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The combined use of Spatial Multicriteria Evaluation and stakeholders analysis for supporting the ecological planning of a river basin

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ABSTRACT

River basin planning and management constitute complex decision problems, characterized by many actors and stakeholders with conflicting objectives and values, ranging from the protection of local flora and fauna and the enhancement of the recreational value of the river, to the preservation of the water resources for industrial purposes and human activities. In the light of the aforementioned complexity, specific evaluation methods are needed for supporting decision-making processes in this context. The present paper proposes an evaluation approach based on the combined use of two different evaluation techniques, the Spatial Multicriteria Evaluation and the stakeholders analysis, for supporting the definition of policies and actions for a river basin. In particular, alternative predictive scenarios are generated through the Ordered Weighted Average method in order to explore different solutions. Starting from the Pellice river basin (Italy), the study presents the results of the integrated evaluation approach, focusing on the potentialities of the methodology for supporting the definition of future policies and plans for the area.

1. Introduction

The river basin planning and management is characterized by an unstable balance between conflicting aspects, which represent two faces of the same system. On the one hand, the fluvial ecosystem constitutes an ecological and recreational value to be conserved in order to protect the regional flora and fauna; on the other hand, the quantity and the quality of the water need to be maintained in order to ensure the use of the resource for human activities. These aspects lead to take in consideration simultaneously several interests, which involve different actors and stakeholders. In this context, a proper evaluation of the different objectives and values on the basis of transparent criteria is necessary (Reichert et al., 2015). Mention has also to be made to the fact that the issues related to public participation and transparency in decision processes concerning river basins and water resources are recognized as crucial by the European Union (EU) Water Framework Directive (2000/60/EC) where stakeholder analysis is recommended as a method to support river basin management.

Following this reasoning, it becomes of particular importance to evaluate different possible uses of the land in a river basin in order to find the most sustainable scenario to be implemented; this optimal scenario would allow to satisfy the demand for multiple land uses and to offer at the same time an optimal protection for natural resources (Geneletti and van Duren, 2008).

The present paper proposes an approach based on the combined use of Spatial Multicriteria Evaluation (SMCE, Malczewski, 1999) and stakeholders analysis to support the ecological and environmental planning for a river basin. In particular, the objective of the research is to provide a map of the river basin that can be used for identifying ecological conservation priorities and for supporting decision-making processes related to the nature protection of the river basin. The proposed model has been applied to the Pellice[1] river basin located in North-West Italy. In particular, the specific phases for the development of the model are:

-to identify the relevant stakeholders having an interest in the process;

-to structure the decision problem, defining evaluation criteria;

-to perform a Spatial Multicriteria Evaluation and to provide a final map;

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-to generate alternative predictive scenarios through the Ordered Weighted Average (OWA) method (Yager, 1988) and to explore different solution maps.

2. Overview of stakeholders analysis

Stakeholders analysis can be defined as a process to support decision-making and strategy formulation (Yang, 2014). It constitutes an approach for understanding a system by identifying the key actors, and assessing their respective interest in that system. Generally speaking, the theory is based on the identification and classification of the stakeholder groups, which can be defined as those that who can affect the realization of organizational goals or group of individuals affected by the realization of organizational goals.

The stakeholders can be classified according to the points of view adopted in their interventions and of the criteria upon which they base their decisions (Dente, 2014). Therefore, it is possible to divide stakeholders into five categories, namely political stakeholders, bureaucratic stakeholders, special interests, general interests and experts.

According to Dente (2014), political stakeholders have a role in the decision arena on consideration of the fact that they represent citizens and thus they have a significant consensus on the problem under discussion. Bureaucratic stakeholders are allowed to take part to the decision-making process because legal rules give them a specific responsibility in the decisional procedure and they have the formal competence to intervene. Other actors that can have a role in the process are the stakeholders representing special interests, meaning that the possible alternatives directly influence their interests and they can be affected both in a positive and in a negative way. General interests stakeholders represent subjects and/or interests that cannot defend themselves. The last category of actors refers to experts who play a crucial role in the decision procedure as they have the necessary knowledge to structure the collective problem and to find the most appropriate alternatives to solve it.

The identification and selection of the relevant actors, their representativeness and legitimacy strongly influences the extent to which the results of the evaluation are relevant to the governance process and, thus, to successfully contribute to conflict resolution.

Moreover, according to Dente (2014), in order to understand the dynamics of the actors with the decision-making process it is important to analyze the resources they have available. The resource that can be exchanged in a decision process are classified according to different categories. Political resources concern the amount of consensus that a stakeholder is able to get and it can refer to the whole population or to specific social groups involved in the project. Economic and financial resources consist of the ability to mobilize money or any form of wealth in order to influence the behavior of the subjects whose agreement is useful to make the decision possible and effective. Legal resources represent advantages or disadvantages attributed to particular subjects by legal regulations and competence principles. Cognitive resources concern specific knowledge, important information or conceptual models about the available alternatives in the decision problem and the associated costs and benefits.

Various practical methods have been proposed in the scientific literature for the stakeholders analysis, including focus groups, surveys, interviews (Starkl et al., 2009), power/interest matrix (Mendelow, 1981), Stakeholders Circle Methodology (Bourne and Walke, 2008) and decision network analysis (Dente, 2014).

Applications of stakeholder analysis can be found in several fields of study, including business management, international relations, policy development, participatory research, and increasingly more often natural resource management (Ramírez, 1999; Nash et al., 2006; Kontogianni et al., 2012). As an analytical tool, the stakeholders theory has been applied many times in the context of project management (Olander and Landin, 2005) while the works in the domain of environmental decision-making are less consolidated (Hostmann et al., 2005; Reichert et al., 2007; Marttunen and Hämäläinen, 2008Rosso et al., 2014).

3. SMCE and OWA approach

Multicriteria Evaluation (MCE, Roy and Bouyssou 1993; Figueira et al., 2005; Bouyssou et al., 2006) is a valuable and increasingly widely-used tool to aid decision-making where there is a choice to be made among competing options. It is particularly useful as a tool for sustainability assessment and territorial planning, where a complex and inter-connected range of environmental, social and economic issues must be taken into consideration and where objectives are often competing, making trade-offs unavoidable. In fact, MCE has been regarded as a suitable set of methods to perform sustainability evaluation as a result of its flexibility and the possibility of facilitating the dialogue between stakeholders, analysts and scientists (Cinelli et al., 2014). Many applications of MCE exist in the field of sustainability assessment and environmental decision-making (Munda, 2005; Huang et al., 2011; Reichert et al., 2015; Tervonen et al., 2015; Capolongo et al., 2014; Bottero et al., 2015a).

Spatial multicriteria evaluation (SMCE) couples MCE with GIS and it is a procedure to identify and compare solutions to a spatial problem; the method is based on the combination of multiple factors that can be represented by maps (Malczewski, 2006). It has been noticed that this methodology helps in dealing with weak and unstructured problems thereby supporting users in alternative scenarios exploration (Eastman, 2001; Kordi and Brandt, 2012; Malczewski, 1999; Thill, 1999).

The SMCE technique has the advantage of being able to store and manipulate complex spatial data structures, to conduct analyses within the domain of spatial analysis, and to provide spatially-explicit output (i.e. maps) and other reporting tools compared to a non-spatial DSS. This provides a robust framework for exploring resource management issues by highlighting potential limits to resource use and the consequences of different allocation schemes (Rutledge et al., 2008).

Over the last decades, coupling GIS and MCE to provide spatial decision support has stated to become a common strategy to deal with decision-making problems related to nature conservation (e.g., Cipollini et al., 2005; Geneletti, 2004; Marjokorpi and Otsamo, 2006), cultural heritage (Oppio et al., 2015) environmental and ecological planning (e.g., Bottero et al., 2013; Giordano and Riedel, 2008; Orsi and Geneletti, 2010; Vizzari, 2011; Ferretti and Pomarico, 2012) and forest management (e.g., Greene et al., 2010; Orsi et al., 2011; Wolfslehner and Vacik, 2008). The full range of Spatial Multicriteria Evaluation techniques and applications has been recently discussed in an interesting survey developed by Malczewski (2006); furthermore, Ferretti (2012) provided an uprgrade of the classification of the scientific international literature in this domain.

A very important phase of SMCE consists in the aggregation of the scores related to the different criterion maps in order to provide a unique map useful for the decision. Many methods are available to perform such aggregation (Malczewski, 2006). The application proposed in the present article makes use of a specific family of multicriteria aggregation operations: the Ordered Weighted Average (OWA) method. The OWA method was developed by Yager (1988) as a generalization of the Boolean overlay operations and the Weighted Linear Combination (WLC) method. In particular, the OWA operator can be defined as a technique for ranking criteria