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Transdisciplinary conceptual modeling of a social-ecological system—A case study application in Terceira Island, Azores

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ABSTRACT

Science and policy integration towards natural resource management is not novel; however it has not always been successful. Partially, this failure is explained by the lack of consideration of different forms of knowledge. In order to incorporate the diversity of knowledge, transdisciplinary has been proposed and, this paper tests conceptual modeling as a tool to promote it. Qualitative modeling is an intermediate step of Systems Approach Framework (SAF) that is a methodology towards the sustainability of social-ecological systems. SAF has been applied in Praia da Vitoria Bay, in the Azores to analyze the future use of wetlands. We promoted a workshop bringing together 18 stakeholders: scientists, managers, private sectors and Non-Governmental Organizations. This paper presents the procedures and discusses the observed interaction between participants, their views and, how the wetlands services were described. Results show that non-scientists found the exercise particularly challenging but with high value due to: the systemic view and, opportunity of sharing viewpoints. The wetlands were mostly described by the direct benefits. The results show that transdisciplinarity can be operationalized and that conceptual modeling is an adequate exercise to achieve it. However, interdisciplinary work and stakeholders' analysis are also necessary because the knowledge gathered is different.

1. Introduction

Science and policy integration within management of natural resources is proclaimed by several scientific fields as well as by regulation (e.g. Directives for Natura 2000: 92/43/EEC directive, Integrated Coastal Zone Management: EC, 1999). This integration is not novel however, previous formats based in a top down approach and in reductionist specialized knowledge have frequently failed in defining sustainable management actions (Berkes, 2003; Ludwig, 2001; Ostrom, 1990). This failure promoted the development of alternative formats based on systems view, knowledge integration and stakeholders' participation (Reed et al., 2009; Tomlinson et al., 2011). Systems Approach Framework (SAF) is one of the procedures recently proposed (Hopkins et al., 2011).

SAF is a step by step process (Fig. 1) towards the assessment of coastal zone systems using the principals of sustainability and systems thinking. Despite the fact that it has been focused solely in coastal systems, the approach can be applied in any social-ecological system. The first step of SAF is the identification of a policy issue (Fig. 1) that is analyzed in detail by an integrated simulation model that presents management alternatives to solve the issue (system formulation and appraisal, Fig. 1). In the end of SAF application, the tool is delivered to stakeholders so that it can be used in a deliberative process towards decision making (system output, Fig. 1).

Along the process there are several intermediate steps and conceptual modeling is one of them. This qualitative model is used in the construction of the simulation model. SAF has been tested in 18 case studies along Europe in a European project called SPICOSA (www.spicosa.eu). So far, the conceptual modeling exercise had been a process performed within the scientific team

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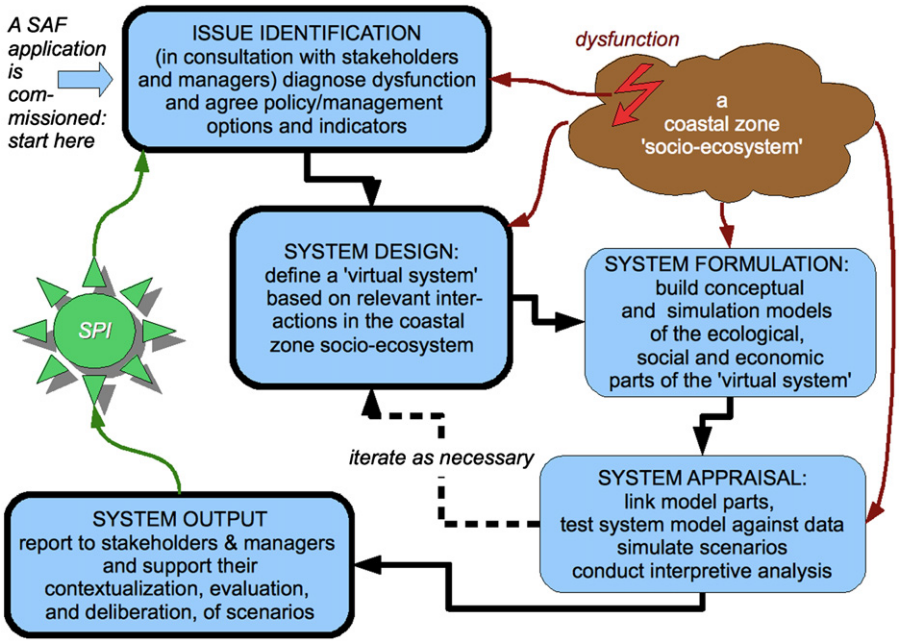

Fig. 1. The steps of SPICOSA's Systems Approach Framework or SAF (from Tett et al., 2011). The issue is a dysfunction in the social-ecological system (including its economy) involving human activity's impact on ecosystem goods and services. The symbol SPI stands for Science–Policy Interface.

(Hopkins et al., 2011) that, by interaction with stakeholders, understands better the system and improves conceptualization.

In 2009, SAF application started in Praia Vitória bay, in Terceira island part of Azores archipelago. In the first year we realized that a relevant issue was the degradation of wetlands (Guimarães et al., 2011), that are habitats that provide several goods and services. Nevertheless, their degradation is a global problem partially explained by the lack of understanding of this habitat value (Dimitrakopoulos et al., 2010; Johnson and Pflugh, 2008; Turner, 1992). In Praia da Vitória bay, the existing wetlands are highly susceptible of disappearing (e.g. conversation into housing, recreational park, industrial structures).

At the conceptual modeling step of SAF we decided to move away from previous applications and develop this task in a transdisciplinary setting (Cundill et al., 2005; Klein, 2004). For that, we promoted a conceptual modeling workshop where scientist, stakeholders and decision makers worked together towards the definition of this social-ecological system. Our hypothesis is that SAF will benefit if this task is developed in such a setting. Transdisciplinarity is proclaimed as the way to move forward in an increasing complex world, nevertheless so far no framework or procedure has been proposed (Cundill et al., 2005). We present the results of this empirical exercise and we discuss the benefits and drawbacks of such a transdisciplinary exercise. Explanations concerning the structure of the workshop can be of utility to other potential users; hence we also share what can improve the effectiveness of the exercise. We frame our findings within SAF but we consider them relevant to other approaches. Since we are dealing with the future use of areas today occupied by wetlands, the results also report how this ecosystem goods and services are perceived and described by non-specialists.

The next section provides further theoretical background behind the SAF. After this we present the case study (Section 2) and move into the procedure of the conceptual modeling exercise (Section 3). Results are presented (Section 4) and discussed in Section 5. We finalize by providing some final remarks about the proposed procedure (Section 6).

2. Theoretical outline of System Approach Framework

SAF was been developed taking into account the current best practices of science and policy integration toward nature resource management. Before going into the case study context this section provides a glimpse of the theoretical background of SAF however a proper review is not the scope of this article.

2.1. Science and policy integration

Simply documenting the changes in natural systems, or providing static indicators of environmental conditions, constitutes an insufficient role for science (Hopkins et al., 2011). There is a need to incorporate inputs of social and natural sciences into the science used in policy making (Tett et al., 2011). Furthermore, the traditional reductionist approach does not provide the appropriate scale and a systems view is required (Capra, 1997). Complexity, resilience and non-linearity are characteristic found to be of extreme relevance when trying to understand how natural resources should be managed (Folke, 2006). Finally, top-down approaches are not effective since they lack of agreement for proper application (Reed, 2008). Therefore, people that affect or are affected by a natural resource status (stakeholders) need to be included in the process of science and policy integration,

In SAF the interface between science and policy has been defined has a communication space, a forum in which governance, civil society and science interact. Within SAF, *Science* mobilizes knowledge to explain the dynamics of a selected system and to explore the potential consequences of alternative policy scenarios or management actions; *Stakeholders* deliberate on the basis of their interest and this knowledge; and *Governance* decides in the interest of society as a whole (Hopkins et al., 2011; Tett et al., 2011). In this context, governance is considered to be the steering and ruling of society and the ways in which citizens and groups articulate their interests, mediate their differences, and exercise their legal rights and obligations.