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A research agenda for data and scale issues in Strategic Environmental Assessment (SEA)

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Abstract

The way in which Strategic Environmental Assessment (SEA) succeeds in its key aim – to integrate the environment into strategic decision-making – is affected by the choice of both data and scale. The data and scale used within SEA fundamentally shape the process. However, in the past, these issues were often not discussed in an explicit or in-depth way. This article proposes a research agenda, and recommendations for future practice, on data and scale issues in SEA. Future research on data issues, spatial and temporal scales (both in terms of detail and extent), tiering, data quality and links to decision-making are recommended. The article concludes that questions of data and scale in SEA are not just technical, they are essential to identifying and understanding the issues that SEA should be addressing, and therefore are a core element of SEA.

Keywords: Strategic Environmental Assessment (SEA); Data; Spatial scale; Temporal scale; Research agenda; Tiering; Scale effects; Data quality

1. Introduction

This article is about data and scale issues in Strategic Environmental Assessment (SEA). This topic goes to the heart of the SEA process in more ways than one. From a pragmatic point of view, data is essential as it can be argued that data is needed in order to carry out an SEA. From a quality perspective, the choice of 'appropriate' data and respective scale (both temporal and spatial) are also key, as different data (or scale) might produce different outcomes to the SEA process. In more philosophical terms, data issues are also fundamental in terms of what the SEA process is about. Namely, should issues identified by the SEA process work as a 'cookie-cutter' to select the data

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needed or should data collection precede the identification of key issues? One overall-arching theme discussed in this article is what should come first — data or issues.

The article starts by discussing the links between SEA and decision-making (Section 2). Ultimately, which data (and which scale) is chosen, depends not only on the needs of the SEA process but also on the requirements of the decision-making that the SEA is informing. SEA data issues are discussed next (Section 3), taking into account that SEA is composed of different topics (e.g. biodiversity, health, water) and can be applied to different sectors (e.g. transport, forestry) — all with many different data and scale needs. Section 4 proposes a research agenda related to scale issues in terms of scale effects, spatial and temporal scales, and choice of both the amount of detail and the extent of the study. Tiering versus multi-scale analysis is discussed in Section 5, in terms of scale choice for each tier and also in terms of the need to investigate the interaction or dialogue between those tiers. The study of data quality, metadata and uncertainty issues is fundamental considering the importance of generating results that decision-makers and the public can trust. This is covered in Section 6. Section 7 discusses the importance of researching the possibility of data and/or scale abuse. This is the rare occasion when data and/or scale might be chosen by corrupt practitioners or politicians as a way to get a preferred result. Finally, Section 8 concludes the article.

2. Links between SEA and decision-making

SEA is a tool that intends to inform decision-making processes related to proposed policies, plans and programmes. Therefore, a discussion on which data and scale are needed for SEA should start with understanding the nature of SEA and how it intertwines with the decision-making associated with proposed strategic actions. The ultimate aim of SEA is *not* to carry out the SEA *per se* but to use the SEA to achieve the best possible strategic decision (João, 2005a). Therivel (2004, p. 209), for example, concludes her book with the following statement, while talking about what hopefully will happen in the future:

> "… decision-makers will start 'thinking SEA' while they develop their strategic actions. Instead of perceiving SEA as a separate process that is 'done on' their strategic actions, they will start integrating environmental and sustainability thinking into their strategic actions … to the point where ultimately, hopefully, SEA will make itself (and this book) redundant".

The established best-practice way to achieve this is through an 'integrated model', which assumes that strategic actions are subject to multiple stages of decision-making and attempts to integrate SEA into each of those decisions (Therivel and Partidario, 1996).

More research is needed on how data collection and analysis matches the needs of decision-making processes. For example, in terms, of what are the data and scale needs for *informal* decisions and also *how timely* it is all done. SEA needs to keep pace with the often swift decision-making (see Partidário, 2007-this issue). This also means that SEA might need to rely on less 'data-hungry techniques'. Therivel (2004, p. 162), for example, suggests that "quick-and-dirty techniques may be the only ones that can keep up with a rapid decision-making process". It is also crucial to research how best SEA can interact at the 'appropriate points' in the decision-making process — the so called "decision windows" (ANSEA Team, 2002). From an environmental point of view, it can be argued that the key decision windows of concern to SEA are when critical choices are made which have *significant* environmental consequences.

Other 'real world issues' related to data collection (and scale choice) are what can be called the 'pragmatic aspects of SEA'. In other words, how resources (e.g. money, staff) – or lack of them –

affect the type, quantity and quality of data chosen. João (2002) uncovered evidence that in project EIA the choice of the scale of the data could be directly related to the amount of funding. In relation to SEA, Wright (2007-this issue) found that resource restrictions and decision-making deadlines limited the amount of data that could be collected. Consequently, it is important to further study how budgets and schedules affect data and scale choice.

In addition, future research could investigate (as a possible solution to lack of resources) whether SEA data could be classified in terms of its importance and if priority could be given to data collection that is considered 'most important'. For example, Seht (1999 p. 6) suggests, "when describing the baseline environment, special emphasis should be put on existing environmental problems and constraints as well as ecologically important and/or sensitive areas". A kind of sensitivity analysis could be carried to find out which data might be particularly relevant, both in terms of decision-making purposes and identifying significant impacts. The ultimate test, of how effective a *selective* data collection may be, is how well the SEA process is protecting the environment and how well the SEA can withstand a public presentation and defence of the SEA.

3. How much data is enough and what type of data is needed

One key aspect of data in SEA, which partly sets it apart from project EIA, is the recognition that SEA can be done with missing data. "Not all the baseline data must be available for an SEA to proceed. The first SEA can be seen as a way of identifying what needs to be monitored in the future" (Therivel, 2004, p. 38). Objectives and indicators identified in the SEA can affect what baseline data are collected and what data gaps are acknowledged. However, as baseline data is collected, this further informs what SEA objectives and indicators are particularly relevant. This ideally results in an iterative relationship between SEA objectives, SEA indicators and baseline data (see Fig. 1). It is crucial to note that poorly chosen objectives/indicators "will lead to a biased or limited SEA process" (Therivel, 2004, p. 76). In addition, the identification of SEA objectives and SEA indicators depends on the scale of the study. So, for example, English Nature et al. (2004) proposed different SEA objectives and SEA indicators for different scales (international/national, regional and local) for biodiversity assessment within SEA.

Data collection in SEA needs to achieve the difficult balance between being swamped under too much data (that is more appropriate to project level EIA) and collecting sufficient information

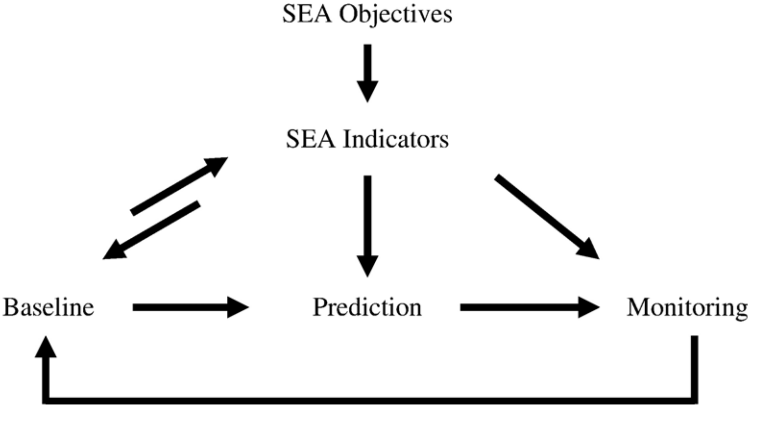

Fig. 1. Links between SEA objectives, indicators and baseline data (Therivel, 2004).

necessary for decision-making purposes. For example, it may not be necessary to collect a very detailed list of plants and animals present on a particular SSSI (Sites of Special Scientific Interest of national or international importance in the UK). If a certain SSSI is determined by the characteristics of the water table, for example, then all is needed is to assess if a proposed strategic action might affect the water table (which will then affect the SSSI and the species within it). A report by ICON Consultants Ltd (2001), on the integration of the environment into strategic decision-making, identified both cases where the excessive detail used was superfluous in the context of strategic planning and the opposite where issues were glossed over and vague. This is where the approach illustrated in Fig. 1 can help. SEA objectives (and associated indicators) can be used as a way to select the data that is needed and therefore avoid collecting unnecessary data. On the other hand it can also ensure that issues considered important are selected for further assessment, irrespective of the existence or not of data.

The question of which data to use is further complicated when considering *what type* of data is required. Different types of data will be needed for: different sectors (e.g. transport, energy, agriculture); different issues (e.g. biodiversity, health); different levels (linked with tiering); different alternatives; different stages (e.g. scoping, monitoring); cumulative impacts; transboundary issues; different methods; and, environmental, social and economic issues. Data availability, data quality and other problems in general, might be variable for all these different issues. So, for example, one particular issue might be very data rich while for another issue there is no data at all.

For some of the issues, quantitative information might be available, while for others only qualitative information exists. There will even be SEA impacts that are "unquantifiable and/or not spatially fixed" (Therivel, 2004 p. 161). The question that arises therefore is how the disparity in the data availability for different issues (in terms of the type, quantity and quality of data) might affect the importance given to these same issues. For example, it would be relevant to determine if 'data-poor' SEA objectives might lose out in relation to 'data-rich' SEA objectives during the decision-making process or during a public inquiry. Also, would quantitative data be given more importance than qualitative data, maybe because quantitative data is perceived as 'robust' while qualitative data is perceived as 'unreliable'? The use of less conventional data or knowledge also needs to be further investigated — such as 'story telling' of alternative scenarios or anecdotal 'data'. Even less-conventional data or knowledge could be used for environmental analysis. For example, Câmara et al. (1987) proposed a new dynamic modelling methodology, SLIN, which allowed for the analysis of systems defined by *linguistic* variables using logical rules (e.g. if dissolved oxygen is *low* then fish population is *low*). The potential use of such techniques in SEA would be an interesting area of research.

Finding and collecting the 'right' data for SEA also includes knowing trends and targets (João, 2005b). Existence of 'snap-shot data' might still be considered a *data gap*, because of lack of historical data that gives an indication of how a certain situation might have improved or got worse. Monitoring must address identified data gaps and that may be done in part through the participation of the public. For example, Gouveia et al. (2006) proposed the creation of an environmental collaborative monitoring network that uses willing citizens in order to carry out environmental monitoring. This collaborative monitoring uses people's own senses, like smell and vision, to monitor environmental quality while using people's mobile phones or mobile GIS to record and pin-point locations. Gouveia et al. (2006) suggest that this system not only supports public participation but also promotes the use of data collected by citizens. The importance of the public in terms of data collection is supported by a study on baseline data requirements for the SEA Directive, by Fry et al. (2002 p. ii), who suggested that "data assembly and public/

stakeholder consultation should not be seen as separate exercises". Future research could therefore further investigate how public participation could help the SEA process with regards to data gaps, monitoring and tackling poor data quality.

4. Spatial and temporal scale issues

Space and time are ubiquitous in all environmental assessments because impacts occur in time and space. Therefore both spatial and temporal scale issues are critical in both project EIA and SEA. Despite its importance, scale is often ignored (João, 2002; Meentemeyer and Box, 1987) and, despite being such an integral concept in many disciplines, it remains largely misunderstood. According to Montello and Golledge (1999, p. 3) for example, "scale is one of the most fundamental yet poorly understood and confusing concepts underlying research involving geographic information". Part of the problem is that the meaning of scale varies between disciplines and communities (Goodchild and Quattrochi, 1997). So, for example, using cartographic terminology, 1:250 000 is a smaller scale map than 1:10 000. However, other disciplines and day-to-day language often refer to large and small scale in the *reverse* sense, i.e. that large scale are maps that cover a large portion of the earth surface, albeit with small detail. It is therefore important to either clarify what one means by large and small scale, or alternatively to talk instead about 'more detailed' and 'less detailed' scales.

Scale has two key meanings, applicable to both spatial and temporal issues. The first meaning of scale is the *extent* of the assessment (e.g. size of area, overall time period studied). The second meaning of scale is the amount of *detail* or granularity used (e.g. rate of sampling, such as every 10 m or every day). Extent determines the size of the 'window' to view the world, while the amount of detail is related to the level of resolution and determines the smallest entities that can be seen in the study. Although not often explicitly recognised, the 'scale of the study' is the interaction of extent and detail. Extent and amount of detail affect each other. For example, if an assessment is being carried out for a very large area or for a very large time period, it is unlikely that it will be done in a lot of detail (because it is not possible or not adequate to deal with so much detailed data).

The questions posed in Section 3, of how much data is enough and what type of data is needed for SEA, can be reinterpreted as scale questions particularly when it comes to the concept of amount of detail. For example, in relation to the spatial scale, O'Neill et al. (1996, p. 169) recommended that "in reporting landscape pattern, grain should be 2 to 5 times smaller than the spatial features of interest". In relation to the temporal scale, Laube et al. (2006) warned about the importance of choosing adequate temporal granularity, i.e. not undersampling nor oversampling. For example, in their Porcupine caribou[1] case study, Laube et al. (2006) suggested that in order to search for *seasonal* migration patterns an analysis granularity of hours would not be adequate because it might introduce noise caused by *daily* movement patterns, i.e. 'you can't see the wood for the trees'.

Determining the boundaries (in space and time) of SEA is not easy (Ortolano and Shepherds, 1995). Strategic-level decisions are often based on long-term actions, over a large geographic area (Noble, 2004) and this "makes the assessment process very complex" (Seht, 1999 p. 3). Boundaries will vary according to impacts in question, i.e. there will be different boundaries for different issues. Fry et al. (2002 p. ii) suggested that the "study area needs careful definition as effects may extend beyond the immediate plan/programme extent". Mitigation and enhancement boundaries may also be different from the ones of the strategic action. In addition, boundaries may

[1] A herd of caribou located in the northern Yukon and Alaska, which are called after the Porcupine River.

Box 1

Information to be provided according to Annex I of the 'SEA Directive' (European Union Directive 2001/42/EC "on the assessment of the effects of certain plans and programmes on the environment")

The likely significant effects[2] on the environment, including on issues 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 the above factors.

be convoluted and vary with time (see Forman and Debblinger, 1998). When it comes to cumulative impacts, the choice of both the spatial and the temporal boundary of the study is critical. This has not been done appropriately in the past (see Burris and Canter, 1997). More research is needed on predicting techniques, and associated uncertainty, that can address space–time lags, path dependencies, non-linear relationships, positive and negative feedback mechanisms, and critical thresholds (see Therivel and Ross, 2007-this issue).

In addition to the appropriateness of scale *choice* in SEA, another key aspect is scale *effects* — i.e. how the choice of scale may affect results found in SEA. It is well known that results vary according to the choice of spatial and/or temporal scale. For example, scale effects have been studied in ecology (e.g. Fernandes et al., 1999), environmental assessment (e.g. João, 2002), landscape studies (e.g. Meentemeyer and Box, 1987), water quality (e.g. Osterkamp, 1995), hydrology (e.g. Sposito, 1998) and archaeology (e.g. Stein and Linse, 1993). Gray (1999, p. 330) suggested that "the scale at which studies are undertaken affects the conclusion because processes and parameters important at one scale may not be important or predictive at another scale". This ties in to the concept of characteristic scales (see Goodchild and Quattrochi, 1997). Because SEA needs to cover different topics, which may all have different characteristic scales (e.g. biodiversity, health — see Box 1 listing the topics that are supposed to be covered according to the SEA Directive), different scales might need to be chosen for different topics within the same SEA process.

The appropriateness of scale choice and scale effects in SEA are both areas ripe for research. What is the potential effect of scale choice on the outcomes of SEA? For example, will the choice of scale influence the type of impacts found and their significance, the recommended mitigation and enhancement measures, and, ultimately, the decisions taken. A comparative study could also be done in terms of determining if scale effects are more critical in SEA or in project EIA. Maybe scale issues are particularly important in project EIA because EIA are normally done with more detail, or maybe scale issues are more vital in SEA because SEA usually covers larger areas.

5. Tiering versus multi-scale analysis

Tying together many of the concepts of data and scale is the notion of tiering. Tiering means that aspects of SEA carried out at one level (e.g. national, regional) do not necessarily need to subsequently be revisited at 'lower' levels, so that tiering can potentially "save time and resources" (Therivel, 2004, p. 13). However, more research is needed to confirm the assertion that

[2] These effects should include secondary, cumulative, synergistic, short, medium and long-term, permanent and temporary, positive and negative effects.

issues do not need to be revisited at lower levels. Could it be that, in fact, issues also need to be dealt with, and with more detail, at lower levels? In other words, is multi-scale analysis needed? If not, then what data and what detail are relevant for each tier and at what level should certain issues be dealt with?

The danger of tiering, and of the concept of avoiding duplication, is that it assumes that there is a single scale where analysis is necessary. However, many times a multi-scale analysis is needed and the same issue needs to be re-visited at different tiers with different scales. In a multi-scale investigation of landscape change in Southwestern Burkina Faso (in West Africa), in order to determine if land was being degraded, Gray (1999, p. 330) found that: "one's conclusions about whether land is degraded are influenced by the scope and scale of the analysis. For example, if we examined changes at the local or regional scale using aerial photographs, we would most likely arrive at a different conclusion than if we examined soils at the farm scale". Specifically in relation to SEA, Fry et al. (2002) suggested that it is necessary to have a heterogeneous approach to scale. This is because "some areas of the study area may need to be addressed at an area wide level of detail while others may need greater level of detail on a specific topic" (Fry et al., 2002, p. ii).

The other key aspect that requires investigation is the interaction or *dialogue* between the different tiers (e.g. between the national and the regional tiers). Therivel (2004, p. 99), for example, asks: "how should targets at different spatial scales be related? — e.g. how should national greenhouse gas emission targets be reflected in a local plan, or in a housing development?" The dialogue between tiers also relates to the implementation of mitigation and enhancement measures. SEA carried out at one tier (e.g. national) might make recommendations regarding mitigation and enhancement that will only be implemented at project level on the ground. Cross-country initiatives regarding data availability and management – such as the European INSPIRE (Infrastructure for Spatial Information in Europe) – could have an important contribution to make regarding the effectiveness of EIA and SEA studies (see Vanderhaegen and Munro, 2005). However, any database of relevant information for SEA, should also keep track of mitigation and enhancement measures that may affect other SEA and project EIA. This means that a national effort is necessary to keep track of mitigation and enhancement recommendations for different tiers. The next question is who should be in-charge of such national databases in order to reduce duplication of effort and ensure quality.

6. Data quality, metadata and uncertainty

Although it is generally acknowledged that data and scale issues can have important repercussions on SEA, SEA practitioners might fail to warn about any uncertainty linked to the data used or might fail to evaluate the quality of the data chosen. A common criteria for evaluating data quality is to determine if the data is 'fit for purpose'. This means that the user will need to determine the suitability of the data in each case. In order to be able to do this, a quality report is normally required that can provide the basis for a user to decide if the data is good enough for the intended use. This quality report is called 'metadata' (i.e. data about data). Fry et al. (2002 p. 33) suggested 20 metadata fields relevant for SEA as a "starting point for SEA practitioners" (see Box 2).

Other key data quality issues relate to uncertainty and accuracy, and how to handle them. "Strategic actions are inherently fluid and nebulous" (Therivel, 2004, p. 161) and forecasting future baseline conditions leads to uncertainty — see Box 3 for different ways in which uncertainty may creep into SEA and Box 4 for different ways in which to handle uncertainty in

Box 2

Metadata fields relevant for SEA (modified from Fry et al., 2002 p. 33)

General fields:

1. Title
2. Description
3. Owner (organisation name)
4. Primary supplier (organisation name)
5. Primary supplier contact name
6. Primary supplier Tel/Email
7. Secondary supplier (website) if applicable
8. Frequency of update (e.g. hourly, daily, weekly, fortnightly, biannually, annually, decennially, continuous, irregular, never, not known, other)
9. Archive (time series available)
10. Data format (e.g. spatial digital or non-digital, non-spatial digital or non-digital)
11. Presentation type (e.g. image, graphic, map, numeric, text, other)
12. Geographic extent (e.g. national, local authority)
13. Scale/resolution (e.g. 1:1250, 1:250 000; 100 m; not applicable, unknown)
14. Availability (e.g. now, future [by end of year…], future [unknown when])
15. Access constraint (e.g. financial, legal, other, not known, none).

Study-specific commentary fields:

16. Any experience of the usefulness for SEA (e.g. poor, OK/best available, good, unknown)
17. Forecasting potential (e.g. to project a future baseline) (e.g. poor, OK, good, unknown)
18. Relevance to topic(s) (e.g. biodiversity, soil, water, air, climatic factors, cultural heritage, landscape, natural resources, human health, population, material assets, economy)
19. Suitability for: 'policy oriented', 'area wide' and/or 'specific zones' strategic actions[3]
20. Other comments.

SEA. Addressing uncertainty is also a scale issue — for example, the Canadian Environmental Assessment Agency observed the following for project EIA:

> "If large boundaries are defined, only superficial assessment may be possible and uncertainty will increase. If the boundaries are small, a more detailed examination may be feasible but an understanding of the broad context may be sacrificed. Proponents may perceive assessments with large boundaries as onerous or unfeasible, whereas the public

[3] Fry et al. (2002, p. 21) classify strategic actions into: "*policy-oriented* (with overarching baseline data for considering proposal that are not location-specific — e.g. regional planning guidance); *area-wide* (broad characterization of the entire study area to consider location-specific proposals within a wide geographic extent — e.g. tourism plans); *specific zones* (where more detailed assessment may be required to consider local proposals (e.g. corridors within local transport plans).

Box 3

Different ways in which uncertainty may creep into SEA (modified from Holling, 1978; Munn, 1979; Therivel and Partidario, 1996)

1. The natural variability of the environment
2. Predicting the likely future state of the environment
3. Determining carrying capacities
4. Inadequate understanding of the behaviour of the environment
5. Inadequate data on the strategic action and on the baseline conditions
6. Changes in future technology
7. Socio-economic uncertainties — including extreme events like war
8. Changes in political priorities
9. Changes in economic priorities
10. How the strategic action will be translated into projects and action on the ground
11. Unanticipated changes in the strategic action's characteristics during its implementation.
12. The effects of other strategic actions and projects
13. Simplifications in the models used
14. Errors in applying the models used, analysing and interpreting the results, and presenting the results in report form
15. Judgement values.

may think small boundaries do not adequately encompass all of the project's environmental effects." (Canadian Environmental Assessment Agency, 1996, p. 13).

DHV Environment and Infrastructure BV (1994), in the Netherlands, suggested that "the causes of the tendency towards unnecessary detail in SEA are that environmental experts are not used to dealing with such a degree of uncertainty". Noble (200, p. 7) adds, "many of the impacts resulting from policy or plan-level decisions are indirect and difficult to measure with regard to the accuracy of impact predictions". For example, it may be difficult to identify causes and their effects. Confidence for data used might also be lacking. Sadler (1996) reported that 75% of the time, assessments were 'unsuccessful to only marginally successful' in indicating confidence levels for data used in predicting impacts. It is important that uncertainty and accuracy in SEA are tackled in order to ensure that SEA are as robust as possible.

Appropriate follow-up in SEA is crucial in order to check that predictions went according to plan and overcome issues of uncertainty (see Partidário and Arts, 2005). Monitoring and follow-up in SEA would test not only whether the strategic action is achieving its objectives and targets but also identify any negative impacts that require remediation (that may have not been predicted by the SEA). Follow-up should help to ensure that mitigation and enhancement measures proposed in the SEA are implemented, give feedback to assist in impact predictions for future SEA, and collect data to fill identified data gaps. Finally, it is also necessary to take into account data and targets that might change during the timeline of the strategic action.

Research in this area should evaluate what are the uncertainty and accuracy issues in SEA, and how best to handle them. Other questions relate to how public participation might help with poor

Box 4

Different ways in which to handle uncertainty in SEA (modified from Holling, 1978; Munn, 1979; Therivel and Partidario, 1996; DHV, 1994)

1. All assumptions underpinning predictions should be clearly stated.
2. Probability and confidence in predictions should be addressed.
3. Carrying out sensitivity analyses, to find out how changing the assumptions on which predictions are based influences the outcome of the predictions.
4. Basing predictions on different scenarios, which reflect possible future events and conditions (including the worst-case scenario based on the precautionary approach).
5. Stating predictions in terms of ranges, rather than giving precise figures, to reflect uncertainty.
6. Monitoring of outcomes of similar strategic actions.
7. Appropriate follow-up, reviewing outcomes of the implementation of the strategic action.
8. 'Adaptive SEA' — with periodic reviews of the SEA through the strategic implementation.
9. Uncertainty report — bringing together the various sources of uncertainty and the means by which they might be reduced.
10. Showing different points of view.
11. Preparing contingency plans.
12. Postponing decisions.

data quality and how can the public be trusted on the data provided. Finally, research could investigate if data collection should be on-going throughout the implementation of the strategic action. In other words, should an 'adaptive SEA' (similar to the adaptive EIA suggested by Holling, 1978) be the solution?

7. Data and/or scale abuse

Data and/or scale abuse is defined in this article as the choice of data and/or scale that leads to the preferred answer rather than the solving of the problem. If that is the case, then it is important to investigate what can be done to protect the SEA process from this abuse. It is possible that guidelines or guidance might be useful regarding data and/or scale use for SEA. However, given the 'multiple nature' of SEA, it is likely that any guidelines would need to vary for different sectors (e.g. agriculture, waste), levels (e.g. regional, local), topics (e.g. biodiversity, health), and SEA stages (e.g. scoping, monitoring). Underlying the possibility of data and/or scale abuse is the issue of *trust*. With regard to the use of research results in public policy, Costanza et al. (1992, p. 121) point out that "the users of this information must either be knowledgeable in the details of the research methods or accept the results with no idea of their quality".

There is little documented evidence that data and/or scale abuse is taking place and it would be useful if future research could clarify the extent of this potential problem. Ross (1998, p.271) noted the possibility that results could be manipulated according to the size of the area studied in relation to cumulative effects assessment (CEA): "The greater the area assessed for CEA, the smaller will be the percentage of impacts caused by the project, because more other sources of impact get captured in the analysis. While I would not suggest this happens on purpose (a proponent wishing to have it appear that a project causes only a small portion of the impact), it is an interesting feature of this and other regionally based CEAs". João (2000) reported on the case of corrupt enterprises in Brazil that were using maps of poor detail to help them get work commissioned. More seriously, this was also allowing these enterprises to escape being penalised afterwards due to the lack of definition of the scales used. While Fry et al. (2002, p. 31) described bias in sustainability appraisal where "the scope of the appraisal was steered to avoid having reported negative effects".

Another aspect of this data and/or scale abuse is related to choosing strategic action issues or SEA objectives for which there is already data or data would be easier or cheaper to collect. For example, in September 2004, while carrying out an SEA, a local government official in Scotland suggested that certain SEA objectives should be eliminated from the analysis only because it would be difficult to monitor them in the future.

8. Conclusions

This article outlined a research agenda for data and scale issues in SEA. Data and scale in SEA are not just technical matters but are fundamental for identifying and understanding the issues that SEA should be addressing (e.g. health, accessibility, biodiversity). In other words, data and scale help define what SEA is about (and for what purpose) and set it apart from project EIA. As an overall conclusion, and as a recommendation for future practice, this article proposes that issues (defined for example by SEA objectives) should normally come before data collection. This way it can be ensured that issues considered important (e.g. reduce air pollution, improve people's health, maintain biodiversity) are selected for further assessment (irrespective of the existence or not of data) while at the same time avoiding unnecessary data collection. That said, the selection of issues can be affected by iterative elements, such as data collected (see Fig. 1) and what is found at other stages or other parts of the assessment.

However, this might not be what is happening in practice. Organisations attempting SEA for the first time might be spending a lot of time and money collecting data before they start to do their SEA. The risk is that data is collected that is not necessary or that data needed for certain issues is neglected. It is also more difficult to identify data gaps if issues are not identified first. In order to help SEA practitioners shy away from collecting too much data in SEA (and remaining 'strategic' in its true sense), Partidário (2007-this issue) argued that the terminology of 'baseline data' was not very useful and should be replaced by a new term (e.g. context).

The reality is that not all issues need be dealt at the same time or with the same level of detail. Therefore, data collection could probably be incremental and spread through the SEA process (linked for example to some form of adaptive environmental management — see Morrison-Saunders et al., 2004). It is also crucial that SEA keeps up with the timing and the needs of the decision-making process. This might be incompatible with large and time-consuming data collections. Perhaps a 'just in time' SEA is needed that can work more effectively within political arenas.

Data (and scale choice) are of course not politically neutral, with different stakeholders and different sectors having preferences for different scales (see Karstens et al., 2007-this issue). This links up to the concept of political ecologies of scale – how different hierarchical levels of *vested* interests (e.g. local, regional, national, global) determine the management of key resources – see Natter and Zierhofer (2002). Scale choice affects the problem addressed, the options found, and the impacts evaluated. The study of scale effects in SEA – how scale choice might change the identification of the type and importance of SEA issues, and how it might affect the results of SEA and, ultimately, the outcomes of the decision-making process – is critical. It is therefore always necessary to clearly specify what scale and what data are used and why. Fundamentally, what is needed in the future, is a careful, transparent and accountable choice of scale.

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