
COST 350 – WG5

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COST350
Integrated Assessment of
Environmental Impact of Traffic and
Transport Infrastructure
- A Strategic Approach

Part C
Chapter 5
Impact Scoring and Aggregation

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ANNEXES

EXAMPLES OF GOOD PRACTICE TOWARDS IMPACT SCORING, ASSESSING SIGNIFICANCE AND AGGREGATION

Annex 5.1

Sommer A. 2002. Assessment of the Significance of Environmental Effects. Screening Approach and Criteria Applied in Strategic Environmental Assessments. – 58 p.

Annex 5.2

James E., Tomlinson P. 2004. Significance in Strategic Environmental Assessments of Transport Plans: Findings of a Literature Review. UPR SE/080/04. TRL. *Unpublished project report*. – 39 p.

Annex 5.3

Simmons S., Cole P., Gardner R. 2004. Strategic Environmental Assessment of Local Implementation Plans: Significance Criteria for LIPs. UPR SE/127/04. TRL. C4S. *Unpublished project report*. – 14 p.

Annex 5.4

James E. 2004. Somerset County Council Local Transport Plan SEA: Approach to Significance. UPR SE/097/04. TRL. *Unpublished project report*. – 18 p.

Annex 5.5

Strategic Environmental Assessment for Transport Plans and Programmes. TAG Unit 2.11. 2004. Department for Transport. – 55 p.
www.webtag.org.uk

ABBREVIATIONS



item for further research



principles of good practice



recommended further
reading

The SEA Directive states.

5.1. INTRODUCTION

Chapter 5 is the report of the research and findings under the COST 350 Action carried out by the Working Group 5. This Working Group explores the themes of impact scoring (significance) and aggregation in the context of integrated assessment. The principles of the SEA Directive are followed.

The SEA Directive requires that a comprehensive or **integrated approach** is to be used for assessing the likelihood of **significant environmental effects** of PPs.

Annex I of **the SEA Directive** describes the information to be included in the environmental report according to *Article 5*. The environmental issues identified in this *Annex* explicitly include a list of factors to be protected (such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape) and the **interrelationship** between those factors. Moreover, secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative effects should be taken into account. Consequently, impacts across all environmental media / factors have to be assessed in a **multi-disciplinary integrated way**.

The Chapter consists of two main sections dealing with impact scoring – significance (Chapter 5.2) and aggregation (Chapter 5.3). The inventory of relevant guidance documents and methods was carried out. Examples of the best practice are explored and highlighted. The report also seeks to achieve a common understanding on the issues analysed and to optimise use of the existing research results.

Significance

The SEA Directive considers **significance** at two points in an environmental assessment process:

- At the screening stage: only plans and programmes that are likely to have significant effects require an environmental assessment; and
- When assessing impacts: only impacts that are deemed significant by the assessment need to be identified, described and evaluated.

Impact significance is determined through impact scoring which is the process of assigning a quantitative or qualitative value to environmental impacts arising from the transport measures. Given scores reflect significance. In good practice, pre-defined structured frameworks or significance criteria are used to reach transparent, acceptable and auditable results. The practice of defining significance criteria within project level EISs is often not to the highest standards and the application of significance criteria to SEA is at a very early stage of development. There is a lack of guidance available to practitioners.

Though, significance criteria are set for use in impact assessment stage, in order to help determine the significance of the effects of the alternative options, they can also be used to help in the initial determination of the likely significant environmental effects.

One of the tasks of the WG 5 is to explore best practice in assessing significance at the impact assessment stage.

The WG seeks to bring together existing guidance across the member states participating in the COST initiative. A variety of techniques exist, such as those that employ GIS techniques to judge impact, and others that are based upon expert judgements. Some techniques are closed to external examination being an equation within a model, where as others are more transparent with scores being critically examined by external organizations.

Chapter 5.2 is an attempt to define what an assessment system for significance should include and take into account.

Aggregation

In undertaking an environmental assessment of transport plans, as detailed in chapter <WG2 chapter>, it is clear that the assessment must adapt to the planning context. Hence some transport plans, particularly those at a national scale are likely to have a policy focus, whereas those further down the planning hierarchy could well have a high project content. As a result, the assessments are likely to give rise a variety of impact types. Those with a high policy focus are likely to be dealing with broad trends in the relationship between transport and the environment, while those with a high project focus could exhibit an emphasis upon the impacts derived from the specific transport projects. In both cases, the aggregation of significant impacts is a key task in communicating the impacts of the plan to decision makers and the public.

Where the assessment focuses primarily upon transport policies, the impacts identified may well be explored through a series of causal links each with an implicit assumption of the magnitude and significance of the impact. Such high level impacts involve a representation of multiple diverse and cumulative effects throughout the plan area relying on aggregation undertaken by those undertaking the assessment. This form of aggregation is generally undertaken without any external verification or transparency.

Where the assessment focuses primarily upon transport projects, the impacts addressed are likely to be similar to those in project EIA. Hence the impact on, say biodiversity, would be the sum of the individual impacts that may be created by the individual transport projects within the plan. It is suggested that guidance is required on how individual impacts from potential projects should be aggregated. Such aggregation should recognise that trade-offs may be appropriate and that cumulative effects may be required. For example, loss of a wet grassland in one area may be offset by the creation of similar habitat elsewhere. Alternatively two projects may result in the loss of two areas of wet grassland such that there is little or no remaining wet grassland remaining in the plan area. In such situations, the loss is greater than just the loss of two areas.

These issues lie at the heart of aggregation, while other issues focus upon how individual indicators are perhaps brought together into a single index. For example, an air quality index comprising oxides of nitrogen, particulate matter, hydrocarbons etc. Alternatively, some seek a single basis for reporting the consequences of transport plans and projects based on energy or some form of monetisation. In either form of aggregation, issues of the weights given to the individual indicators comprising the index need to be considered.

5.2. IMPACT SCORING – SIGNIFICANCE

5.2.1. Overview

At the impact assessment stage the predicted impacts are translated into statements of significance. Prediction of **the magnitude of likely future impacts** taking into account **the sensitivity & importance of the receiving environment** leads to a statement about **the significance of the impact**. An impact of the same magnitude is expected to give rise to different levels of impact significance depending upon the likely evolution of the environment without the implementation of the PP. The magnitude of environmental effects must be seen not only in the context of the concrete environmental conditions (existing pressures, sensitive areas) but also with the specific characteristics of PPs. Thus, significance has to be determined on a case by case basis. This then gives information to the decision-maker on the significance of the predicted impacts for individual stakeholder groups, and which groups will win or lose because of those impacts under the specific strategic action.

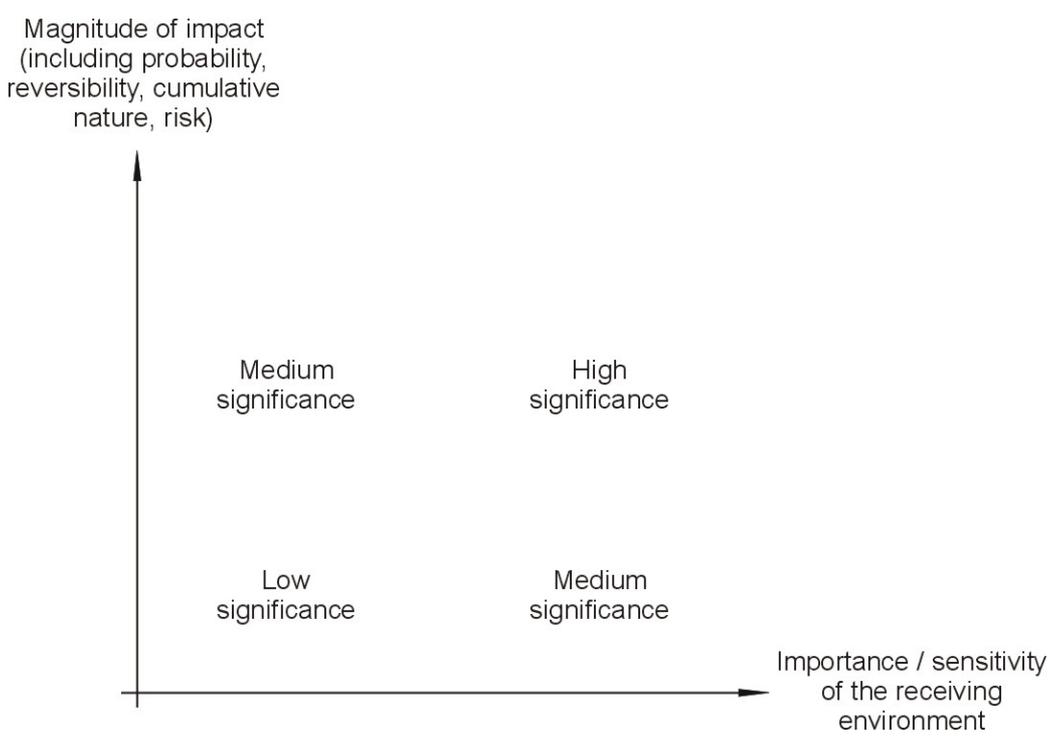
Impact significance is assessed through impact scoring which is the process of assigning a quantitative or qualitative value to environmental impacts arising from the transport measures. Given scores reflect significance. In good practice pre-defined structured frameworks or significance criteria are used to reach transparent, acceptable and auditable results. Such frameworks or significance criteria can be prepared for most, if not all, environmental topics. Essentially, the criteria can be established using regulatory norms, “*distance- to- target*” and other quantitative or qualitative description of the environmental impact.

While the practice of establishing and defining significance criteria within project level EISs is often not to the highest standards, the application of significance criteria to SEA is at a very early stage of development. While assigning positive or negative impact scores may appear to be a simple procedure, it can raise questions of consistency and transparency of the scoring. The issue of who sets the criteria and whether there should be a standardised set of significance criteria applied nationally across all tiers in the transport planning process to provide decision-makers with an equal basis on which to compare plans, remains to be considered let alone answered. Whereas a general framework of significance criteria should be considered necessary, this report advocates that impact scoring should always be undertaken on a case by case basis for individual PPs.

Annex II of the SEA Directive suggests criteria for determining the likely significance of an effect (Chapter 5.2.2).

To summarize, in environmental assessment practice the significance assessment system comprise several steps which are shown in **Table 5.1**.

Table 5.1. Identification of Significance of Impacts.

<p>Step 1. Determining the sensitivity/importance/value and the bearing capacity of the receiving environment. A pre-defined scale (with explanations) for value and vulnerability of the area likely to be affected could help to reach clear results.</p>
<p>Step 2. Measuring the current state of the environment and predicting the future magnitude of the impact. A pre-defined scale (with explanations) for magnitude of the effects is necessary.</p>
<p>Step 3. Assigning scores and estimating the overall assessment score.</p>  <p>Figure 5.1. Identifying impact significance (according to Glasson et al, 1999).</p>

Guidance may be required on the definitions of the overall assessment score which could be used to cross-check once a score been assigned.

The overall assessment scores are then assigned a “significance rating” expression (Figure 5.1). The final overall significance rating should ultimately be considered within the context of each specific plan and the associated geographical area. This issue will be discussed in more detail in Section 5.2.4.



Further reading:

Annex 5.2:



James E., Tomlinson P. 2004. Significance in Strategic Environmental Assessments of Transport Plans: Findings of a Literature Review. UPR SE/080/04. Unpublished project report. – 39 p.
(Tables 1-4.)

5.2.2. European Approach to Scoring - Significance

Annex II of the SEA Directive suggests criteria for determining the likely significance of effects (**Table 5.2**). The criteria are a list of issues that must be considered by plan makers when making a judgement on significance.

Table 5.2. Criteria for determining significance (based on the SEA Directive, *Annex II*).

Criteria for determining the likely significance of effects referred to in Article 3(5)

The characteristics of plans and programmes, having regard, in particular, to

- the degree to which the plan or programme sets a framework for projects and other activities, either with regard to the location, nature, size and operating conditions or by allocating resources,
- the degree to which the plan or programme influences other plans and programmes including those in a hierarchy,
- the relevance of the plan or programme for the integration of environmental considerations in particular with a view to promoting sustainable development,
- environmental problems relevant to the plan or programme,
- the relevance of the plan or programme for the implementation of Community legislation on the environment (e.g. plans and programmes linked to waste-management or water protection).

Characteristics of the effects and of the area likely to be affected, having regard, in particular, to:

- the probability, duration, frequency and reversibility of the effects;
- the cumulative nature of the effects;
- the transboundary nature of the effects;
- the risks to human health or the environment (e.g. due to accidents); and
- the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected).

The value and vulnerability of the area likely to be affected due to:

- special natural characteristics or cultural heritage;
- exceeded environmental quality standards or limit values;
- intensive land-use; and
- the effects on areas or landscapes which have a recognised national, Community or international protection status.

Source: Annex II (Criteria for determining the likely significance of effects referred to in Article 3(5)) of Directive 2001/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

European Commission Guidance on the implementation of the SEA Directive (2003) gives some further direction regarding how to assess the significance of environmental effects. It clearly states that the assessment of significance should take into account:

- the characteristics and value of the receiving environment and
- the magnitude of the impact.

The UK study, carried out by TRL (James E., Tomlinson P., 2004) in parallel with the COST 350 Action, reviews the EC guidance and highlights useful advice on significance:

- It can be assumed that the greater the degree to which the (*SEA Directive*) Annex II Criteria (**Table 5.2**) are met the more likely it is that the effects on the environment will be significant.
- The nature and characteristics of the likely effects will influence their significance in the context within which they are being considered. For example, it is relevant to consider whether the probability or frequency of effects will be very low (accidental cause) or whether the effects will occur continuously. Moreover, the more complex (e.g. due to synergies and accumulation), the more widespread, or more serious the effects, the more likely it is that they should be considered 'significant'.
- An equally important factor to be considered is the spatial area likely to be affected by the plan or programme and consequently by its effects. It should be noted that it is not only areas that have a designated protection status which are required by the Directive to be given attention. The particular value or vulnerability of the area likely to be affected may make it more likely that effects must be considered significant there.
- Applying the Annex II criteria for determining potential environmental effects requires a comprehensive and systematic approach. To enable this to be achieved, some of the elements identified in *Annex I (of the SEA Directive)* may also be relevant. For example, for identifying likely significant effects the 'receptors' of these effects should be considered. The characteristics noted in the footnote to *Annex I(f) (of the SEA Directive)* should also be taken into account (i.e. whether the effects are secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative). The use of *Annex I* together with *Annex II* in this way enables cross-media effects to be considered in a multidisciplinary way.

5.2.3. Overview of the Existing Situation in SPECIFIC COST Countries

The current situation on the transposition of the SEA Directive in the COST Countries is summarised in Annex C of Chapter 2 the WG 2 Final Report. Where, information is available and was provided on guidance on Impact Scoring and significance and aggregation this is described below.

Significance is not well defined in the SEA Regulations and Guidelines of most European countries. No jurisdiction fully combines a coherent definition of significance with a broad definition of the environment and of effects, a broad definition of proposed actions and the flexibility to consider both positive and negative effects (Lawrence Environmental, 2002).

The review undertaken by Working Group 5 concluded that no formalised methods for the definition of significance exist in most COST countries. Formal impact scoring systems are applied in few countries, for example, in England (Guidance on Methodologies for Multi-Modal Studies, DETR, 2000) and Scotland (Scottish Transport Appraisal Guidance (for EIA)). In many member states guidance relates to Environmental Impact Assessment. The current status with

respect to consideration of significance in some member states is reviewed in the following section.

5.2.3.1. Hungary

Based on Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment the following law and decree have been implemented in Hungary:

- Law N° LXXVI/2004 modification of the Law N° LIII/1995 on General Rules of the Protection of the Environment and Law LIII/1996 on nature protection.
- Hungarian Government decree 2/2005. (I.11.) on the environmental assessment of certain plans and programmes.
The decree describes the main aspects of the SEA process and sets out the detailed content of the environmental assessment.

Example of application of SEA

An SEA on the proposed Modification and Timing of the National Development Programme on Road Network (2007-2020) has been almost completed by Institute for Transport Sciences (KTI).

This programme is based on the requirements of the following laws and orders,

- Law N° XXVI/2003 on National Development Plan
- Law N° CXXVIII/2003 Plan of Motorway Network until 2007
- 2004/2003 Governmental Resolution on Development of National Road Network (2003-2015), its Timing, Operation, Maintenance and Financing
- Development of European TEN-T Network

The Environmental Assessment of the Programme takes into consideration different other relevant Programmes, legislation etc. e.g. National Environmental Programme, 275/2004. Governmental Order on Natura 2000 areas.

Outside of the Transport Sector, other SEAs, for example on Local Development Plans are currently in progress.

The preparation of Hungarian Guideline/Manual of SEA of Transport Infrastructure Plans based on experience of COST 350, BEACON, and other studies is in progress.

Transport Network Evaluation in Hungary pre- SEA

In Hungary since the 1990's National (and major urban) Long Term Network Development Plans undergo a complex evaluation process for comparing network alternatives and choosing the most advantageous option. This method was included in Review of tools and **Models for Analysis and Evaluation of Transport Related Environmental Conditions in Chapter 3.**

The main steps of the Network Development Plan's evaluation process are:

- Establishing relevant objectives and sub-objectives.
- Allocating weights to each of them by interviewing a sample of experts and of the population (several hundreds).
- For each element of the network variant considered the degree of satisfaction of each objective and sub-objective is defined in points.

-
- For each variant aggregation across the entire network of the satisfaction points, using weights given in the previous step is carried out.
 - Selection of the “preferred” alternative.

An example table used in evaluation of Network Development Plan is included below.

Table 5.3. Development of objectives for the public road network evaluation.

GROUPS OF OBJECTIVES Please, distribute among them 100 points	OBJECTIVES Please, distribute 100 points among the objectives of each group		Points
	Improvement of road network contacts 29,7	11	Improvement of interregional contacts between the county centres and Budapest
12		Improvement of contacts within a region	17,8
13		Improvement of access to holiday and touristic regions	11,1
14		Improvement of access to underdeveloped regions	19,9
15		Improvement of contacts among different transport modes	12,4
16		Improvement of international highway contacts	14,9
17		Increasing of territorial value enhancing and economic developing effects of roads	11,1
18		Other	0,1
		Σ	100
Improvement of traffic conditions and efficiency 28,9	21	Decreasing road accident losses and hazardousness of the road	29,3
	22	Decreasing travel times in weekday passenger traffic	17,8
	23	Decreasing travel times in weekend and leisure traffic	9,4
	24	Decreasing travel times in road goods transport	13,2
	25	Minimizing vehicle operation costs	16,1
	26	Improvement of parking/storage conditions	14,1
	27	Other	0,1
		Σ	100
Reduction of harmful effects 25,3	31	Decreasing of air pollution caused by road traffic	32,4
	32	Decreasing of noise and vibrations caused by road traffic	21,3
	33	Decreasing of soil and water pollution	16,6
	34	Minimizing of barrier effects of roads and traffic	8,9
	35	Minimizing of value of terrains occupied for development of roads	8,8
	36	Aesthetic layout of roads	11,8
	37	Other	0,2
	Σ	100	
Economic use of investment and maintenance resources 16,1	41	Minimizing road investment costs	46,5
	42	Minimizing road maintenance and operation costs	52,6
	43	Other	0,7
		Σ	100
Σ 100 points			

Source: Monigl et al.: Development of Hungarian High-Speed Road Network, 1994

5.2.3.2 IRELAND

The SEA Directive has been transposed into the national legislation in Ireland through two sets of SEA Regulations:

-
- S.I .No. 435 of 2004 –European Communities(Environmental Assessment of certain Plans and Programmes)Regulations 2004, relates to Plans and Programmes prepared for all sectors other than Land- Use Planning and includes Plans and Programmes for the Transport Sector,
[http://www.environ.ie/DOEI/DOEIPol.nsf/0/b8aeb091f741ee9c80256f5d004cd61c/\\$FILE/S.I.%20No.%20435%20of%202004.doc](http://www.environ.ie/DOEI/DOEIPol.nsf/0/b8aeb091f741ee9c80256f5d004cd61c/$FILE/S.I.%20No.%20435%20of%202004.doc)
 - S.I. No. 436 of 2004 Planning and Development (Strategic Environmental Assessment) Regulations 2004, relates specifically to Plans and Programmes in the Land- use sector.
[http://www.environ.ie/DOEI/DOEIPol.nsf/0/b8aeb091f741ee9c80256f5d004cd61c/\\$FILE/S.I.%20No.%20436%20of%202004.doc](http://www.environ.ie/DOEI/DOEIPol.nsf/0/b8aeb091f741ee9c80256f5d004cd61c/$FILE/S.I.%20No.%20436%20of%202004.doc)

Both sets of Regulations set out the Criteria for determining whether a Plan or programme is likely to have significant effects on the environment. These criteria directly reflect the significance criteria set out directly in the criteria set out in Annex 11 of the SEA Directive.

Two sets of Guideline have been published on SEA. The Department of Environment, Heritage Local Government (DoeH&LG) have produced Guidelines for Regional Authorities and Planning Authorities – Implementation of SEA Directive (2001/42/EEC)–Assessment of the effects of certain plans and programmes on the environment- Guidelines for Regional Authorities and Planning Authorities (DoeH&LG, November 2004). In addition through the Environmental Protection Agency has through the Environmental research Technological Development and Innovation (ERTDI Programme funded the preparation of SEA Methodologies for Plans and Programmes in Ireland–ERTDI Report No. 18 Development of Strategic Environmental Assessment (SEA) Methodologies for Plans and Programmes in Ireland Synthesis Report (EPA, 2004). Both these sets of Guidelines include general guidance on significant effects and the evaluation of the significance of effects.

There is no specific separate Guidance in Ireland relating to the application of Impact Significance/ Scoring or Aggregation in the SEA process for Plans and Programmes.

The National Roads Authority (NRA) is the national authority with the responsibility under the Roads Act 1993, 'to secure the provision of a safe and efficient network of national roads'. The NRA has overall responsibility for planning and supervision of construction works on these roads.

The NRA is currently has developed and continues to develop a series of environmental guidelines to facilitate further the integration of various environmental issues into national road scheme planning. These Guidelines relate specifically to the environmental impact of road schemes. Included below are details of the guidelines which can be accessed through :

<http://www.nra.ie/PublicationsResources/ListofPublications/Environment/>

- Environmental Impact Assessment of National Road Schemes – A Practical Guide
- Guidelines for Assessment of Ecological Impacts of National Road Schemes
- Guidelines for the Assessment of Archaeological Heritage Impact of National Road Schemes
- Guidelines for the Assessment of Architectural Heritage and National Road Schemes
- Guidelines for the treatment of Noise and Vibration in National Road Schemes

Included in the first three of the above listed Guidelines in particular, are Guidance on Impact Significance including Guidance on the application of Significance Criteria.

In addition to the above, the Environmental Protection Agency (EPA) Publication: “Guidelines on the information to be included in Environmental Impact Statements (EPA, 2002)”, provides general guidance on impact significance:

<http://www.epa.ie/TechnicalGuidanceandAdvice/GuidanceDocuments/pdfsforguidancedocuments/EnvironmentallImpactAssessment/>.

5.2.3.3. LITHUANIA

The SEA Directive is fully transposed into the national legal base in Lithuania.

Provisions of Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programs on the environment have been transposed into the national legislation of the Republic of Lithuania by including general provisions in the umbrella legislation, namely the Law on Environmental Protection of the Republic of Lithuania (Zin., 1992, Nr. 5-75; 2004, Nr. 36-1179) and the Law on Territorial Planning (Zin., 1995, Nr. 107-2391; 2004, Nr. 21-617).

Detailed requirements of the Directive have been transposed into:

- an Order of the Government of the Republic of Lithuania on the Approval of the *Order of Strategic Assessment of the Effects of Plans and Programs on the Environment* (No.967; August 18, 2004) and
- two Decisions of the Minister of Environment: *Order of the Screening for the Strategic Assessment of the Effects of Plans and Programs on the Environment* (No. D1-456; August 27, 2004), and the *Order of Public Participation in the Procedures of the Strategic Assessment of the Effects of Plans and Programs on the Environment and Informing the Assessment Stakeholders and Member States of the European Union* (No.D1-455; August 27, 2004).

Following the Order of the Government No.967 (August 18, 2004), one more document was issued - Decision of the Minister of Environment - *Order of Assessment of Significance of the Effects of Plans or Programs on Established or Potential Natura 2000 Sites* (No.D1-609; December 1, 2004).

According to the national SEA regulations PPs likely to have significant effects on the environment require an environmental assessment.

The likely significant effects on the environment, including topics such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage (including architectural and archaeological heritage), landscape as well as the interrelationship between those issues need to be identified, described, evaluated and reported.

The national SEA regulations suggest criteria for determining significance. The significance criteria are in compliance with the Directive. It is required to take into account all categories of criteria for determining significance (the characteristics of PPs, characteristics of the effects and characteristics of the environment likely to be affected) and interaction between them. Prediction of likely significant both, positive and negative, impacts is necessary. Comments and motivation of the decisions taken as well as lack of information must be reported.

Decision of the Minister of Environment *Order of Assessment of Significance of the Effects of Plans or Programs on Established or Potential Natura 2000 Sites* (No.D1-609; December 1, 2004) includes the questionnaire to determine significance.

No formal national guidance on impact scoring – significance and aggregation has been issued yet.

Impact scoring is carried out and significance is assessed through expert judgement. Besides the national environmental legal documents, the internationally known current state of the art in environmental assessment is applied.

5.2.3.4. Spain

On 28 April 2006 the SEA Directive was transposed to the Spanish code of Laws- “ LEY 9/2006, de 28 de abril, sobre evaluación de los efectos de determinados planes y programas en el medio ambiente.”

“Law 9/2006, of 28 April 2006 -*Law on the Assessment of the effects of certain plans and programmes on the environment*”.

Prior to the transposition of the SEA Directive, the Environmental Assessment of transportation plans and programmes is carried out as part of the planning and design process. This is structured into three phases: A and B, and C, where phase C is a stage of detail design.

Guidance about environmental assessment comes from Preliminary and Informative Studies, which are planning instruments prior to the writing of the construction project. They are referred to the development of road infrastructure and commissioned by the General Direction for Roads (Dirección General de Carreteras) of the Ministry of Public Works (Ministerio de Fomento) during the last 10 years, but mostly after 1996.

These are the studies in which the choice between different alternatives of an infrastructure project in a defined corridor or the selection between different transport corridors is made. The preferred option is not yet described in detail. The development of the Informative Study includes the elaboration of the EIA of the project, its approval and the processes of public information.

Initial environmental assessment case studies commissioned by the above-mentioned General Directorate for Roads follow the pattern of Informative Studies and it can only be expected that, once the Directive transposed, acquired experience will eventually lead to detailed guidance on strategic environmental assessment

The most common technique for topic aggregation used in Spain is weighted sum, with different approaches to the basic method. These different techniques are used in the final stages of multicriteria analysis, i.e. for the final integration of environmental, economical and functional criteria. Through giving a weight in percentage to each one of the families of criteria that are represented, a single final indicator is attained. The sum of the products indicator x weight for each alternative action is its final score in the process of decision-making. Different ways of normalizing the measuring scales and giving out weights make the distinction among the methods applied (Analytic Hierarchy Process (AHP), Pattern method, etc.), all of them based in the same principles. All these weighted-sum-based methods are compensatory ones, i.e., alternatives can obtain a valid overall mark despite having bad scores in some criteria because these ones are compensated with a trade-off of good scores in other criteria

Significance is defined through weights, to be applied to different grades of the affected parameter (e.g. different agricultural productivity of affected soil, or class grading of listed heritage). The examples surveyed come from the national Ministry of Development (Roads Division) and can be considered fairly homogeneous for all roads depending on the national

administration. Significance, at this level can be considered fairly stable, but regional authorities, within the scope of their territories are not bound by national significance scores and usually devise their own.

Table 5.4. Significance scale.

Significance	Description
Compatible	The impact on the environment can be recovered immediately without any protective or corrective measure.
Moderate	Environment will recover from the impact in the short or mid term, not immediately, without any mitigating measure.
Severe	Protective or corrective measures are needed to recover the effects of the project in the short – mid term.
Critical	The impact exceeds the acceptable threshold and its effects are unrecoverable.

In some cases this qualitative classification of the significance of the impacts is transformed in a quantitative one to aggregate effects. This is made by transforming the results in different measuring scales, depending on the impact.

Some technical characteristics and guidance through this EIA significance appraisal are regulated by the norm Real Decreto (RD) 1131/1988 that develops the EIA directive of the EU in Spain.

5.2.3.5. United kingdom

The SEA Directive has been transposed as follows in England, Scotland, Wales and Northern Ireland.

The Environmental Assessment of Plans and Programmes (Scotland) Regulations 2004

The Environmental Assessment of Plans and Programmes (Wales) Regulations 2004

The Environmental Assessment of Plans and Programmes Regulations (N. I.) 2004

The Environmental Assessment of Plans and Programmes Regulations 2004(England).

The UK Guidance (DETR 2000) on impact scoring is based upon a standard framework for the following environmental topics:

- a) noise;
- b) air quality;
- c) greenhouse gases;
- d) landscape;
- e) townscape;
- f) heritage;
- g) biodiversity;
- h) severance;
- i) transport and land use policies;
- j) other Government policies.

For each transport measure, its impact is scored using a set of nationally defined significance criteria. UK guidance sets out an impact scoring system based upon a 7-point scale (large adverse to large beneficial) for topics including landscape, townscape, biodiversity, heritage and water. In the case of other topics either a numerical value is presented such as the tonnes of

CO₂ emitted or the net number of people annoyed by noise, or a simple 3-point scale is used.

By being nationally defined the significance criteria provide some comparability, however, the criteria are not robust as frequently require interpretation to assign an impact score. Indeed some criteria are so broad such that they fail to distinguish between the subtleties of different transport alternatives in the same corridor. Essentially, the criteria being set nationally can, on occasion, fail to be sufficiently refined to specific impacts being assessed.

5.2.4. Impact Scoring – Significance: Technical Issues

The Working Group identified the following as key issues:

- Transparency in the assignment of impact scores.
- Addressing uncertainty.
- Standardised scoring frameworks (significance criteria) versus local flexibility.
- Responsibility for Setting Criteria
- Application of weighting to impact topics through scoring.
- Scaling methods (i.e. Scale of 1-5 v's Scale of 1-10).
- Quantifiable and non-quantifiable impacts.
- Dealing with future community values in impact scoring.

These topics are explored in the following Sub- Sections and where appropriate in Chapter 5.2.5.

5.2.4.1. General principles

Though the task of the Working Group 5 is to explore the best practice in assessing significance at the impact assessment stage, the Austrian study (**Annex 5.1**) on screening approach in SEA “*Assessment of the Significance of Environmental Effects*” (Sommer, 2002) is **actual?** because it discusses general principles of significance. The study is also analysed and summarized in the work “*Significance in SEA of Transport Plans*” (James E., Tomlinson P., 2004).



The Austrian study, (Sommer, 2002) notes several principles of significance assessment:

- Significance has to be determined in each case individually. As a result, effects which are significant in one situation may not necessarily be significant in another.
- Flexibility is important so that individual cases can be assessed and justified deviations can be permitted to a certain extent (i.e. significance criteria should be considered as guidelines not absolute rules).
- The effort and time spent to assess significance should be proportionate to the likely severity of the effect.

- A lack of detailed information can be offset by more general data which is actually characteristic of strategic decisions and in many cases even necessary for them. This requires a certain balance between the desired substance of the result and the assessment depth / knowledge based used.
- The uncertainty inherent in environmental assessment makes assessing significance difficult and this should be acknowledged within the assessment. As stated in the Austrian Study Report, “above a certain level of complexity, precision and significance are mutually exclusive.”
- Significance is best assessed using experts guided by systematic and structured criteria in line with the current state of the art. The best way is to apply a knowledge based approach using expert judgement rooted in justified expectations and experiences with the qualified discussion of the topic.
- A “toolkit plus instructions” is one way to achieve a transparent and accountable procedure. If followed, the result could be a structured and justified expert judgement.
- Mathematical models are difficult to use to determine environmental significance. Many aspects can be covered by verbal descriptions. The use of numeric models could give rise to *fictitious precision*. The assessment should focus on qualitative criteria and not on quantitative ones (such as the area in square metres). An attempt at quantifying qualitative and semi-quantitative aspects will not lead to an increase in objectivity.
- The experiences made with the use of rigid lists of quantitative thresholds in EIAs show that the exclusive application of these approaches is little suited to adequately reflecting reality and, moreover, involves the risk of being found not to be in conformity with the EIA Directive.
- The significance criteria listed in the EIA Directive (and SEA Directive^{5.2}) are not useful as a basis for a systematic and technically sound methodology as the characteristics of the environment and the nature of the impact are considered separately.
- A useful addition to significance decisions is the production of a *list of arguments* that sets out why certain decisions or assumptions were made. At the end of the process it may also be useful to produce a verbal argumentative statement for each decision made.

The report of the Austrian Study also states that the sustainability principles and assessment rules by which the decisions are being justified should be made explicit in the Environmental Report. **Table 5.5.** shows a modified (*because the report specifically applies to screening some rules are not relevant*) version of those assessment rules.



Table 5.5. Significance Assessment Rules (according to Sommer, 2002).

The basic objectives and principles that essentially follow from the **SEA Directive** should form the backbone of the approach, in particular:

- the principles of precaution and prevention;
- safeguarding a high level of environmental protection with a view to promoting sustainable development (the preservation, protection and improvement of the quality of the environment);
- the protection of human health;

^{5.2} But the European Commission Guidance (2003) clearly states that the assessment of significance should take into account the value of the receiving environment **and** the magnitude of the impact.

- the prudent and rational utilisation of natural resources;
- the conservation and sustainable use of biological diversity;
- other environmental objectives of relevance to PPs that have been defined at an international, Community, national, regional or local level.

The **criteria for assessing significance** generally **are not ranked in order of importance** and will be of different relevance in each concrete case. Usually, a single criterion will not be decisive and the likelihood of detecting overall significant effects will increase, the more criteria are fulfilled.

The assessment has to include the entire **range of the plan's or programme's objectives**. This includes the examination of the following aspects:

- all realistic planning options;
- alternatives, if they form part of the plan or programme;
- future developments, including growth effects as far as these are foreseeable (e.g. demographic, traffic and other developments) and related impacts.

Potential environmental effects that will occur with sufficient probability are assumed and assessed.

All potentially significant **types of effects** have to be investigated (including secondary, cumulative, synergistic, short, medium and long-term, permanent and temporary, positive and negative, **direct and indirect? Not specified in SEA Directive**, effects. Positive effects on the environment are considered, but the system does not weigh negative against positive effects (i.e. no waiver of SEAs due to the fact that potential negative effects are outweighed by certain potential positive effects).

The **level of detail** and **certainty** of the assessment should reflect the specific objectives proposed for the specific plan under preparation. The assessment should not be more differentiated than the object of assessment.

All decisions made throughout the SEA/ Plan-making process should be justified and adequately documented. This should also apply to the associated consultation process.

In addition to general rules, sector specific guidance is required to assist in making decision on significance and in the justification of these decisions.

The Countryside Council for Wales's guidance on biodiversity (Countryside Council for Wales et al, 2004) includes a table on how to consider biodiversity issues when determining likely significant effects (**Table 5.6**). This example illustrates specific significance criteria for biodiversity topic.

Table 5.6. Biodiversity considerations when determining likely significance of effects.

Criteria for determining likely significance of effects referred to in Article 3 (5) (of the SEA Directive Annex II)	Possible biodiversity considerations in screening: "Might the plan ..."
Characteristics of PPs	
The relevance of the plan for integration of environmental considerations in particular with a view to promoting	...influence how environmental issues, including biodiversity, are dealt with in other policies, plans and programmes? This could include plans to enhance biodiversity in the wider

sustainable development	countryside, eg to implement actions identified by biodiversity partnerships
Environmental problems relevant to the plan or programme	...exacerbate existing threats to biodiversity? ...involve activities already posing a threat to biodiversity in the study area?
The relevance of the plan or programme for the implementation of EC legislation on the environment	...affect other plans that protect or enhance environmental quality?
Characteristics of the effects (<i>impact magnitude consists of ...</i>)	
The probability, duration, frequency and reversibility of the effects	... have relatively certain effects? ... have long-term effects (taking into account lengths of lifecycles)? ...have repeated impacts on the same biodiversity resources at such a frequency that their recovery might be compromised? ... have irreversible impacts on biodiversity, ie impacts from which spontaneous recovery is impossible and there are no known effective mitigation techniques?
The cumulative nature of the effects	...affect areas where biodiversity is already exposed to significant threat, eg through habitat loss or fragmentation? ... exacerbate space-crowding with significant effects on certain components of biodiversity or on a high proportion of the resource within the study area? ...exacerbate environmental deterioration such that critical thresholds may be reached? ...make a significant contribution to 'in-combination' or cumulative effects on biodiversity?
The magnitude and spatial extent of the effects	... lead to projects that are space- or resource-hungry, eg occupying large areas or using large volumes of water?
Characteristics of the area likely to be affected (<i>sensitivity / importance of the environment consists of ...</i>)	
The value and vulnerability of the area likely to be affected due to: special natural characteristics or cultural heritage, exceeded environmental quality standards or limit values, intensive land-use	... affect areas of high biodiversity (whether designated or not) that could be threatened? ...affect areas covered by Biodiversity Action Plans?
The effects on areas or landscapes which have a recognised national, EC or international protection status	... affect Natura 2000 sites? ... affect SSSIs (see Section 28 of the Wildlife and Countryside Act)? ... affect other designated sites?

Source: "Significance in Strategic Environmental Assessment of Transport Plans: Findings of a Literature Review" James, E; and Tomlinson, P.(Unpublished Report 2004).

The above table could be useful also when evaluating significance of effects at the impact assessment stage which is discussed in the following Section.

5.2.4.2. Application of Significance in Impact Assessment Stage

Significance must not be confused with **the magnitude of the impact** which is measured by factors such as its duration, the number of people affected, area of land taken, etc. Significance is essentially the result of combining the predicted magnitude of the impact and the importance

attached to the resource or feature that is being affected (**Figure 5.1**).

In practice there are several techniques of determining significance:

- Expert judgement.
- Dialogue with stakeholders.
- Reference to legislation and regulations.
- The use of environmental thresholds.
- Risk assessment.
- Ranking and weighting procedures.
- Some notion of environmental capacity.
- Trends analysis, literature reviews and consulting with professionals.



In good practice environmental assessments should describe the **significance assessment process**. Somerset Local Transportation Plan's SEA example (James E., 2004; **Annex 5.4**) suggests three sub-stages for that process:

- Statement of sustainability principles and assessment rules (Chapter 5.2.4.1, **Table 5.5**).
- Designing significance criteria.
- Provision of information on decision.

Of the above, the most important sub-stage of the significant assessment process is designing significance criteria.

The application of significance criteria is recognised tool for use in the assessment. They can support the above-mentioned techniques and support decisions while also providing transparency on how these decisions were reached. Clear frameworks and transparency also help in consultations with the public and other interested stakeholders.

Environmental assessments often rely upon a simple three points approach to scoring the impacts (-, 0, + or "adverse, neutral, beneficial"). Some employ a five points scale (--, -, 0, +, ++ or "large adverse, adverse, neutral, beneficial, large beneficial") or a seven points scale (---, --, -, 0, +, ++, +++ or "large adverse, moderate adverse, slight adverse, neutral, slight beneficial, moderate beneficial, large beneficial"). A balance needs to be struck between the scale used and the capabilities of the forecasting techniques being used in the assessment.

The approach to establishing significance relies on reasoned judgement taking on board the advice and views of appropriate organisations. There are five project-universal significance criteria which can be applied to different topics. The application of these criteria to different topics facilitates the comparability of significance between topics. These five outcomes or project 'universal' significance criteria are illustrated in **Table 5.7**.

Table 5.7. 'Universal' significance criteria.

Very Large:	Only adverse effects are assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of national or regional importance that are likely to suffer a very damaging impact. However a change in a site or feature of district importance may also enter this category.
Large:	These beneficial or adverse effects are considered likely to be important considerations and are likely to be factors in the decision-making process although this depends upon the relative importance attached to the issue during the decision-making process.
Moderate:	These effects may be important, but are not likely to be key decision-making issues. The cumulative effects of such issues may become a decision-making issue if leading to an increase in the overall adverse effect on a particular area or resource.
Slight:	These effects may be raised as local issues. They are unlikely to be of importance in the decision-making process, but are important in enhancing the subsequent design of the project.
Neutral:	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

It is important to note that significance criteria are required for positive as well as negative effects.

When setting criteria it is worth asking the question - is a major impact in a plan or programme SEA the same as a major impact in a project level. Over prescription of local issues must be avoided.

The three analysed UK reports analysed in this study give examples of the application of significance criteria in Local Transport Plans' SEA topics:

- noise,
- air quality,
- climate change,
- soil,
- water,
- biodiversity,
- cultural heritage,
- landscape, townscape,
- population and human health,
- material assets.

The reports are:

“Significance in SEA of Transport Plans: Findings of a Literature Review” by James et al (2004) (**Annex 5.2**);

“SEA of Local Implementation Plans: Significance Criteria for LIPs” by Simmons et al (2004) (**Annex 5.3**) and

“Somerset County Council Local Transport Plan SEA: Approach to Significance” by James E. (2004) (**Annex 5.4**).

The above mentioned Somerset Local Transport Plan (LTP) SEA suggests criteria for use at the beginning of the impact assessment process to provide early guidance to assessors on what

strategies and policies within the LTP may cause significant effects and, therefore, need further investigation. Like the issues presented in **Table 5.7** the suggested Somerset LTP significance criteria for each SEA topic fulfil the requirements of the SEA Directive. Aspects of **impact magnitude** and **importance of the environment** are considered (**Table 5.8**).

Table 5.8. SEA significance criteria for biodiversity, fauna and flora.

Impact magnitude:

Probability of effect	Biodiversity effects from a new road are likely to be easily predicted. General traffic changes resulting from other policies will be more difficult to predict and the probability will be more uncertain.
Duration, frequency and reversibility	Transport can have wide ranging effects on biodiversity. Some effects will definitely be considered permanent and irreversible, for example, if a new road destroys a valued habitat. Some effects can be considered temporary as long as the traffic effect is temporary. For example, levels of road kill.
Cumulative nature	Biodiversity can be affected in many ways through cumulative effects. This may be a general decline in air quality that can change the nature of ecological communities or can result from developments causing habitat fragmentation. Even developments that are geographically separate can have cumulative effects by impacting upon the same habitat or species. The adoption of an ecosystem approach (which values all biodiversity not just the rarest and protected) means that all impacts that can potentially have an impact on biodiversity should be assessed.
Risks to human health / environment	Transport poses great risk to biodiversity. The links between human health and biodiversity are complex although it is a factor in quality of life.
Magnitude and spatial extent	The magnitude depends on the measure. A new road can cause significant changes to biodiversity. Policies which lead to increased traffic will have varying magnitudes depending on the magnitude of the traffic changes. Even small changes can be significant.

Value of environment:

Special characteristics	The adoption of an ecosystem approach (which values all biodiversity not just the rarest and protected) means that potentially all areas have special characteristics. Rather than only assessing direct impacts on valued ecosystems components a variety of issues needs to be considered concerning function and viability including potential habitat fragmentation, land take and habitat loss, hydrological changes and other outside influences such as air quality and water quality.
Inequities in impact distribution	Plans could cause impacts that are inequitable on a geographical basis if many developments are concentrated in one area.
Exceeded environmental quality standards or limit values	Biodiversity Action Plans have a number of targets.
Recognised status	A variety of sites and species have designated status from international status through to local status.

Source: Somerset County Council LTP

In addition to these criteria, which are mainly based on the requirements of the SEA Directive, the quoted document suggests more specific significance criteria. Depending on the complexity of the specific environmental topic(s) under consideration, there may be a need for a larger number of criteria to be applied.

Somerset LTP SEA example of specific significance criteria (for biodiversity) used at the assessment stage:

Will the plan (in combination with other plans and projects) result in:

- Increased / reduced habitat fragmentation or habitat loss?
- Exacerbate creation, loss or fragmentation of habitat affecting important/rare species?
- Exacerbate environmental deterioration such that critical thresholds are reached – for example is there enough habitat to support the existing population of important/rare species in the geographic area?
- Effects on an area of high biodiversity value whether designated or not?
- Effects on an area in a way that could have long term effects in relation to species lifestyles or irreversible effects where there are no known mitigation techniques?
- Effects on areas where biodiversity is already exposed to significant threat, e.g. through habitat loss or fragmentation?
- Help to reach targets or compromise targets of Biodiversity Action Plans (either local or national BAPs)?
- Affect Natura 2000 sites, SSSIs or other designated site?
- Promote design that helps conservation of species or includes unsympathetic design of mitigation?

It is important to note that statements on significance expression should take into account the likely success of proposed mitigation measures.

Finally, guidance on definitions of overall scores of significance assessment can be designed, an example is included in **Table 5.9**.

Table 5.9. Guidance on definitions of expression of overall significant assessment score, reached based on significance criteria for Biodiversity, Flora and Fauna (from Somerset LTP).

Biodiversity, Flora and Fauna	
Significance	Effects
Severe adverse	<ul style="list-style-type: none"> • Either on its own (or with other plans / proposals) may adversely affect the integrity of an international, national or regionally important site by damaging its ecological structure and functions that sustain the habitat(s) and or the population levels of species of interest and limited potential for substitution exists
Major adverse	<ul style="list-style-type: none"> • Whilst not adversely affecting the integrity of the types of site above is likely to compromise its ecological objectives
Moderate adverse	<ul style="list-style-type: none"> • Potentially adverse effects upon a site of national or regional importance but which do not compromise its ecological objectives • Potentially adverse effects on the integrity of a regionally important site with potential for substitution by damaging its ecological structure and functions that sustain the habitat(s) and/or population level of species of interest • Potentially adverse effects on the integrity of locally designated site by damaging its ecological structure and functions that sustain the habitat(s) and/or population levels of species of interest with no potential for substitution
Minor adverse	<ul style="list-style-type: none"> • Some negative effects that do not compromise the ecological objectives of a regionally important site • Adversely affect the integrity of locally designated by damaging its ecological structure and functions that sustain the habitat(s) and/or population level of species of interest with no potential for substitution • Give rise to reduced development activity in areas where protected species are frequently killed
Neutral	<ul style="list-style-type: none"> • Is unlikely to affect the integrity of a resource or feature
Minor beneficial	<ul style="list-style-type: none"> • Enhance the integrity of a potentially substitutable regionally important site • Enhance the integrity of locally designated sites or sites of earth heritage
Moderate beneficial	<ul style="list-style-type: none"> • Enhance the integrity of a site of international, national or regional importance that cannot be substituted
Major beneficial	<ul style="list-style-type: none"> • A clear enhancement of a site of international, national or regional importance that cannot be substituted which is associated with protected and priority species

Source: Somerset County Council LTP

The 2004 Annual meeting of the International Association of Impact Assessment held a special session on the role of significance criteria in SEA. Some additional issues to those specified in the SEA Directive were suggested to be addressed by significance criteria. These are:

- Which community groups would be affected and in what way?
- Would the impact be controversial?
- Does the impact increase or decrease with time?
- Are mitigating measures available and how costly are they?
- Can the impact be better assessed at a more local plan or in a project?



The Centre for Sustainability (C4S Report, 2003) recommends the use of significance criteria, stating that plan makers can define their own significance criteria at the commencement of the SEA process and then gain consensus among stakeholders on their composition. This supports the idea of flexibility, whereby criteria should be considered as guidelines and not as absolute rules. Also the very important aspect of consultation with stakeholders is recommended.

The above mentioned report also recommends the use of a significance table which can be used to record decisions made regarding the significance of certain impacts. The table must include the following elements:

- Full coverage of the environmental topics required under the SEA Directive.
- Why the specific aspect of the plan is considered significant (with reference to significance criteria).
- A way to record how a view was reached on the significance of the policy or strategy element (dialogue with stakeholders, professional judgment, etc.).
- A scoring system that identifies if a policy is likely to have a significant effect.

It is also important to report whether there are any uncertainties inherent in the assessment.



Further reading:

James E., Tomlinson P. 2004. Significance in Strategic Environmental Assessments of Transport Plans: Findings of a Literature Review. UPR SE/080/04. TRL. *Unpublished project report.* – 39 p.

Simmons S., Cole P., Gardner R. 2004. Strategic Environmental Assessment of Local Implementation Plans: Significance Criteria for LIPs. UPR SE/127/04. TRL. C4S. *Unpublished project report.* – 14 p.

James E. 2004. Somerset County Council Local Transport Plan SEA: Approach to Significance. UPR SE/097/04. TRL. *Unpublished project report.* – 18 p.

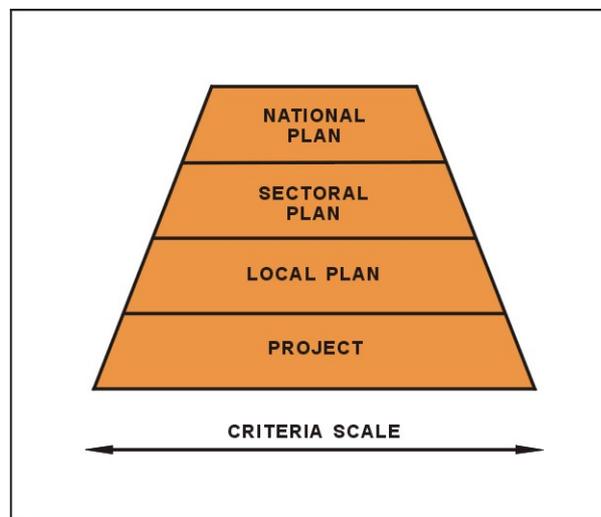
Harmonisation of significance criteria across planning levels.

Issues of global concern where regulations or conventions exist on such aspects as biodiversity or air quality may merit some harmonisation in the assignment of impact significance. Also, for municipal plans similar principles could apply reflecting national regulations. Hence, the level of regulatory authority may be used as a mean for encouraging harmonisation. Harmonisation at different geographical levels should also be encouraged.

Possible levels of harmonisation of significance criteria are:

- International for global impacts (e.g. greenhouse gases).
- National.
- Sectoral -Frameworks set nationally for each sector.
- Local.
- Project level.

Figure 5.2. illustrates the above- mentioned levels.



Source??

Figure 5.2. Levels of harmonisation of significance criteria.

However, experience in the UK seems to indicate that nationally set significance criteria can, sometimes, fail to be sufficiently refined to assist in the harmonisation of specific criteria being assessed.



Thus, harmonisation and standardisation of scoring frameworks or significance criteria remains a theme for further debate. Should there be a standardised set of significance criteria applied nationally across all tiers in the transport planning process to provide decision-makers with a benchmark on which to compare plans?

Moreover, mechanisms for stakeholder involvement in establishing significance criteria (for both, quantitative and qualitative impacts) still need to be explored.

Among other issues raised by the Working Group include:

-
- Some level of quantification should be undertaken with qualitative impacts. However, an attempt at fully quantifying qualitative and semi-quantitative aspects will not lead to an increase in objectivity.
 - Political agenda can sometimes influence the approach of dealing with qualitative impacts.
 - Involvement of stakeholders with specific local/ traditional knowledge is necessary.

5.2.4.3. Valuing the Environment

In cost-benefit analysis the valuation of long-term impacts is required to consider the question of discounting, which entails making choices about inter-generational equity, as well as the question of / length of investment/ appraisal period and that of possible irreversibility of environmental effects. As Governments lower the discount rate so the future carries a slightly greater value not just for economic costs. Interestingly, the UK Department of Transport supplement to its Guidance on Methods for Multi-Modal Studies (GOMMMS) states that the lower discount rate conceptually applies to *all* costs and benefits, whether monetised or not. Hence the present value of future environmental and other costs and benefits that currently cannot be monetised should be assumed to be greater than before. No guidance is provided on how this is to be made to work.

Polarised views exist on the extent to which environmental costs can be valued using a common unit such as money. Those that agree on the principle often disagree on the valuation or weights attached to environmental effects. The EUNET project found that the uncertainty of values applied to environmental effects or costs which results from the different assumptions made in their derivation (like the choice of discounting system or the type of eco-system model) could be as great as +/- 95% (Commission of the European Communities, 1992).

Other groups disagree on the principle of valuing environmental impacts, considering that it is undesirable to monetise impacts and submit them to simple form of aggregation in the framework of say a cost-benefit analysis. For this group environmental resources are a form of critical capital for which critical thresholds must instead be established and implemented. Disagreement focuses upon which environmental resources are critical. In transport assessment, such differences should be appreciated as they are likely to inform stakeholders' interests and their representation of various problems (Trans-Talk, 2001).

This issue is discussed further in Section 5.2.5.3.

5.2.5. Issues related to Impact Scoring

This Section deals with some technical issues related to impact scoring, namely, uncertainty discounting and the risk of double-counting impacts.

5.2.5.1. Uncertainty

Predictions undertaken in connection with SEA are often fraught with high levels of uncertainty. For instance about how the strategic decision will be translated into actions on the ground, the likely future state of the environment, future technological development, the possible cumulative effects of other strategic decisions **or even the probability of occurrence of particular impacts**. Uncertainty also exists on the implementation and effectiveness of the proposed

mitigation measures. Uncertainty can involve both inaccuracies and lack of precision (TAG Unit 2.11, 2004). One of the aims of SEA is to reduce uncertainty where it makes sense to, and otherwise to record it and cope with it. SEA should not aim, as a general principle, to replicate the level of certainty of project EIA. In many cases, a “good enough” result for decision-making can be achieved despite uncertainties, so that uncertainties do not need to be dealt with specifically. For instance, future social conditions may clearly be better than current conditions; one alternative may be clearly better than another one; the economic benefits of a strategic action may clearly outweigh its environmental costs (Therivel R., 2004).

Uncertainty can accumulate throughout the assessment process and hence decisions based on facts with an accumulated degree of uncertainty may not be justifiable.

The European Commission (2003) also recognises that the assessment of significance can be difficult due to the high level of uncertainty present in decisions. It states:

Many uncertainties exist, and insufficient or missing data and inadequate knowledge may make it difficult to decide whether significant effects are likely. Nevertheless, it is assumed that a rough estimation of the effects should always be possible (paragraph 3.57).

Techniques for reducing uncertainty Sensitivity analysis.

- Identifying risks.
- Clarifying assumptions.
- Precautionary principle.
- Preparing contingency plans.
- Monitoring (Monitoring also assists in impact prediction for future environmental assessments).

Specific additional techniques can be recommended for each SEA stage and are included in **Table 5.10**.



Table 5.10. Techniques for reducing uncertainty (from TAG Unit 2.11, 2004).

SEA stage	Techniques for reducing uncertainty
A. setting the context, establishing the baseline	<ul style="list-style-type: none"> • discussions with the statutory consultees etc. to agree appropriate indicators, timescales, spatial scales, data sources, etc. • interdisciplinary working • identification of key areas of uncertainty in the SEA
B. assumptions about the plan's implementation	<ul style="list-style-type: none"> • as the plan evolves, discussions with the statutory consultees, elected members etc. about what it will "look like" on the ground
C. prediction of the impact magnitude	<ul style="list-style-type: none"> • reference to other similar examples • clarification of assumptions made in prediction • scenarios and sensitivity analysis • use good, validated models • reference to relevant guidance • analysis of impact likelihood, duration, cumulative impacts, etc. to ensure comprehensiveness • use of GIS where appropriate • triangulation of information • use of experienced SEA practitioners who know the geographic area and environmental topic
judgement about impact significance	<ul style="list-style-type: none"> • involvement of statutory consultees etc. and interdisciplinary working • use of 'true sustainability' targets and thresholds • use of the precautionary principle
identification of mitigation	<ul style="list-style-type: none"> • involvement of statutory consultees etc. and interdisciplinary working • reference to other similar examples where the mitigation has been used in practice
D. decision-making	<ul style="list-style-type: none"> • capacity building of decision-makers • start SEA early enough so that it can influence decisions • compare alternatives / scenarios • identify and document major sources of uncertainty in the SEA predictions
E. implementation and monitoring	<ul style="list-style-type: none"> • put measures in place to ensure that the plan achieves its objectives, taking into account the need to be flexible and adaptable in line with government guidance

Source: TAG Unit 2.11, 2004

Additional Practical Guidance/Recommendations suggest that "uncertainties" and data limitations should be well documented and all assumptions made should be clearly stated. "Qualitative" predictions should not be "guessed": they should be supported by evidence, such as references to research, discussions or consultation. This is crucial to transparency and acceptability of the results.

The quality of information or rather the levels of uncertainty in the forecast should also be taken into account within the criteria for assessing significance.

If effects of a plan are uncertain, close to permitted emission limit(s) or cumulative, testing the accuracy of predictions is a useful tool. Where uncertainty affects the outcome of the

assessment, additional tests for the accuracy of predictions should be undertaken. During the implementation stage, appropriate environmental monitoring, as a required by the SEA Directive, may also confirm or otherwise the accuracy of predictions. Any discrepancies can be taken into account in the preparation of subsequent PPs and/or reviews of PPs.



Further reading:

Manual on Strategic Environmental Assessment of Transport Infrastructure Plans. 1999. EC DGVII Transport. DHV Environment and Infrastructure BV. 211 p.

Strategic Environmental Assessment for Transport Plans and Programmes. TAG Unit 2.11. 2004. Department for Transport. – 55 p. www.webtag.org.uk

Therivel R. 2004. Strategic Environmental Assessment in Action. Earthscan. 276p.

5.2.5.2. Double counting

There is always a risk that indicators for transportation impacts may experience some degree of double counting. For example, financial benefits from accident reductions are included within the economic appraisal, while the environmental and social indicators may also consider accidents and community safety issues. Also as more topics are examined so the problem of double counting increases as some issues may be at least partly, be included within other topics. For example, the use of natural resources is captured in the construction and operational costs of a particular transport proposal, while air quality, noise and accident costs also relate to health effects.

While double counting should be minimised and efforts to avoid double counting in different parts of the evaluation process should be taken, it does not present a fundamental obstacle to appraisal provided its occurrence is clearly indicated. A pragmatic approach is needed which allows a meaningful exploration of the issues, even where this brings some degree of double counting. Double counting can, however, be acceptable where it provides additional understanding or explanation. For example, taking the headline economic indicators, decision-makers are not able to judge the relative performance of measures in terms of consumption of resources; a key element of sustainable development as such information is assumed to be aggregated into the overall economic figures.

5.2.5.3. Intergenerational issues and discounting future impacts

Often the attainment of certain outcomes/ targets may only be expected after many years (generations in some cases) but decision-makers need to make decisions well ahead of these timescales. For example, it may take several years for the objectives of a Transport Plan to be fully realised. Long time frames introduce greater uncertainty, partly because of the greater likelihood of changes in external variables. It is important in these circumstances to avoid focussing on short-term impacts where more significant long terms changes are predicted.

The difficulty of valuing some outputs, coupled with the long-time frames involved, raises the issue of discounting non-monetised outputs. The process of discounting reflects people's perceptions and valuations of impacts that are phased over time. The inability to value an output like a (non-additional) job is evidence of the limited understanding of society's preferences for such outputs. There are two components to this - how are the values of such outputs expected to change over time and what rate should be used for discounting. It is often argued that given the nature of some outputs that cannot be valued (e.g. non-additional jobs) that no discount rate or a lower discount rate should be used. However, not discounting has paradoxical results and discounting at a different rate confuses the valuation and time preference concepts. In general therefore the benefits of these outputs should be considered and where possible valued. Where benefits have been valued, the valuations may increase over time - but this rate of change may vary from one situation to the next. In most cases it will be best to approach such issues through sensitivity analysis. It is only likely to be material in a relatively small number of situations where bespoke analysis will typically be required.



Further reading:

www.cima.org.uk/downloads/tec_balanced_scorecard.pdf
www.balancedscorecard.org

5.2.6. SUMMARY

The Working Group 5 highlights the following key points on impact scoring – significance:

- Significance must not be confused with the magnitude of the impact. Significance is essentially the result of combining the magnitude of the impact and the importance attached to the resource or feature that is being affected.
- Significance is best assessed using experts guided by systematic and structured criteria in line with the current state of the art.
- Significance criteria are a recognised tool for use in the assessment. They can support judgements, also providing transparency how the judgements were arrived at. Clear frameworks and transparency also help in consultations with public and other interested bodies.
- Significance criteria should be considered as guidelines not absolute rules.
- Significance has to be determined in each case individually.
- Significance should take into account the likely success of proposed mitigation measures.
- The effort and time spent to assess significance should be proportionate to the expected severity of the effect.
- All possible types of effect are to be identified and assessed. Positive effects are also considered, but the assessment does not weight negative against positive effects.
- The reasons have to be given and a documentation has to be prepared on all decisions taken. All consultations should be reported as well.
- The aim of SEA is to reduce uncertainty where it makes sense to, and otherwise to record it and cope with it. SEA should not aim, as a general principle, to replicate the level of certainty of project EIA.

5.3. AGGREGATION

5.3.1. Overview

The purpose of this section is to introduce a state-of-the art review of available methods for the joint consideration (**aggregation**) of socio-economic and environmental impacts originated in development policies, in particular those in the transportation sector. As it is obvious, aggregation is part of the assessment process whereby decision-makers would opt for a preferred transport alternative. It is also evident aggregation is close to the final stages of decision-making and, thence, it can be seen to an aid to those responsible of the final decision; likewise, it can be seen as a tool for democratic public participation in the process of assigning importance scores to all impacts stemming from alternatives under consideration.

Ideally, an unbiased decision ought to be based upon *an objective index* reflecting the “value” of the alternative under consideration. However, the difficulty of reaching such an undisputed index, has led to accept the purpose of aggregation may not be not necessarily to produce a single overall environmental index to be compounded with a socio-economic one, but more simply, to bring together all individual impacts across the plan area to be presented to decision-makers and stake-holders at large. Due to all these shortcomings, no formalised method for impact aggregation is available. Different countries apply ad hoc procedures which often reflect evaluators’ experience rather than unchallengeable procedures. In the following sections a review of current practice in some of the EC Member States is conducted, as well as of the theoretical methods under consideration.

No universally accepted definition for impact aggregation stands out. However, ideas set out so far, as well as the outcome of the literary review undertaken as part of this research, have resulted in the following proposed definition:

Aggregation is defined as the combination of impact scores into a final/overall assessment score at the project and strategy/plan scale within individual topics. Those indexes may be furthered jointly considered and information distilled in order to report to both the public and decision-makers.

5.3.2. Some guidelines on impact aggregation

Guidelines on impact aggregation can be derived from formalised guidance issued by different national/regional administrations, and also from planning practice currently available in those or other Member States. In the present text, guidance from the UK administration and practical experience from the Spanish national road administration are reviewed.

The UK Department for Transport (DfT, 2004)^{*} suggests the following guidelines should be used to aggregate impacts in order to derive the overall assessment score for a transport strategy based upon the separate impacts of the component transport measures on separate key environmental resources:

- a) **Most adverse category:** The principle is that the entire strategy should be assessed according to the most adverse assessment of the resources affected. For example, if a strategy affects, say, five resources, of which one is in the 'large adverse' category and the remaining four are 'slight adverse', then the overall assessment score should be 'large adverse'. The rationale is that highly adverse impacts should not be diluted or masked by less adverse impacts. It also encourages the development of alternative options which avoid such adverse outcomes.
- b) **Cumulative adverse effects:** Where it is clear that there is a cumulative effect across a range of resources, then the strategy as a whole should be scored in a higher category than the resources in isolation. For example, a proposal may affect a number of resources, each of which is assessed 'slight adverse'. Where it is clear that there is a cumulative effect across the resources, the option as a whole would be assessed as 'moderate adverse'. The existence of cumulative effects will usually depend on there being some similarity in the characteristic features or attributes of the affected resources. For example, a group of biodiversity sites might all be habitats for the same species of plant or animal.
- c) **Balancing adverse and beneficial effects:** The principle here is that, where there is a genuine compensatory effect, adverse impacts on some resources may be balanced by beneficial impacts on others. The key issue is whether there are genuine compensatory effects. In most cases, it will be necessary to consider the impacts on each resource at a detailed level, to ensure that the features lost from one resource are provided at another. For example, adverse impacts on groundwater supply at one location would probably need to be offset by beneficial impacts on groundwater supply at another location – beneficial impacts on floodplain would probably not provide genuine compensation. The scope for genuine compensatory effects will often be determined by the substitutability of attributes. In most cases, there is uncertainty about the scope for substitutability, thus balancing should err on the side of caution. In particular, balancing should be restricted to 'slight' or, exceptionally, 'moderate' impacts. It is very unlikely that adequate compensatory effects can be identified to justify any balancing of 'large adverse' or 'very large adverse' impacts.

In the Spanish experience[†] all individual indicators are measured in their own units (m², dB, m, etc.), depending on the nature of the impact analysed, and then translated to relative figures,

^{*} DfT, 2004: The Biodiversity Sub-Objective, Transport Analysis Guidance, Tag unit 3.3.10.
www.webtag.org.uk/webdocuments/3_Expert/3_Environment_objective/3.3.10.htm

[†] Spanish experience is derived from internal guidance issued by the National Road Administration in order to draft Informative Studies (see section 5.2.3.4 above)

normalized between 0 and 1 most of the times, where the maximum value of the scale is the worst possibility recorded among the alternative options, or the worst possible situation for that indicator (e.g. in accordance with normative benchmarking). When the indicator is measured qualitatively in origin, its qualification is transformed to a numeric scale ranging from 1 to 3, 1 to 5, or 1 to 10, and then normalized to a 0-1 scale by allocating the maximum value of the scale the integer 1.

Those indexes do not have units but are comparable and so operations can be made with them. Each of them has a weight according to its significance in global evaluation. Indexes pertaining to the same thematic issue are, then, aggregated by means of a weighted sum ($\sum \text{index} * \text{percentual weight}$, for each alternative) onto another index at a higher tier. By this way a normalized index, between 0 and 1, is obtained for each of the important thematic issues analysed in the assessment (hydrology, protected sites, fauna, heritage, etc.) and the final index provides an overview on how the option behaves with that issue and how it behaves in regard to the other alternative options. Sometimes value 0 means a better mark (if the index is of the type as less as better) and sometimes it means a worse mark (if the index is of the type as much as better).

The final aggregation of impacts of different thematic fields is not based on a specific unit but is made with non-dimensional indexes. All indexes have been normalized or transformed to the same scale trying to keep its original unit value, in order to not lose its relative differences of valuation. They are then comparable and a technique of aggregation is applied to achieve a final overall score.

5.3.3. Methodological issues in impact aggregation

It has been argued that numeric values associated to any checklist of indicators cannot provide the information required for an integrated appraisal of any development policy. Value judgements and subjective ratings of importance make up an essential part of the evaluation as stakeholders perceive the consequences of a policy decision in quite different ways. Factoring the objective figures of the magnitude of different impact indicators by weights reflecting perceived importance is, in itself, a technique of marked interest. This issue has been dealt with in previous sections. However, no possible aggregation at any level can be attained unless weights, reflecting perceived impact significance are granted; hence, the clear relationship between both issues (impact scoring - significance and aggregation) dealt with in this Chapter 5.

There is a twofold purpose for aggregation: On the one side, the number of indicators is reduced, and the aggregation of indicators into indices removes to a certain extent, duplicities. On the other hand, grouping up indicators facilitates decision-taking presenting politicians with a reduced set of values which characterise the sustainability on any policy option.

The possibility of aggregation may be based upon:

- Aggregation over parts of a territory of one or more groups of impacts: These areas of the territory can be classed according to their vulnerability/quality.
- Aggregation of impacts without distinguishing quality of supporting environment.

A GIS-based approach may encompass both, as geo-referenced data may later be aggregated, and it is frequently used as a numerical/non-numerical method for aggregation.

In any case, **geo-referenced** aggregation and appraisal requires dealing with geographical boundaries. Those may vary according to type of impacts. (e.g. for noise pollution, unpopulated

areas may be excluded – or rated zero, as non-significant-; on the contrary other impacts do affect larger areas as pollution disperses, or they have a cause-effect relationship. Moreover, taking into consideration the quality of the supporting environment as a preliminary issue to assigning significance factors and, then, aggregate weighted impacts requires defining two more concepts usually referred to at state-of-the-art literature. First is the concept of **environmental capacity of a territory**, often used as an aid to assess the impact a development strategy places on the space where it is located. As such, **environmental capacity** can be defined as

the aptitude of the receiving environment to absorb changes following the implementation of a strategy or project.

In the standard definitions consulted the absorption of changes is supposed to take place without major or irretrievable damage to the environment.

Environmental capacity is usually appraised through the assessment of a set of features in the receiving territory reflecting its environmental quality, ecological values and natural resources. As it happens, an unspoiled territory will retain its environmental capacity entirely, whereas another one subject to human action would have a low capacity, used up by that human activity. The use of **environmental capacity** as a tool to allocate impact significance requires defining the acceptable level of environmental quality compatible with accepted development and, likewise, coming to terms with the loss of quality consequent to certain impacts.

Secondly, and quite close to the concept of **environmental capacity**, another one is frequently used in many countries. This is the **bearing capacity** of a territory, reflecting to what an extent a territory is suited to locate on it the proposed strategy, given the physical and environmental features of that territory. It is, thus, obvious that those territories with a limited ecological and environmental value will have a greater **bearing capacity** since the proposed strategy will bring in a lesser negative impact. Likewise, territories with great ecological value will have a limited **bearing capacity** if conservation is an overriding policy option.

In Phase A of the Spanish Informative Studies Note a characterization of the area likely to be affected by the transport action is undertaken, called **Bearing Capacity Analysis**, which is a kind of sensitivity assessment of the environment. This analysis is based on four main issues:

- Physical;
- Environmental;
- Cultural and
- Territorial characteristics.

Each one of these issues is appraised, in the area likely to be affected, in a three-degree scale of significance: high, medium or low bearing capacity. Low bearing capacity implies the exclusion of the area to support the infrastructure, medium bearing capacity means restrictions to the construction, and high bearing capacity features a territory with no impediment to receive the infrastructure. This approach may lead to the least bad option being selected, if it disregards the possibility of mitigating significant negative effects.

The aggregation into **thematic indices** is based on several criteria, following measurements of relevant indicators; the magnitude of these indicators is transformed to non-dimensional values and these values (already in comparable scales) aggregated to form the main thematic index.

The **physical index** takes into account topographical, geological, hydrological, **edaphic** and climatic characteristics. The **environmental index** is made up with fauna, flora, landscape and

protected sites criteria. The **cultural index** of the territory is judged analysing the different cultural, archaeological or architectural heritage sites affected by the transport initiative. The **territorial index** refers to the impact on settlements, population, traffic and different categories for urban (according to development possibilities) and rural (according to agricultural values) land. Description and thresholds of every category of significance for each of the four thematic indexes are not clearly explained or justified in most of the Informative Studies reviewed and are not fixed in any regulation. Despite of this, the various Studies reviewed can assist in showing the importance of the resource of the affected territory and, thence, provide tips for impact aggregation onto territorial indexes (see Table 5.3.)

Table 5.11.

Bearing Capacity	Theme	Criteria
Low	Cultural	Very high or high valued cultural heritage elements.
Low	Environmental	Interest natural spaces with high fragility and low recovery capacity.
Low	Environmental	Regional, national and international protected sites.
Low	Environmental	High or very high valued ecosystems and very high valued landscapes.
Medium	Environmental	High biotic interest communities (riverside forests, animal farms, etc.) and high quality landscapes.
Low	Physical	Permanently flooded areas (wetlands) and zones with slope higher than 15%.
Medium	Physical	Aquifers vulnerable to pollution
Medium	Physical	Unfavourable constructive characteristics and high slope areas.
Low	Territorial	Land earmarked for urban development, special protection areas and rural settlements.
Medium	Territorial	Land preserved from development due to agricultural, forestry or landscape interest (because its high productive capacity, for instance).

High bearing capacity area is usually defined as the one that is not included in the other two categories.

This approach to aggregation also prevails in Germany, where it is recommended that it should be conducted *“only with logical, not arithmetic operations because of the original character of the assessment scales (sic)”*

In the Road Plan of Nordrhein-Westfalen (1998) aggregation took place in several methodological steps of the projects' assessment:

1. Maps of "importance/sensitivity", created for each environmental factor (fauna and flora, human health, soil, water, air ..., step D in Figure 1), were aggregated into a new map of "environmental resistance" in order to find an alignment of the new road with minimum environmental impacts (step E in Figure 1. This technique is well known from EIA.

2. Each project causes several impacts along its alignment, depending on the project's impact magnitude and on the importance and sensitivity of the area affected (e.g. 20% of the length causes "high" impacts, 50% "middle" and 30% "low"). In order to get one result for the complete length the separate individual impacts were aggregated for each environmental factor by applying special aggregation rules (e.g. "high" impact for fauna and flora because of having high impacts on more of 15% of the total length, step G in Figure 1).

Result: class of the project's impact for each factor, e.g.

class of the project's impact for each factor	partition of the highest class of factorial impact
above average	> 15% with above average
intermediate	< 15% with above average
below average	others

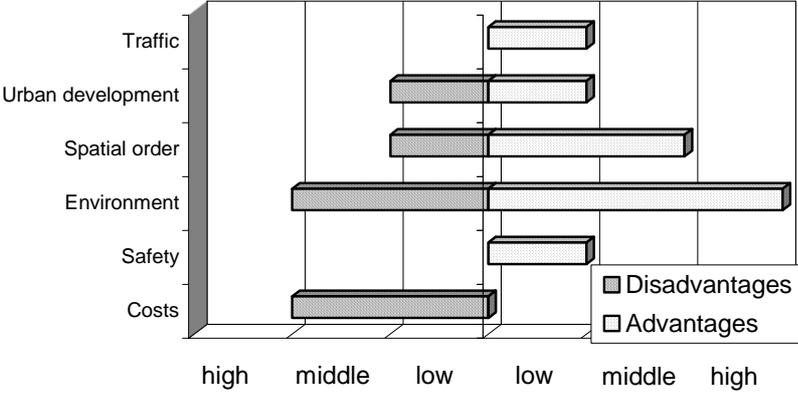
3. The separate individual impacts of the project on each environmental factor (e.g. high impact in fauna and flora, middle in human health) were aggregated to a new overall impact referred to as the "total negative environmental effects" (step H in Figure 1). There were specific aggregation rules for this step also. The result was a classification of the environmental disadvantages over all environmental factors of the proposed project. **Analogue** there was carried out and a classification of the total positive environmental effects. These two numbers (total negative and total positive) were the environmental criteria which the decision-makers considered.

Result: class of the project's environmental impact, e.g.

class of the project's environmental impact	class of the project's impact for each factor
above average	3 – 7 factors with above average
intermediate	1 – 2 factors with above average or 3 – 7 factors with intermediate
below average	others

4. . The last aggregation showed all advantages and disadvantages of the project for all interests (environment, safety, accessibility and so on) in one figure avoiding mathematical operations for balancing. The final decision for the proposed Road Plan was based on this combined aggregation figure.

Result: Table of Advantages/ Disadvantages of the Project



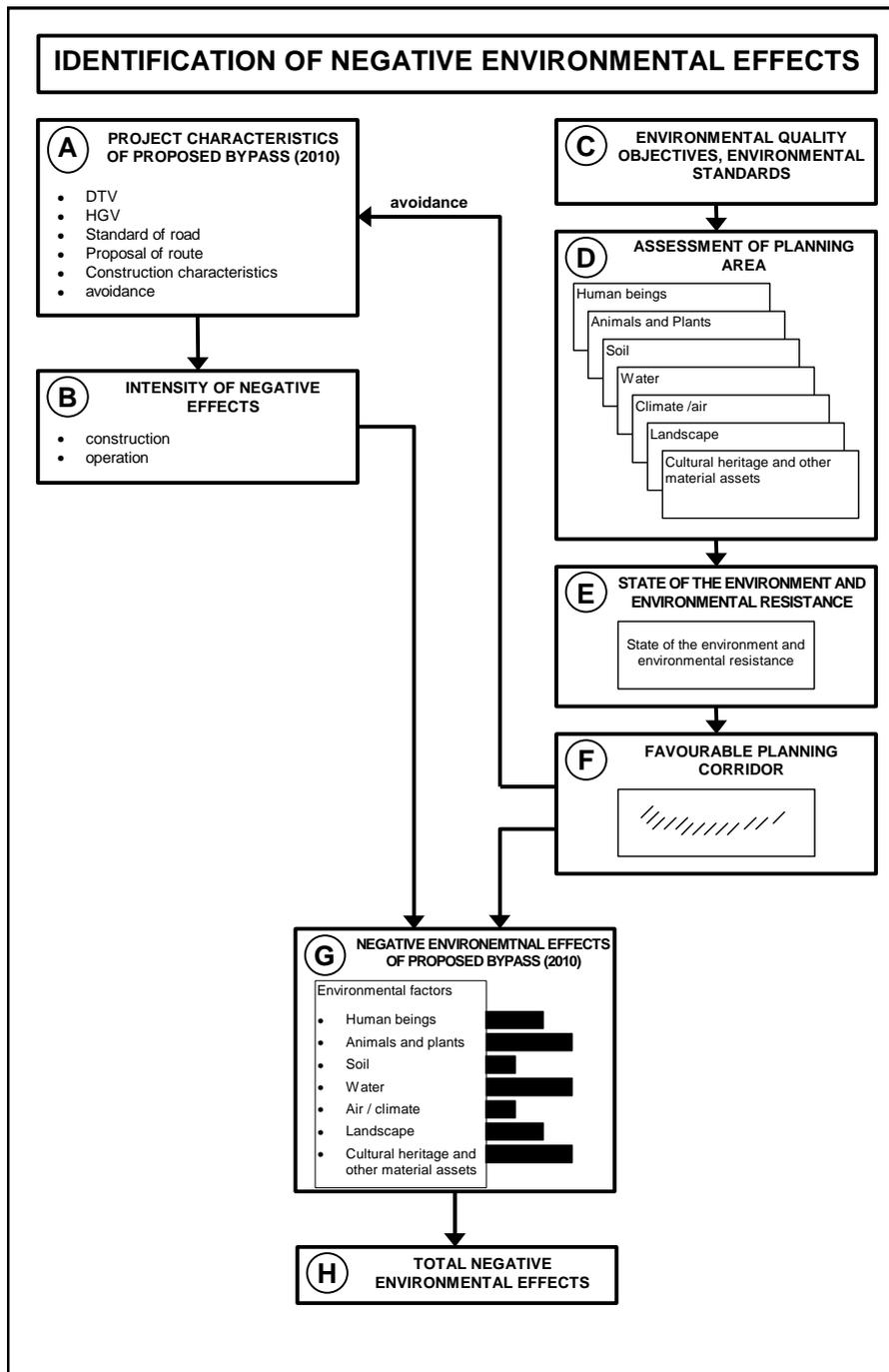


Figure 1 Road Plan of the state of Nordrhein -Westfalen –The application of Aggregation in the Road Plan Making Process.

Source: Smeets und Damaschek; Wolfgang Stein; Stadt- und Regionalplanung Dr. Paul G.Jansen: Dissemination of the Database "Environmental Objectives" and ist Application in the SEA-Practice – Pilot Study. Commissioned by UVP-Gesellschaft (not published). Hamm 2002.

5.3.4. Approaches to weighting and aggregation of indicators

There is an implicit request to conduct significance assessment and aggregation processes as stated in the SEA Directive. The setting up of geographical limits within which the significance

and aggregation processes may be conducted can, obviously, be influenced by administrative responsibilities, budgetary constraints, time limitations, etc. However, in many situations the significance of an impact is reduced over time and space and as a result the magnitude and importance of certain impacts will be less. Likewise, the selection -scoping- of impacts to be addressed is related to stated goals and objectives but also to preliminary allocation of significance rates by a team of experts through their own expertise and the assistance of guidelines. Finally, the selection of alternative actions to be assessed is related, among other things, to a preliminary consideration of the significance of the overall impact it is likely to generate. This concept of overall impact may, perhaps, not respond to a formalised aggregation procedure but, surely, the decision to consider an alternative action for assessment has to be based on a –subjective- aggregation of significant impacts caused by that alternative action.

There is no universally accepted method for impact aggregation, and not even a common approach. Quantitative aggregation is, of course, desirable if subjective judgement or political considerations are to be ruled out. However, the perceived difficulties of attaining a unbiased set of criteria for weighting and aggregating impacts into indexes has led to many administrations to recommend “soft” approaches to aggregation rather than those based in mathematical factoring and aggregation.

In addition to the German recommendation (see previous section), the European Commission (1999)[‡] mentions as samples of evaluation/aggregation approaches

- a) Textual description, explaining impact significance, mainly through reference to objectives and targets
- b) Impact matrices, summarising types of impacts for each alternative
- c) Graphic illustrations and maps
- d) Results of consultation
- e) Monetary evaluation (Unicriteria)
- f) Multicriteria analysis

The cited reference includes another interesting issue further supporting some of the comments above when considering types of aggregation. When dealing with criteria to assist on the significance of effects on the environment, the EC suggests looking at the characteristics of the PLAN, the EFFECTS and the affected AREA (Chapter 5.2.2.). The relevance of these suggestions for impact aggregation is obvious:

For instance, a PLAN may be broken down into a set of operations, each of which should generate impacts. An initial aggregation exercise may be conducted separately on each of those operations. An obvious example is breaking down the plan into building and operational phases, but many other options are available as a way to simplify direct/indirect impacts, or to use existing experience for certain parts of a transportation plan.

Likewise, EFFECTS may be singled out in regard to the different parts of the plan. For instance, noise due to building operations and to the flow of traffic itself. Affection to biodiversity during construction or caused by earthmoving. The aggregation of impacts may be attempted on the basis of anyone impact generated by different components of the Plan. Of course, time and spatial dimensions (propagation) should be taken into consideration. Finally, the characteristics of the AREA in terms, for instance, of vulnerability/constraints, are also relevant as the aggregation may be done on a geographical basis, or the significance of the impacts is surely different in regard to that vulnerability (see above).

[‡] *Manual on Strategic Environmental Assessment of Transport Infrastructure Plans*, European Commission, DG Transport, (February, 1999)

Further on the consideration of individual effects, another common approach to weighing and aggregating indicators is grouping up all those indicators belonging to the same category or domain, i.e., ecological, economic or social indicators. (see next subsection) It is, of course, easier allocating importance scores to indicators within the same category. Domains can subsequently be broken down to mere specific groups up by area of impact: Air pollution, noise, biodiversity, etc. Weight allocation and avoidance of duplicity is, then, made simpler.

Aggregation is usually undertaken bottom-up, that is weighed indicators are added up into “first level” indices, which, in turn, are factorised again and combined onto a higher order index. Reaching a single index reflecting a comprehensive impact of an alternative policy option implies, as it has been argued, accepting a number of hypothesis and cross-factoring quite hard to compromise with. Any level of aggregation carries on subjectivity and the final report should clearly highlight all hypothesis made.

Notwithstanding the interest of “soft” aggregation methods, research within COST 350 has also been concerned with the “hard” methods, namely those based on single criteria (monetary or otherwise) and multicriteria analysis.

The following paragraphs summarise the main conclusion of our own research.

5.3.4.1. Methods for impact aggregation within a single domain (economic, social, environmental...)

These methods are quite similar to those applicable to integrated assessment. The only difference is, obviously, that impact indicators to be integrated are closer to each other and they even may be expressed in the similar units. Usually, aggregation in this case is rather straightforward by directly weighing indicators through **significance** scores or by previously converting magnitudes into a-dimensional units. In this case, indexes will be those a-dimensional comparable figures (e.g. ratios, percentages, etc) representing an individual domain but integrating several –aggregated- impacts featured through weighed indicators.

As indicated previously/ above the lowest level in the aggregation process is that of the original indicators, each measured in a certain type of units, quantitative or qualitative. One level up the aggregation ladder, the working elements will be the domain indexes, all measured in a-dimensional units without a physical **significance**, but in any event, all comparable among themselves. From there up, indexes can be theoretically aggregated to obtain a more complex index. An example could be an environmental level where **indicators/indexes** describing parameters such as air pollution, water quality, flora, fauna, etc, each represented by an index of a lower level, have been aggregated into a single figure.

As it was also hinted, for every step up the aggregation ladder measuring scales for all elements to be aggregated must be harmonised. Harmonisation can be done in various ways but the fundamental goal is to retain, in the final scale, the value ratios between the different impact indicators to be aggregated, that is to say value differences in the original measuring scales of impacts of equivalent importance must be retained in the level above. Again, for every level of aggregation weights must be granted to the **indicators/indexes** reflecting the significance allocated to each of them.

5.3.4.2. Methods for integrated impact aggregation

A great deal of the on-going research on integrated impact aggregation is geared towards discreet multicriteria analysis as recorded impacts will be measured in different units and

scales; moreover, the number of alternative options to be subject to appraisal will be a pre-determined, finite set.

There exist two main methodologies for discreet multicriteria analysis, depending on whether or not they allow compensation among criteria (**additive methods**) or not (**methods based on preference**). Uncertainty in decision-taking decision-making may be introduced and it may be dealt with from a deterministic or fuzzy logic. Small variants may also be introduced depending on individual or group decision-taking.

Additive or compensatory methods

This group of methods allows for low ratings for certain criteria to be compensated with high ratings in others: global analysis of alternatives is the final decisional criterium. Additive methods of aggregation are based on a simple weighed sum:

$$V(i) = \sum p_j v_{ij}$$

where $V(i)$ is the final evaluation of alternative i , p_j is the weight allocated to impact j , and v_{ij} the initial unweighed evaluation of alternative i in regard to impact j . Provided all impacts are transformed into numerical units, it is possible to rank alternatives; however, the method is not fool-proof in what concerns clarity, reliability, homogeneity of data and normalisation of scales, which limits the quality of the aggregated value. Aggregation may be undertaken in a hierarchical, pyramidal manner: At the lowest level alternatives are placed, characterised by a series of meaningful attributes. At the intermediate levels partial aggregations of impacts into indexes is achieved, those indexes linked to specified types of effects/criteria (air quality, land take, total economic costs, etc. Of course, theoretically the summit of the aggregative pyramid will be occupied by a single index describing in a univocal way the value associated to each alternative

Methods based on preference

Methods in this group are based on an outranking rule and they do not result in a univocal index of evaluation but allow comparisons between pairs of alternatives. The predefined outranking rule established when one alternative is better than one another. As a consequence, these methods do not result in a complete list of ordered alternatives each one with an associated number representing its relative value. This type of methods, in different variants[§] is the most commonly used throughout Europe.

The use of multicriteria methods –in particular ELECTRE III- and their application to environmental analysis of transportation systems is well documented in the technical literature so it does not require further explanations. However, it should be reminded that any method chosen shall help to structure the decision problem and process, notably by providing – or at least allowing – feedback and revision loops (i.e. a iterative method) and shall allow the integration of knowledge and valuations of a great number of concerned or interested people, groups or organisations (i.e. a participatory method). This implies in particular a transparent distinction between factual analysis and value judgements.

Lastly, the ultimate goal for an environmental assessment is sustainable development.

Sustainable development as it was originally conceived and adopted is a normative concept (intra- and inter-generational equity and protection of natural resources) and clearly states limits,

[§] Some of the best known of those are ELECTRE, PROMETHEE and MACBETH

not least imposed by the ecosystem. If we want the method to allow for this position of the so-called 'strong sustainability' then not all criteria or their scores may be traded against each other, and thus implicitly compensated, but some kind of non-compensation or veto-mechanism must be provided.

5.3.4.3. Methods for impact aggregation based on practical experience

In anticipation to the formal coming into force of the SEA Directive, some Member States and the Commission itself have embarked upon some practical exercises on Strategic Environmental Assessment and the integrated consideration of impacts stemming from transport corridors.** Although the Study is mainly a summary of the practical way to carry out the SEA in five different countries and, as a matter of fact, no advanced methodological research is undertaken, it contains interesting views on approaches taken by leading Member States in what concerns SEA of transport corridors. Some views on aggregation issues are worth highlighting.

In the UK study†† traditional cost-benefit analysis linked to SEA has been used to pre-select alternatives (i.e. to grant major interest to certain alternatives over others). This may be tantamount to say the study relies more in CBA than on the joint the consideration of all effects through an ad hoc integrated method. The shortcomings of the approach are made evident as the Report mentions that

“The order of the analysis may have crucial implications for the final selection”

In other words, a pre-screening exercise whereby economic and financial considerations are considered in the first place, may rule out other alternatives more beneficial from an environmental point of view. This would have been equivalent to allocate a greater degree of significance to economic issues over environmental ones. It is also quite obvious this type of ordered analysis may respond to previously defined levels of importance for the policy goals.

The French- Belgian method‡‡ for corridor assessment looked at 12 themes, each of them further defined into area components/ categories (e.g. agricultural soil defined in terms of typology, landscape in terms of quality, natural environment in terms of level of protection, etc). For each theme maps were built up showing:

- ◆ Intrinsic value of the environmental component
- ◆ Sensitivity of the component
- ◆ Residual impact after mitigation measures

These three dimensions were rated from 1-6 through expert judgement. Maps were then prepared for each of the three scored dimensions and components. Finally the maps were combined showing the cumulated constraints

SEA analysis was meant to be matched to other studies, including CBA, as well as to the technical and socio-economic implications. This is, in a way, equivalent to an attempt to consider jointly (aggregate) environmental and other effects. That was the case with the UK study, where the final assessment

...has sought to trade-off the CBA results against the environmental impacts. This balancing process has been based on documented judgements made on the basis of successively

** See in particular EC Commission (2001) *Strategic Environmental Assessment of Transport Corridors: Lessons learned comparing the methods of five Member States*. Prepared on behalf of DG Environment by Environmental Management Consultants, London, UK. This document reports on five case studies on SEA of Transport corridors.

†† The Trans-Pennine Corridor

‡‡ The corridor Nord between Paris and Brussels

summarised and distilled information. We have preferred to avoid the use of any quantified weighing and scoring systems which imply unsupported monetary valuations between impacts (MVA, 1999)

The UK study did not value impacts in monetary (currency) terms. While monetary valuation techniques are well developed in relation to certain environmental topics, in the case of many others they are not sufficiently well developed to undertake such an approach. Thus, it was felt that since monetisation could not be applied on a consistent basis across all environmental topics within the study, a consistent, non-monetised approach was the best way forward in respect to environmental impacts. This is a different approach to the Swedish case

The Swedish study^{§§} chose to include a CBA as part of the overall SEA. It was particularly interested to calculate the value of time savings, changed numbers of anticipated road accidents (safety), vehicle emissions, and energy consumption. The study stresses the fact that costs and benefits resulting from an investment will relate to different parts of the society.

A concluding remark to the three most meaningful studies reviewed clearly shows that, short of an integrated method of impact aggregation, the use of a standard, well-accepted method such as CBA supplemented by a “specialised” method to deal with environmental impacts seems to be preferred. This is approached was also favoured at COST Action C8^{***}

5.3.5. Some final comments on aggregation issues

As it has been repeated along the previous paragraphs, an integrated aggregation – or rather, the joint consideration- of all impacts stemming from a major transport policy decision is fraught with subjectivity. Coming up with a universally accepted method to reduce that subjectivity is still far out in the research horizon. The simplicity of the methods reviewed ranges from comparing scenarios (do-nothing vs. forecasting consequences at a horizon-year may provide an aggregated view of impact) or accepting a democratically stated experts’ opinion to devising an academically sustained multicriteria model where different weights, opinions and ratings of significance may be tested and then, compounded. Short of those methods, practical experience is proving a used tool to gauge public reaction and the sensitivity of subjective assessments.

In looking forward to a research agenda, aggregation of positive and negative effects, is an area insufficiently researched for which not enough experience exists. Mitigation is, of course, a part of the assessment process but residual negative effects cannot always be offset by positive ones, mainly if not perceived by the same social group. Monetary compensation, by way of compulsory purchase or simple financial payments may be a way to fence off citizens prejudices against a transportation operation. Moreover, other forms of compensation may be considered even outside the transport sector.

Recommendations for further research include:

- A review of the approaches adopted in the environmental assessment of transport plans to the aggregation of impacts stratified by the different planning level and project content of the plans;
- Examination of different weighting methodologies employed across Europe in the aggregation of transport generated environmental impacts;

^{§§} The Gothenburg –Jönköping Transport Corridor

^{***} Best practice in Sustainable Urban Infrastructure where the most common methods- economic, social and environmental- for impact assessment were surveyed in order to explore their possibility of integrating in a comprehensive way all effects stemming from urban infrastructures

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- Examination of how Environmental Reports prepared on transport plans communicate their findings to decision makers.

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