]	
WFD River status		
• High	2[b]	Statutory: Environmental quality
• Pass/Good/Moderate	1[b]	
• Poor/Bad	2[b]	
Soils and Geology		
Bedrock geology	[c]	Omitted as sensitivity criteria
Land cover (CORINE 2012)	[c]	Omitted as sensitivity criteria
Geoparks and Geosites	3[b]	Statutory: International importance
Outcrops	2[b]	Value judgment: Protection priority
Peatlands	2[c]	Statutory: Protection priority
Soils	[c]	Omitted as sensitivity criteria
Well drained soils	2[c]	Value judgment: Environmental quality
Poorly drained soils	2[c]	Value judgment: Environmental quality
Air and Climatic Factors		
Air quality	[c]	Omitted as sensitivity criteria
Air zones		
• Dublin/Cork/Cities	1[c]	Value judgment: Environmental quality. Omitted as a sensitivity criteria
• Rural areas	1[c]	
Coal restricted areas		

Table 2 (*continued*)

Criteria and Final Sensitivity scores where 1 = Low, 2 = Moderate, 3 = High		Basis of the Score/Comments
• Restricted	1[c]	Value judgment: Environmental quality. Omitted as a sensitivity criteria
• Unrestricted	1[c]	
Historical flood extents	3[b]	Statutory: Risk status
Landscape		
Landscape character areas	[c]	Omitted as a result of current inconsistencies in the dataset
Scenic views and prospects	[c]	Omitted as a result of current inconsistencies in the dataset
Cultural Heritage		
National Inventory of Architectural Heritage	2[a]	Statutory: protection priority
Record of Monuments and Places	3[a]	Statutory: Legal protection
Material Assets		
Discharge licenses	[c]	Omitted as sensitivity criteria
IPPC licenses	[c]	Omitted as sensitivity criteria
Landfill sites	[c]	Omitted as sensitivity criteria
Licensed waste facilities	[c]	Omitted as sensitivity criteria
Quarries	[c]	Omitted as sensitivity criteria
Waste water treatment plants and status	[c]	Omitted as sensitivity criteria
Water boreholes and source	[c]	Omitted as sensitivity criteria
Wind farms	[c]	Omitted as sensitivity criteria

[a] The preliminary score was maintained.
[b] The preliminary score was adjusted; and.
[c] No preliminary score was provided.

salmonid waters) were consented by all participants to be high. Contrastingly, certain criteria protected under European legislation (e.g. saltmarshes) were widely agreed to have a moderate score. Criteria for which value judgments were required (e.g. plantation forests and ancient woodlands) were subject to wider debate but, ultimately, full consensus was reached at the second workshop in the scores assigned to them. Overall, a degree of expert-bias was observed to ultimately determine biodiversity sensitivity scores.

Landscape criteria are considered to be highly subjective. Differences in landscape characteristics have been shown to indicate subjectivity of aesthetic values, yet consensus seems to be easier to form around positively perceived landscapes (Kalivoda et al., 2014). This is supported by the outcomes of the consultation. In Ireland, landscape assessments are undertaken at county level and the lack of a standardised national methodology has resulted in a highly inconsistent characterisation. Nevertheless, there was full agreement between participants on the sensitivity scores allocated to valuable landscapes, assigning the highest sensitivity to areas of outstanding natural beauty, high amenity areas and scenic views commonly defined in County Development Plans, prepared by local authorities under the Planning Act (Govt. Ireland, 2000b). Despite the achieved consensus and high sensitivity ascribed to these criteria, existing inconsistencies in landscape-related datasets impeded their inclusion in the Webtool.

4.2. Water, air and climate

Creation and collation of spatial datasets for water features and their status is a mandatory requirement under the Water Framework Directive (WFD – EC, 2000). These datasets incorporate status categorisation (e.g. poor, good) on the basis of achieving the WFD conservation targets. Preliminary scores were assigned using this categorisation, assuming that poor and bad status water resources are already at risk of achieving established targets and are more susceptible to further pollution. Stakeholders contested this postulation during the first workshop, arguing that high status meant high sensitivity, as it is much harder to achieve high status and it is a WFD requirement to maintain water quality at that level. Nevertheless, a number of participants in this thematic group (3/8) suggested that perhaps poor, bad and high water quality are all to be assigned high sensitivity scores for the opposing reasons noted above. These considerations were revisited at the second workshop and unanimously agreed by all participants; moderate and good waters were assigned a moderate score. On further discussion, the project team and the EPA representatives debated the importance ascribed to these criteria and the fact that the large amount of water quality data available and their wide geographical coverage can wrongly intensify the overall environmental sensitivity of certain areas. As the Webtool enables magnifying the sensitivity of a given environmental theme by means of context-specific user-defined significance weights, it was ultimately established that all WFD datasets were to be adjusted to the lower ranges of the scale – i.e. moderate and low (where bad, poor and high status waters represent moderate sensitivity).

Air quality was unanimously assigned a low sensitivity score at the first workshop on the basis that Ireland's air quality is currently good (EPA, 2012). Moreover, stakeholders at the second workshop noted that as air quality does not present a significant issue for Ireland, the associated spatial datasets should be omitted from the Webtool's assessment criteria. The only publicly available climate-relevant spatial dataset relates to flooding. Although Catchment Flood Risk Assessment and Management plans are currently being prepared, in response to the Flood Risk Directive (EC, 2007), related spatial datasets are yet to be published. Therefore, the historical flood extents are used as a proxy in the Webtool. Given that these areas are not fully illustrative of flood risk (as some are singular rather than recurring events, and they do not account for risk prediction), a preliminary moderate score was assigned to the dataset and maintained by the thematic group. However, the majority expressing opinion at the second workshop (11 out of 15) felt that this score should be raised to high, given that flooding represents a high risk to development and human well-being, and it is the only dataset available within the theme.

4.3. Soils, geology and cultural heritage

Despite concerted efforts to engage geology and soils experts in the workshops, no representatives were present at the first workshop, and a single expert in agricultural soils contributed to the second workshop. Online communication was maintained in between the workshops with representatives from the Geological Survey of Ireland and Teagasc to explore the possibility to assign sensitivity scores to bedrock geology and the recently prepared soils map of Ireland (Teagasc, 2014). However, one-to-one consultations revealed that it was not considered feasible to score either geology or soils given current knowledge on their susceptibility, other than on related key properties such as richness or permeability. In the light of this, inclusion of soil permeability datasets was recommended at the second workshop. Interestingly, the soil expert recommended to have well drained and poorly drained soils as separate spatial datasets and to assign them both a moderate sensitivity score which was questioned by another stakeholder. Open discussion led to wide agreement to separate them so the end-user can decide which to factor in, as their relevance can change depending on the purpose of the assessment. Peatlands present sensitive soil types and associated habitats are protected under the Habitats Directive (EC, 1992). On this basis, a high score would have been anticipated but 12 out of 17 who expressed their views supported assigning it a moderate score. Outcrops were included as geology proxies, and full agreement was reached at the second workshop on assigning them a moderate score, purely on the basis of value judgments of the thematic group which was not contested by the rest of the stakeholders. Geoparks and geosites were preliminarily assigned a moderate score by the thematic group but overall stakeholder review during the second workshop led to wide agreement on raising it to high on the basis of their international importance.

Cultural heritage was represented by the publicly available National Inventory of Architectural Heritage (NIAH) and the Record of Monuments and Places (RMP) datasets. RMPs are protected under national legislation (Govt. of Ireland, 2004) and NIAH are inventoried for potential future inclusion in the RMPs. The proposed preliminary scores of moderate for NIAH and high for RMPs were fully supported by the stakeholders.

4.4. Population and material assets

The population and material assets group at the first workshop were unable to agree on the scores for a number of criteria. There are no statutory population thresholds or targets, albeit depopulation decrease is commonly considered a trend to be reverted (Beauregard, 2015). The significance of population density and change were considered by the stakeholders to be highly dependent on context, on whether it is a good or bad thing that it is high/low or goes up/down in the study area. Contrasting opinions were voiced. A stakeholder noted that, in general, higher density and increasing population areas are more sensitive to change. Lower density areas can be indicative of rural communities that perhaps may be less sensitive to human-induced change in the form of further sectoral development to increase services and jobs. Similarly, decreasing population may indicate a need for further local investment to attract new residents or retain those leaving in search of jobs and opportunities. Another pointed to the fact that the opposite may also hold true. Low density areas may be more adverse to large developments in certain sectors (e.g. industry), while increasing population areas may continue to benefit from change. This is the case in rural Ireland where scattered housing and scarce population renders these areas more susceptible to change, particularly for some developments such as wind energy. As a result of the significant variation in expert opinion, and a reconsideration of population as environmental sensitivity criterion during the second workshop, these spatial datasets were ultimately removed from the Webtool.

Record of Protected Areas (RPAs) relating to drinking water under the WFD (EC, 2000) were preliminary scored as moderate, a value that was unanimously increased to high by the thematic group at the first workshop and maintained in the second workshop. It was considered that these areas should be ranked higher as drinking water quality is of importance to human health impacts. It is worth noting that despite agreeing to lower the scores for all the WFD spatial datasets under the water theme, this was not the case for drinking water, with an emphasis on the fact that this was the only spatial dataset available acting as a proxy for population and human health.

All datasets under material assets were open to discussion and value judgments from the onset due to the complexity of legislative considerations and pertaining risk (e.g. capacity and proximity of waste treatment facilities when assessing potential impacts on ecological designations). Material assets were considered to have low to moderate sensitivity during the first workshop, but no consensus was reached amongst the 8 stakeholders participating in this thematic group. Furthermore, a number of participants (5/8) highlighted that the significance of these spatial datasets is sector-specific (e.g. the sensitivity of the electricity network should be graded by voltage level and that of waste treatment plants by capacity for certain assessments). Discussion in the second workshop led to agree that, in a similar way to population, material assets are not representative of environmental sensitivity and, therefore, these criteria were also omitted from the Webtool.

4.5. General observations

Widespread agreement was reached amongst stakeholders on the majority of environmental themes; although consensus was easier to reach on some themes (e.g. biodiversity, water and cultural heritage) than others (e.g. population and soils). This is possibly due to the presence/absence of statutory measures under EU and national legislation influencing perceptions, coupling sensitivity with protection and conservation requirements. Overall, the lack of specific statutory measures for certain datasets rendered them less sensitive than those protected/designated. However, in the majority of cases (16 out of the 29 criteria), expert opinion was observed to ultimately determine relative sensitivities rather than existing statutory thresholds or targets. It has been argued that evidence-based subjective judgments reflective of societal values can be considered credible (Ehrlich and Ross, 2015). Therefore, the structured and deliberated exchange of expert knowledge adopted in the consultation process could be seen as providing robust and reliable outcomes. Yet, a number of discrepancies can be observed. As previously noted, while assigning a high score to NHAs was contested by some stakeholders for being a national designation, other national designations, such as salmonid waters or RMPs, were unanimously agreed to be high. By extrapolation, it can be argued that national legislation was generally perceived as having the same level of protection as European legislation, rendering all pertinent designations as highly sensitive. However, contrastingly, saltmarshes and peatlands are protected under the EU Habitats Directive and yet were agreed to have a moderate sensitivity. These divergent scores could be related to a thematic group bias. Yet, when all the scores were open to wider debate during the second workshop, they were not disputed.

For certain criteria, sensitivity was magnified on the basis of data representativeness (e.g. protected areas for drinking water and historical flood events). This poses a question on the reliability of the assigned scores. If additional datasets were available, scores may have been differently assigned. Also, the narrow sensitivity scale adopted may have helped reaching consensus. For criteria perceived as having a lower degree of protection or quality, the immediately lower score was logically assigned (i.e. moderate). However, if a wider range of scores were adopted, reaching consensus on these may have been compromised.

In those cases where scores assigned to certain criteria were contested, the dialogue led to a majority agreement which facilitated attaining a group decision. The expertise and stewardship of those contributing to the assignment of scores often played a significant part in reaching consensus (e.g. the scores assigned to NHAs or to soil permeability were significantly influenced by individual experts). This was also generally the case for thematic criteria. Only 6 of the 54 (i.e. 11%) criteria reviewed were further adjusted at the second workshop. These included flood extents, NHAs, wetlands, and groundwater and surface water status criteria. Moreover, a clear knowledge-led bias was observed during the workshops (e.g. ecologists favouring biodiversity conservation or hydrologists prioritising the protection of water quality). At one point during the first workshop this resulted in a large majority of datasets being assigned the highest sensitivity score (i.e. all datasets being scored 3). This supports other findings on professional agendas influencing preferences and opinions (e.g. Boonstra et al., 2015; González et al., 2011b). Although efforts were made to engage a range of experts for each environmental theme (e.g. a NPWS divisional ecologist, local authority heritage officers, and ecologists from BirdWatch and private consultancies participated in the biodiversity theme discussion), engaging a different set of actors may have resulted in a different set of scores.

Almost half (i.e. 13 out of the 29 or 45%) of the preliminary scores assigned on the basis of the proposed conceptualisation framework were consensually maintained (Table 1). Overall, 32 of the 54 reviewed criteria (i.e. 59%) were unanimously agreed, 7 (13%) widely agreed (two of which were rather determined by individual experts) and 15 (28%) not agreed and, therefore, omitted from the Webtool. Of the unanimously agreed criteria 72% were based on statutory measures and 28% on value judgments alone (Table 2).

Reaching consensus on criteria and significance, or sensitivity in the context of this paper, is necessary to find a planning alternative that is acceptable by multiple individuals involved in decision-making. It has been argued that the geovisualization and spatial analysis capabilities of GIS and multi-criteria assessment procedures can potentially enhance both spatial decision-making and consensus reaching processes (e.g. Boroushaki and Malczewski, 2010; Feick and Hall, 1999; Gorsevski et al., 2013; Jelokhani-Niaraki and Malczewski, 2015). They promote a more inclusive participatory decision-making processes (Elwood, 2006), helping to empower community groups when responding to local geographic issues (Fraser et al., 2006; Tang and Waters, 2005; Wood, 2005). Moreover, GIS have the potential to facilitate more transparent decision-making for spatial planning as decisions can be demonstrably based on spatially-specific and objective evidence (Skehan and González, 2006). Nevertheless, when such GIS-based decision-support tools have embedded assumptions or weights, as in the case of the ESM Webtool, the transparency and the capacity to support consented assessments and decisions may be compromised unless rules are clearly defined and communicated. The stakeholders participating at the workshops described in this paper are engaged in SEA processes and their involvement in the definition of the methodological rules (i.e. scores) ensures their awareness on the benefits and limitations of applying the Webtool for creating sensitivity maps. An online user manual is also available for all end-users, which includes a detailed account of the scores assigned to each dataset through consultation, and the basis for such scores to ensure transparency.

5. Conclusion

In the current absence of globally accepted metrics for harmonising environmental sensitivity, the pragmatic conceptualisation framework presented in this paper provides operational support. The process of assigning scores, to define the intrinsic/perceived sensitivity of environmental criteria, reflected a practical, transparent, systematic and effective way to reach general agreement. Framing sensitivity around statutory considerations provided a workable starting-point. The semi-structured workshops then provided a platform for meaningful deliberation. Following such group discussions with one-to-one consultation facilitated clarification on ascribed sensitivity scores and corroborated the difficulty of assigning values to certain criteria.

It can be concluded that combining evidence- and knowledge-bases in a structured way, by means of the proposed conceptualisation framework, facilitated building consensus. Overall, full or wide agreement was reached on 72% of the reviewed criteria, and almost half of the preliminary scores assigned on the basis of the proposed conceptualisation framework were consensually maintained. Nevertheless, further consultation is warranted to ascertain the validity of the assigned scores. This is particularly relevant for environmental criteria which currently lack comprehensive spatial datasets and, indeed, statutory protection measures (e.g. landscape, soils). Engaging experts across all SEA-relevant themes is necessary for a holistic deliberation, and for the appropriate consideration of inter-relationships between environmental criteria in order to ensure a focused and effective sensitivity analysis.

It is imperative that SEA criteria, scores (i.e. intrinsic/perceived sensitivity) and weights (i.e. public/stakeholder value judgments) are meaningfully identified and scoped in to ensure a sensitivity analysis tailored to the planning hierarchy and sectoral characteristics of the plan/programme under assessment. Their full standardisation across planning hierarchies and sectors would result in the sensitivity of the plan/programme area being always the same no matter the proposed course of action. Therefore, involvement of stakeholders in defining criteria and scores can be considered itself as a component of the SEA process. The sensitivity scores represent the only standardised parameter in the ESM Webtool and have been fixed through consultation. Their harmonisation was necessary for combining them into a single sensitivity index that supports consistency and comparability of assessments. Although consulted stakeholders' perceptions naturally reflect the national backdrop (e.g. where air quality does not represent a significant environmental issue), harmonising sensitivity provides the foundation for additional insight, and increased objectivity and robustness in baseline assessments. This benchmark can, in turn, contribute to enhancing the evidence-base for characterising the significance of potential impacts by establishing how much change is acceptable/unacceptable on sensitive areas. The scores presented in this paper are, in principle, not directly applicable to other jurisdictions, but the applied framework for conceptualising sensitivity is transferable to other SEA contexts.

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