Measuring sustainable development in the European Union:

Developing indicators for environmental, social and economic sustainability

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Abstract

The European Commission (the executive agency of the European Union) seeks to improve its understanding of the impact of policies on sustainability. Therefore, it is sponsoring a large interdisciplinary research project called SENSOR, aimed at designing tools for the *ex-ante* evaluation of policies related to multifunctional land use. In other words, the project develops methods to predict the impact of such projects on sustainability – seen under its social, economic and environmental aspects.

A central concern in the project is the identification (and modelling) of suitable indicators for sustainability. To do this, we need a proper understanding of what sustainability means, and how it is related to policy evaluation. The next step is to establish criteria for suitable indicators. We propose five: they must represent politically relevant aspects of sustainability; they must be scientifically sound in that they are valid measures of those aspects; they must be practicable in that they can actually be modelled; they must be relevant to the policies being evaluated in that they are likely to be influenced by those policies; and there must be as few of them as possible.

This paper discusses how these questions were addressed in the SENSOR project. In particular, there was a difficulty in reconciling the concerns of political relevance with those of conceptual rigour and clarity. A basic problem in interdisciplinary research is how to develop a conceptual approach that is acceptable to all and also has sufficient depth to deserve the name scientific.

Keywords

Cost-benefit analysis, externalities, impact assessment, indicators, sustainability.

The rationale for impact assessment

Impact assessment (or ex-ante policy evaluation) is concerned with determining in advance whether a proposed policy will be an effective cure for the problem it is designed to solve, and whether or not it will have undesirable side-effects which may be worse than the problem. The market for this is good. There are many scientific researchers around, and progress in science generally is substantial. Policy-makers, themselves usually university graduates, are aware of this, even if their understanding of the powers of research is not necessarily realistic. Legislatures look more favourably on policy proposals backed by scientific reports. We scientists are keen to prove our usefulness, the more so since it helps to fund us.

Still, it is good to be aware of our limitations. If it were really possible to adequately predict the impact of policies, Iraq would not be where it is today. The goal of science is not to predict the future, but to understand the present. We are all aware of this, of course, and this is why modellers work with different scenarios without saying too much about how likely these are to

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come true. We deny that we are in the business of forecasts and instead we call our results projections. Yet, any practical usefulness of these projections can only lie in the likelihood of them coming to pass. Perhaps one thing we could do as scientists is to help clarify the issues. This paper identifies some issues where greater clarity is needed. As an example we use the experience gained in the SENSOR project. This is an ambitious attempt to design a comprehensive system of impact assessment for EU policies, built around the concepts of sustainability and multifunctional land use (http://www.sensor-ip.org). The intended result is a software machine which will be easy to use and quick to generate outcomes of policies on a range of topics related to sustainability.

In this it is part of a trend to develop standards of impact assessment for public policy, a trend which is evident in many parts of the world. The United States are highly advanced in this respect. Regulatory requirements to conduct cost-benefit analyses prior to public projects go back as far as 1902 (Prest & Turvey 1965:683). The River and Harbor Act of that year was concerned with commercial benefits and with direct costs incurred by the public. By the 1930s, this was expanded to consider external costs and benefits, i.e. the effects of a project on third parties (*ibid.*:684); this is known as social cost-benefit analysis. In more recent decades, attention has become focused on environmental effects. A landmark in this respect was Executive Order 12291 of 1981, which requires federal agencies to conduct an impact analysis of proposed major regulations (Bos 2003:28-31, EPA 2003).

In the European Union the situation is somewhat different. The EC Treaty enjoins to carry out cost-benefit analyses on environmental regulations (article 174 sub 3, European Commission 2002:76). However, the Commission has shown a marked preference for impact assessment, which it has set out to implement as a concomitant for all major initiatives from 2003 onwards (European Commission 2002). This is not to say that cost-benefit analysis is not applied. Commercial CBA is usually done for large infrastructural projects, and the Commission also is interested in social cost-benefit analysis, as one of the commissioners clearly stated (Verheugen 2005).

Impact assessment means something more generic than cost-benefit analysis: in the former, you identify all relevant issues and quantify them. For instance, you state by how much a certain policy will reduce pollution. If the policy also leads to lower economic growth, you will say so too. What you do not do, as opposed to cost-benefit analysis, is to *value* the environmental gain in money terms. Thus, cost-benefit analysis is a type of impact assessment, but impact assessment is not necessarily cost-benefit analysis. However, we shall treat them here for simplicity's sake as two different approaches.

Both approaches have their advantages. A strong point of social cost-benefit analysis is that it can state the problem of whether or not to implement a policy in terms of a yes/no decision. This makes the policy process very transparent, since policy-makers are obliged to make their value judgments explicit in terms of the weights they attach to various quantities. They inevitably attach such weights, since a decision as to whether or not to implement a policy will eventually be made. Impact assessment allows a policy-maker to consider all the pros and cons of a policy and make a decision which is supposedly based on a scientific report, but without revealing his ultimate motivations. This leaves him much freedom to make his own decision. Cost-benefit analysis, on the other hand, may show him up as a hypocrite: he may proclaim the virtues of a clean environment, but actually attach a low weight to it.

On the other hand, the weights themselves can be difficult to establish. Moreover, as the original statement from the European Commission on impact assessment says, some changes may be irreversible, and this does not show up in a cost-benefit analysis where it can be overridden by some other positive impact. We shall return to this problem in the discussion on sustainability below.

The concept of sustainability

It is fashionable to talk about sustainability, although as a concern it is not very new. Undoubtedly our hunting-and-gathering ancestors worried about the depletion of natural resources as much as we do, although not always about the same resources. The 18th-century economist Malthus famously compared the different rates of growth of population and potential food production. Several 19th-century economists were similarly pessimistic about economic growth having to decline eventually because of the scarcity of natural resources. We might say that today it is not only the marketed natural resources (such as ores and fossil fuels) that we worry about, but non-market resources such as the atmosphere and biodiversity (Pezzey & Toman 2004:126).

Sustainability became a concept in policy discourse with the Brundtland Report (WCED 1987). This introduced the idea of sustainable development, defined as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'. Thus, sustainability was meant to be intergenerational; and sustainable development incorporates both environmental responsibility and the need for progress in social goals (prosperity, emancipation, equity). There is obviously a tension between these two and policy-makers would like to reconcile them into some sort of win-win solution. This desire is at the heart of the concept as it developed over the last twenty years.

In the years that followed, the idea has been picked up also by business, as a way to implement corporate social responsibility: companies could contribute to sustainability by judging their performance not only on the bottom line (i.e. profits), but also on other socially desirable criteria. This was operationalized in the 'triple bottom line': social, environmental and economic sustainability (Elkington 1994) – or People, Planet and Profit as they are commonly called. Basically, social sustainability means that you employ minorities and generally treat workers well, and perhaps contribute to charity; economic stands for the old bottom line: no company can be sustainable if it does not earn any money; and the environmental aspects refers to such actions as controlling pollution, saving energy, and maintaining attractive premises.

The European Commission has also adopted this classification of impacts in its Impact Assessment Guidelines (EC 2005:27-32), although it does not explain what the terms are supposed to mean.[2] Indeed, perusing the checklists of possible economic, social and environmental impacts in this document reveals many overlaps and even duplications. In particular, economic and social impacts are difficult to distinguish. For instance, is employment a social or an economic concern? And, as an economist would ask, what are economic concerns anyway? We believe that our discipline is not concerned with how to make the most money, but with problems of choice in a situation of scarcity, and sustainability speaks to precisely such problems.

It is unfortunate that a concept from the world of business administration has been adopted uncritically for application in the quite different world of policy evaluation. It makes the task of identifying suitable indicators that much more difficult. For instance, if public health is a social

[2] And, by the way, it does not use the term sustainability.

issue and air pollution an environmental one, should we develop indicators both for the incidence of diseases caused by fine dust and for the density of fine dust in the air?

It would be preferable, instead, to return to the original two conflicting dimensions recognized in the Brundtland Report: the environmental one of sustainability and the social one of welfare (or development as it is called there), i.e. direct human concerns such as poverty, justice and security. Strictly speaking, sustainability ought to refer to the issue of intergenerational equity. Thus, environmental problems which are easily reversible but which affect health would be considered welfare rather than sustainability issues. Those which threaten our survival in the long term (or the survival of other species, or the happiness of future generations) should be considered matters of sustainability. This also avoids the use of sustainability as a synonym for general goodness, which diminishes conceptual clarity. Impact assessment should measure the effect of a policy on welfare, which tells us whether it will improve our lives; we shall also want to know whether or not this will be at the expense of future potential welfare – sustainability.

There is, by the way, a major theoretical difficulty in deciding when an action is sustainable or unsustainable. This is the problem of knowing the needs of future generations (cf. Taylor 1998). Our Paleolithic ancestors would have wanted to ensure the supply of mammoths for their descendants, whereas people in the Middle Ages would have thought that a minimum of five acres of fertile land was the minimum to ensure our survival. As recently as the 19th century, the supply of whale oil was considered essential for lighting the world. Although this difficulty cannot be solved, we need to keep it in mind as a limitation on our knowledge, especially when we try to think more than one generation ahead.

We must now return to the problem addressed in the previous section, namely whether sustainability (and welfare for that matter) can theoretically be reduced to a single yardstick, which will tell us immediately whether one policy is to be preferred over another. This boils down to the question of whether one resource can be subtituted for another. It can be argued that this is always the case in welfare matters (people will be willing to sacrifice the beauty of a landscape if they can have a higher income, and the reverse is true as well), but not in sustainability, because irreversible changes may occur. This has led to a distinction between 'weak' and 'strong' sustainability (Pearce & Atkinson 1992): weak sustainability applies when substitution is possible, strong sustainability when it is not. The former is aimed at maintaing the total stock of natural and human capital, whereas the latter identifies stocks of capital that should be maintained at all cost; the latter may include natural resources (marketed and non-marketed), but also forms of human capital such as art and knowledge, or mixes of natural and human capital such as landscapes or ways of life.

It will be clear that deciding what ty should be considered as belonging to strong or weak sustainability is in the end a matter of political choice, although it is also a topic of sometimes bitter debate among scientists. Furthermore, there is a continuum between them rather than a sharp distinction. What is important to our discussion is that social cost-benefit analysis can be applied only to weak sustainability. Strong sustainability is the proper domain of impact assessment. The two can, however, be used in combination: strong sustainability (monitored by impact assessment) can be used to set thresholds below which the impact of a policy should remain. Within the space thus created[3], substitution among objectives is possible and weak sustainability applies. That would be the proper domain for cost-benefit analysis. In order to do so, one still needs first to quantify the indicators. And with that we return to the problem of what the indicators should be.

[3] This is based on the idea of 'sustainability choice space' (Potschin & Haines-Young, 2006).

A framework for causality: the DPSIR approach

Impact assessment may be seen as studying a process in which the policy under consideration acts as a driver and the indicator measures the outcome. Inside this process we have a set of causal relationships connecting the drivers with the indicators. In SENSOR this set is conceptualized following the DPSIR framework, which has become popular in policy-oriented environmental research in recent years (EEA 1999:9, UNEP 2002). It stands for driver-pressure-state-impact-response: a driving force such as economic growth (D) exerts a pressure on the environment in the form of, for instance, waste water (P); this will affect the state of the environment as measured in water quality (S), which may lead to a decrease in the number of fish (I). This can be considered deplorable and lead to some sort of remedial action (R). obviously, this is just one way of looking at an environmental process, and the five elements could be expanded indefinitely.

The question for us is: which of these elements is to be represented by indicators? It is important to ask this question, because elements at different causal levels may lead to double counting. For instance, polluted water may cause mortality among fish, which can concern us because of reduced biodiversity but also because of lower catches by fishermen. Furthermore, it may cause health problems for humans as well as reduce our enjoyment of a beautiful scenery. Finally, we may decide to take certain measures to clean the water, which will cost money. If we use all of these elements as indicators, we shall overstate the problem.

Since we are here concerned with something called impact assessment, it may be most appropriate to identify indicators from impact elements. Thus, we shall not use water quality as an indicator, but its effects on other worthy things. In practice, we may not always be able to measure the impact, and it such cases we may have to opt for measuring elements of state or pressure; but we should at least be aware of doing so and prefer indicators related to impact whenever possible.

Criteria for identifying indicators

Having established what it is that we are trying to measure, and where in the cause-and-effect framework we should measure it, we must now ask whether there are any suitability criteria that we can apply to a set of indicators. We propose five:

1. They must represent politically relevant aspects of sustainability; we are dealing with applied research, so it is important that the client or stakeholders participate in the selection of indicators.
2. They must be scientifically sound in that they are valid measures of sustainability. often, the particular aspect the stakeholder is interested in (say, biodiversity) cannot be measured directly or comprehensively; the onus is then on the researcher to find a variable that can be considered a reasonable indicator for that aspect.
3. They must be practicable in that they can actually be modelled; ideally, indicators should be identified first, after which models are sought or created that can forecast those indicators.
4. They must be relevant to the policies being evaluated in that they are likely to be influenced by those policies. For instance, one may have established that biodiversity is important to the stakeholders, one may have found a variable that can be modelled and

that is a good indicator for it; but if the policy being evaluated has no effect on it, it cannot be a useful indicator.

5. Finally, there must be as few indicators as possible. The more indicators there are, the more opaque the process of impact assessment will become. As argued before, the ideal would be to have a single indicator (net benefit), but this is possible only under conditions of weak sustainability.

Identifying the indicators in SENSOR

Since SENSOR is intended as a tool for policy-makers, a policy document was chosen as the basis for identifying indicators: the aforementioned Impact Assessment Guidelines of the European Commission (Kristensen *et al.* 2006:21). This seemed to be a logical choice at the time. However, once indicators were being identified (which was done by a different team from the group defining the framework for identifying them) the weaknesses of this approach as described above soon became apparent.

Meanwhile, a third group was working on how to assess sustainability in a *regional* context. This group, which was supposed to adopt the indicators identified, measured and modelled by the second team, took the central concept of multifunctional land use as its point of departure. A natural way to use that concept would be to identify multiple functions of land use as a basis for the analysis, and this is indeed what they did (Jones *et al.* 2006:30-31). From the list drawn up by the second group, indicators were selected on the basis of their relevance to these land use functions. Thus, indicators were identified on the basis of a policy document, and then shortlisted from a theoretical point of view. In hindsight, it might have been more advantageous to work the other way round: land use functions as the basis for defining indicators, and then checking back with the policy document whether all policy concerns are catered for; but then projects do not always proceed in a theoretically optimal way.

The result is that we have ended up with a long list of indicators drawn from the Guidelines, some of which will be used to assess land use functions, and some will be used for a type of cost-benefit analysis which is also part of the project[4]. Some indeed will be used for both. There are also some which were identified but cannot be implemented, and yet others that can but will stand alone in the final product as they are not incorporated. This paper will not discuss or even list all of those indicators, which would unduly bore the reader. Instead, we set out to list those which, in our view, are the most useful ones. We shall group them in the two main categories we have identified above: sustainability and welfare. The indicators are intended for measurement and forecasting at regional level, where possible.

Sustainability indicators

1. Air quality: ammonia deposition, important because it influences the viability of forests.
2. Water quality: nitrogen and phosphorus surpluses, which affect aquatic life through eutrophication.
3. Water abstraction: affected by land use change, important for the quantity of water available to human activities and ecosystems.

[4] In SENSOR, this is called an externality accounting framework. It is not strictly speaking a cost-benefit analysis as such, but an attempt to value the external effects of policies inasfar as they give rise to actual flows of money (Ortiz *et al.* 2007).

4. Soil erosion: a major impact of land use.
5. Soil sealing: an effect of urbanization, irreversibly changing the water balance, structure and biodiversity of the soil.
6. Greenhouse gas emissions, not only of carbon dioxide, but also methane and N_2O.
7. Carbon sequestration & balance.
8. Consumption of fossil & renewable sources of energy.
9. Populations of farmland birds, as one indicator of biodiversity.
10. Area of high-nature-value farmland.
11. volume of deadwood in forests.
12. Consumption of pesticides in agriculture.
13. Volume of deadwood in forests.
14. Spatial cohesion: a measure that can express to what extent nature areas are of sufficient size and/or connected to each other.
15. Landscape diversity, measured as a function of land use.
16. Landscapes as cultural heritage.
17. Visual attractivity of landscapes.

It is beyond the scope of this paper (and the competence of its author) to discuss these indicators in any detail at all. They are described in detail in SENSOR Deliverable 2.3.2, which is presently being revised.

Welfare indicators

1. Gross domestic product (GDP) per head. This is the most natural indicator to use, since it is so readily available and familiar. Its defects as a measure of welfare are also well known. yet, for all its shortcomings, it is still the most consistent measure of the level of economic activity we have, and as such it may be considered one important factor influencing welfare. It is best measured in terms of purchasing power parities (PPP), in order to correct for differences in purchasing power between countries.
2. Unemployment rate. One of the drawbacks of GDP is that it does not tell us how income is distributed. Employment and unemployment data can correct this to some extent. Moreover, having a job often contributes directly to a person's wellbeing.[5]

The Impact Assessment Guidelines identify many more economic impact issues, such as competitiveness, consumer prices and administrative costs. All of these are also considered in SENSOR; however, the relevance of most of these issues is derived entirely from their contribution to GDP, which is already an indicator. In that sense, they are superfluous. However, an exception can be made for

3. Administrative costs on business, which is an important policy objective in the European Union (Verheugen, *op. cit.*). The impact of a policy on administrative costs is unlikely to be captured by our macroeconomic and sectoral models, so it deserves a separate indicator – albeit a qualitative one.
4. Exposure to toxic chemicals: this is a function of air and water pollution in combination with the numbers of people living in affected areas. As a measure of air quality, the quantity of nitrous oxides (NO_x) can be used. Water quality is derived from the N&P surplus indicators mentioned above.

[5] Another important distributional issue is the spread of income between regions within a country. This issue is captured by measuring income at regional level, so it is included in the GDP indicator.

5. Exposure to disasters: changes in land use can, for instance through their effect on erosion and on the consumption of water, increase the risk of mud-flows, drought, floods and forest fires.
6. Tourism pressure: mass tourism can affect the pleasure derived from visiting recreation areas, both by tourists and by residents. It can be expressed as the number of tourists per km² in a given area, or as the ratio between tourists and residents.

Application to land use

How relevant is all this to the topic of land use, or to put it differently, what is the relevance of land use to sustainability? In the SENSOR concept, driving forces will lead to changes in land use, and these will have an impact on sustainability. To take an example from my own country: European subsidies on maize have induced farmers to grow it on peat soils (Histosols) formerly used only for pasture – in other words, land use change. This necessitates lowering the water table through increased drainage, and that in turn causes the peat to oxidize and therewith to shrink. From there we can explore what impact this will have on different functions of the land: agricultural production, water balance, soil biodiversity, carbon balance, and the value of the land for recreational purposes.

There are also aspects of sustainability that are not modelled as an impact of land use change: economic growth, for instance. In SENSOR, we have asked ourselves whether these indicators are within the purview of a project dealing primarily with land use. We decided that they are, basically because our models can generate them. However, it is interesting to note the conclusions of another recent scenario-modelling exercise: the predicted impact of different possible European cohesion policies on income differentials by region was very small, but its impact on land use change highly significant (ESPON, 2006:529-543). This is all the more ironic since land use policy as such is outside the authority of the European Commission. Thus, it would appear that SENSOR deals with a topic which is highly germane to sustainability and on which European policies are likely to have a strong influence. In other words, the project is relevant - if it succeeds.

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