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Multicriteria development of synthetic indicators of the environmental profile of the Spanish regions

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ABSTRACT

Sustainable development is establishing itself as a goal pursued by the policies of many national, regional and local governments. However, progress in this regard is proving slower and more complex than expected, in part because of the difficulty in measuring sustainability. The objective of this paper is to provide a synthetic measurement of sustainability serving to analyse overall sustainability, in addition to sustainability in each separate aspect, allowing us to detect whether regions are failing in one particular dimension. To this end, the proposed scientific model is based on an aggregate focus with a dual reference point (reservation or acceptable value, and aspiration or desirable value). The method also incorporates the opinion of various experts by means of a system of preference aggregation. The result is a dual weak–strong sustainable development indicator. For each region we obtain a weak indicator, measuring aggregate sustainability, allowing for compensation across the different indicators, and a strong indicator, which measures the state of the worst of the weighted indicators, in other words not allowing for compensation. The method has been applied to each of the regions into which Spain is divided, using the official data published by the Spanish Ministry of the Environment [Ministerio de Medio Ambiente]. The indicators obtained are particularly useful because they serve not only to measure the relative sustainability of each region, but also provide a warning system to forestall problems and assist in strategic decision-making.

1. Introduction

Ever since it was first formulated in 1987 by the Brundtland Report, the concept of sustainable development, has provided the basic framework and objective pursued by the political approach adopted by many national, regional and local governments. However, progress in this regard is proving slower and more complex than expected, among other reasons because of the complexity involved in measuring and evaluating the current sustainability of a territory on different supra-national, national, regional and local scales, and in finding "models, metrics and tools for articulating the extent to which, and the ways in which, current activities are unsustainable" (Bebbington et al., 2007).

A number of methodologies have been developed, leading to progress in the application of sustainability standards and indicators (OECD, 2002), but there is no single system or synthetic indicator accepted by the entire community. The origins of sustainability indicators date back to the first third of the 20th century, when the Chicago School performed its initial studies within the context of Urban Ecology (Castro, 2004). It was seen in the 1970s that the traditional economic development indicators (GDP, GNP...) were inadequate, leading to the emergence of other synthetic indicators such as the Human Development Index (HDI), the Environmental Performance Index (EPI), and the Genuine Progress Index (GPI). Sustainability indicators are now recognised as a useful tool assisting in public communication and the creation and tracking of sustainability policies. The integration of natural, social and economic systems, adopting short- and long-term views, can help establish which actions should or should not be taken, in an attempt to achieve sustainable development.

Other sustainability indexes of great importance are: the so-called "Ecological Footprint" (EF) (Rees, 1992), whose purpose is to calculate the necessary land area to produce and maintain the goods and services consumed by a particular community, building a matrix of "consumption/use of the land", and the environmental sustainability index (ESI) (Samuel-Johnson and Esty, 2000). As a matter of fact, the scientific literature considers these two indices (the EF and ESI) as those of bigger impact in the evaluation of the sustainability of countries (see Siche et al., 2008 and references therein). It is also worth mentioning the emergy performance

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indices (EMPIs), known as renewability and emergy sustainability index (Brown and Ulgiati, 1997). These indices are compared in the work of Siche et al. (2008), analysing their methodology and applicability and identifying the strengths and weakness of each of them.

The literature contains various classifications regarding tools for evaluating sustainability. Ness et al. (2007) developed a holistic framework in three areas:

(1) Simple indicators and compound indices: Eurostat Environmental Pressure Indicators, Regional Flow Indicators such as physical metabolism of society, and Material Flow Analyses (MFA); and "integrated indicators" within one single index, such as the Index of Sustainable Economics Welfare (ISEW), the General Progress Indicator (GPI) or the Ecological Footprint.
(2) Product-related assessment focuses on flows in connection with production and consumption of goods and services, impacting on the flows of products and services throughout the life cycle. Known examples include Life Cycle Assessment (LCA), Life Cycle Costing (LCC), Material Input per unit of Service (MIPS).
(3) Integrated assessment is a set of tools to measure complex issues such as Multi-Criteria Analysis, Risk Analysis, Vulnerability Analysis and Cost Benefit. These tools are not always used to assess sustainability, but they are used to support political decisions or specific projects.

Another classification of sustainability indicators creates typologies based on two focuses (OECD, 2000; Guijt and Moissev, 2001): the accounting or accountability focus, and the analytical or evaluation focus. The *accounting focus* aims to resolve the inadequacies of the traditional national accounting model, which focuses on macroeconomic aspects, and accounting indicators have been developed in this field to incorporate environmental satellite accounts, such as the UN's System of Integrated Environmental and Economic Accounting (SEEA) the NAMEA (National Accounting Matrix Including Environmental Accounts) developed in the Netherlands, "green GDP", the Index of Sustainable Economic Welfare (ISEW), the General Progress Indicator (GPI), or the Genuine Savings Indicator. This focus also includes those indicators – the variables of which are expressed in some form of physical unit – such as the Natural Resource Accounts (NRA), Material and Energy Flow Accounts (MEFA), Society's Metabolism, the Ecological Footprint, the Ecological Rucksack and others. The importance of this focus is the possibility of integrating the economic, social and environmental dimensions and linking them to physical and monetary data (OECD, 2000), although there are limitations in the difficulties involved in accounting for certain natural assets and integrating human and social capital within the accounting system.

The *analytical focus* creates a system of indicators in which each indicator is associated with a dimension of sustainability (Castro, 2004), allowing for an integrated and multi-dimensional evaluation of sustainability. Sharpe (2004) distinguishes between two types: (1) *non-aggregate indicators*, a system of indicators used to perform diagnoses and identify interrelationships among the components, as in the case of the PSR (Pressure-State-Response) model and derivative versions such as the DPSIR (driving forces-pressure-state-impact-response) model; models organised by themes and sub-themes, as in the case of the United Nations Commission on Sustainable Development, EUROSTAT (2007) and the system of indicators used in New Zealand, Sweden, the United Kingdom and the Netherlands (Quiroga, 2007). (2) *Aggregate indicators*, which comprise a synthetic measurement reflecting the overall state, without the need to analyse the indicators separately. This latter type of indicator is of particular interest in performing comparisons between different units of analysis and in measuring progress or evolution towards sustainability.

The key characteristic of a synthetic indicator is its ability to focus and synthesise a considerable volume of data and to make significant information about the object under analysis more manageable. Meanwhile, sustainability indicators "simplify, quantify, analyse and communicate otherwise complex and complicated information" (Singh et al., 2009). The usefulness of the indicators will depend on the possibility of evaluating the current conditions and establishing trends; flagging up alerts to forestall problems in the space analysed, whether environmental, social and/or economic; assisting in the development of strategic decision-making; and providing a simple way to communicate the situation of a territory. These qualities will depend on the type of information gathered, specifically its scientific validity, the reliability of the data, representativity, relevance, sensitivity to change, comprehensibility, whether an ideal situation is compared with the current status, whether they are comparable and offer consistent geographical coverage, and are cost-effective.

The methodologies set out above have advanced our knowledge of sustainability, but do not address different focuses on sustainability. Economic approaches include "resource accounting based on their functions, sustainable growth modelling, and defining weak and strong sustainability conditions" (Singh et al., 2009). The literature distinguishes between weaker sustainability, in which environmental capital may be replaced by other forms of capital because natural resources have a market value (neoclassical economics); and strong sustainability, in which natural capital must not be diminished, as environmental capital cannot be replaced with any other form of capital (ecological economics) (Hunter, 1997; Singh et al., 2009).

One of the fundamental sustainability criteria is involvement by society. Ludin (Singh et al., 2009, p. 192) proposes two focuses to define and develop sustainable development indicators: (1) The 'top-down' approach, in which the opinion of experts and researchers devises the framework and the selection process, rooted in scientific positivism. (2) And the 'bottom-up' approach, which involves the various stakeholders in devising the method and is based on the participatory philosophy generally accepted among post-positivist studies. However, as mentioned by a number of authors (Castro, 2004; Ayres et al., 2010), in order for the indicators to have a real value there must be a scientific model to make the concept of sustainable development operable, to clarify what is to be measured and to define the class of indicators to be used.

The literature covers various focuses in measuring sustainability by means of synthetic indicators. Such focuses allow for the evaluation of multiple aspects in one simple, comparable index. It is frequently stated that compound indicators are too subjective, because of the possible mechanisms to include or exclude the indicators used in the index, possible standardisation schemas, the choice of weights and aggregation systems, etc. In our opinion, however, nowadays it is impossible to obtain a completely objective sustainability measurement (although there might be one in the future). There is no universally accepted perception of what is sustainable and what is not. The quest for a presumed objectivity should not therefore be the goal, but rather the clear definition of the subjective elements of the study, providing each potential evaluator with a clear understanding of where they are positioned, what their impact is on the solutions obtained and, in certain cases, allowing for adaptation in line with personal preferences.

There exists a series of aspects which must be taken into consideration when choosing the indicators to be included in the study, such as the relevance of the indicator for the regions studied, the possibility of measuring the trend over time, the relationship between the indicators, in other words ensuring that they do not perform the same measurement, the availability of data,