



Selection of sustainability indicators for planning: combining stakeholders' participation and data reduction techniques



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ABSTRACT

The role of spatial planning for sustainable development has been widely acknowledged in academia and in policy. Monitoring spatial plans increases knowledge of whether they achieved their goals in guaranteeing sustainable development on a territorial level. Indicators are suited for this task and could play an important role in determining the applicability or effectiveness of plans. The contribution of indicator sets for effective strategic sustainability monitoring needs to be supported by an analysis of consistency and meaning at each stage of indicator development, from design to implementation. Indicator selection is usually done by experts and/or through participatory approaches and often little is known about the robustness of the selection stage, its utility, accuracy, validity, feasibility and redundancy. The main goal of this research is to identify, through a participatory approach and data reduction techniques, a set of sustainability indicators for strategic monitoring of regional spatial plans. Decision makers and planning practitioners from regional and local authorities, as well as academics, were asked to assess through a scoring procedure the importance of a base set of sustainability indicators to monitor the effects of a spatial plan. Principal Components Analysis, followed by sensitivity analysis with Monte Carlo simulation were used in the data reduction phase. This approach was tested on a set of outcomes/effects indicators developed for the Algarve's regional spatial plan (southern Portugal). It was possible to highlight the importance of involving different groups of stakeholders and to identify relevant indicator selection criteria, as well as a final set of indicators that are more representative of different stakeholders' opinions and more able to translate, in an integrated way, overall changes in sustainability performance. Factors that can influence the results of the approach are discussed, such as stakeholder representativeness and data availability. Recommendations regarding the use of the approach and its results are also presented, for example concerning the use of information conveyed by indicators in an aggregated way, in the form of an index. The approach could be useful to guide the collection of regional sustainability data, contributing to the reporting and assessment of spatial plans, tailored to each particular territorial reality and stakeholders' perceptions, values, needs and concerns.

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1. Introduction

The delivery of sustainable development has been politically identified as the key role of spatial planning (Brackhahn and Kärkkäinen, 2001; Carmona, 2003; Wong et al., 2006). The need to develop plans that assist communities in moving towards sustainability is prevalent in contemporary planning debate, research

and practice (Gillen and Scanlan, 2004). In its turn, monitoring has been widely identified as beneficial to improve planning practice, as stressed by Keiner (2006) and Hoernig and Seasons (2004), among others. In Europe for example, the development of a knowledge base to make available comparable data and indicators is one of the three spheres of action that should be addressed by spatial planning, according to the European Spatial Development Perspective (EC, 1999). Planners and other stakeholders now need to identify and analyse the linkage between plans, implementation efforts and the sustainability of outcomes (Berke and Conroy, 2000; Gillen and Scanlan, 2004). However, as Wong et al. (2006) stress,

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previous experience suggests that monitoring planning policy is not an easy task to accommodate, as there are some inherent difficulties involved, both conceptually and methodologically. The conceptual complexity is higher when dealing with sustainability, since the concept of sustainability means many things to different people, and this diversity of meaning tends to increase (Bolis et al., 2014).

Although planning practices and outcomes can be monitored and evaluated in many different ways (Hoernig and Seasons, 2004), indicators are generally pointed out as suitable for such tasks, as well as for aiding the delivery of the sustainable agenda through planning (Bockstaller and Girardin, 2003; Dalal-Clayton and Krihaar, 2007; Donnelly et al., 2007). For example, Keiner (2006) asserts that indicator based controlling of spatial development could allow planning authorities more flexibility in achieving sustainability targets. Mickwitz and Melanen (2009) report the important contribution a project on sustainability indicators had in giving a prominent role to eco-efficiency in a regional planning strategy in Finland. Employment of sustainability indicators in planning is relatively recent, though the need for sustainability indicators at both the regional and local level in monitoring planning achievements has already been recognised by several authors (Gillen and Scanlan, 2004; Mascarenhas et al., 2010; Moreno Pires and Fidélis, 2015). The role of sustainability indicators in monitoring of plans makes sense in view of the shift from monitoring planning inputs and processes to planning outcomes, or territorial effects. Sustainability indicators have the potential to be a useful planning tool in terms of both providing a suitable basis for informing planning action and in determining the sustainability of planning outcomes (Scanlan and Gillen, 2004). When integrated into planning and decision-making, sustainability indicators also play an essential role in fostering learning (Palme and Tillman, 2008).

Monitoring systems are most effective when indicators are linked to objectives (Keiner, 2006), when they meet essential decision support needs of planning for sustainable development (Briassoulis, 2001), when the needs of decision-makers propel the collection and interpretation of indicators (Hoernig and Seasons, 2004) and when indicators cover issues identified as important both from a scientific point of view and based on stakeholder concerns (Falck and Spangenberg, 2014). For Hoernig and Seasons (2004), indicators become an influential policy tool when their results are used and integrated into regular decision-making processes by a variety of users.

However, some drawbacks have been reported in literature, namely related to the selection and development of indicators, or the integration, interpretation and reporting of information (see for example Gillen and Scanlan, 2004; van Zeijl-Rozema and Martens, 2010), whether in the context of plan monitoring or sustainable development assessment, therefore stressing the need for indicator performance evaluation initiatives (Ramos and Caeiro, 2010; Lozano, 2013). Indicator selection is usually made by experts and/or through participatory approaches, in combination with literature reviews of existing indicator sets, and often little is known about the robustness of the selection stage, its utility, accuracy, validity and feasibility (Bockstaller and Girardin, 2003; Cloquell-Ballester et al., 2006; van Zeijl-Rozema and Martens, 2010). The selection stage is important, for example in influencing the feeling of ownership and commitment towards an indicator system, which impacts on the ability of the indicator system to be institutionalised and therefore used and maintained (Moreno Pires and Fidélis, 2015). Indicators that do not resonate with stakeholders will not be considered useful and consequently not be used by them.

Therefore, indicator development processes are best conducted as transdisciplinary processes (Falck and Spangenberg, 2014).

The needs, values and aspirations of decision-makers and planners can be addressed by a participative selection of indicators and keeping the number of indicators to the minimum necessary. Many mutually isolated indicators overwhelm and even confuse their intended users, especially decision-makers and general public (Yu et al., 1998). Indicator sets must balance the needs for reducing complexity, being easily understandable, resonating with a clearly defined target audience, and being limited in number (Falck and Spangenberg, 2014). One way of reducing the number of indicators is through data reduction techniques. Principal Components Analysis (PCA) is a popular method among multivariate techniques to obtain a smaller number of indicators from an original larger set. It reveals how different variables change in relation to each other and how they are associated (Mainali et al., 2014). PCA has been used to select environmental (Yu et al., 1998), eco-efficiency (Jollands et al., 2004), energy intensity (Bernard and Côté, 2005) and agro-environmental indicators (Soler-Rovira and Soler-Rovira, 2008), among other initiatives. PCA is also employed to build composite indices (Singh et al., 2009), as it can be used to reduce the number of variables that will integrate an index. In this context, recent studies (Mayer, 2008; Nardo et al., 2008) stress the need to establish robust methods for: (i) selecting indicators, while avoiding redundancy and multiple accounting of effects; (ii) choosing the weighting and aggregation methods; (iii) conducting sensitivity and uncertainty analysis for detecting the most relevant variables and the causes for the measured variance. However, in most cases PCA is done using indicators' data. This article explores an alternative application of PCA, using stakeholders' opinions on sustainability indicators.

In a previous paper (Mascarenhas et al., 2012) a framework for monitoring regional spatial plans (RSP) was proposed, comprising outputs/results and outcomes/effects indicators. In the present research, a particular aspect of that framework is explored, namely the contribution of existing sustainable development indicator systems to act as RSP outcomes/effects indicators. The main goal is to identify, through a participatory approach and data reduction techniques, a set of sustainability indicators for strategic monitoring of regional spatial plans. Data reduction was performed through PCA and sensitivity analysis with Monte Carlo simulation (MCS). This approach was applied to a set of outcomes/effects indicators developed for the Algarve's RSP (southern Portugal).

2. Methods

In this exploratory research a mixed methods approach is used. Mixed methods research combines elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration (Johnson et al., 2007). The next sections introduce the Algarve region and its spatial plan as case study, as well as the processes of indicator scoring by stakeholders and indicator selection using data reduction techniques.

2.1. The case of the regional spatial plan of Algarve

To better understand the planning context in the Algarve, first a general description of the region is presented, followed by a more focused description of the regional spatial plan. Considering the exercise conducted in this research, the sustainability indicator set that is in place in the region is also briefly presented.

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