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Handling the 'environmental knowledge paradox' in estuarine and coastal policy making

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ABSTRACT

Knowledge is a key feature in our attempts to achieve sustainable development during environmental decision-making. Particularly complex decision making processes, where integrated economic, social and ecological issues need to be handled, suffer from what could be called the 'Environmental Knowledge Paradox' or EKP (having more and more detailed knowledge does not necessarily reduce uncertainty and settle competing truth-claims). We need to make significant changes in the decision-making process itself and the way we use scientific models to support these decisions. Starting from a simple linear decision-making model we explore potential improvements. Supported by recent progress in the environmental as well as the social sciences, we suggest four main procedural and technical adjustments. (1) To reduce the uncertainty in exploratory studies the 'contra expertise' approach should be explicitly applied. (2) The 'uncertainty' in impact assessments needs to be reduced by combining completely different approaches and model techniques. (3) The discussions during the decision-making process should be led by an independent not discipline-related professional facilitator. (4) Formal and informal actors need to be able to play an explicit and significant role during the decision-making process by contributing to a 'divergence' as well as a 'convergence' of ideas, options and solutions.

1. Introduction

Since the Brundtland statement in 1987 (Brundtland, 1987, 1997) 'sustainable development' has mostly in theory been a strong focus of environmental management. The statement developed from the recognition of all sorts of mismatches basically caused by the continuing wastefulness by a growing human population. As an example, overharvesting was more a general feature than an exception in fisheries and agriculture. In and via the agricultural sector, increased productions led to big problems. For instance, the combination of the exhaustion of natural fertilizers and the extremely high energy needs for the production of artificial phosphorous and nitrogen fertilizers. Concurrently with the increasing agricultural activities and their mechanization, the production of greenhouse gas emissions has increased. The Brundtland Committee challenged these types of practices in 1987 and argued in favour of new and sustainable solutions.

Despite the fact that sustainable development is 'key' as context, there are also problems related to it. We are, for example, not good at following the most suitable path during the decision making process in relation to the natural environment (de Jonge et al., 2003). We operate strongly with a top-down premise, and as such, public participation is underutilized (Bell et al., 2013). As a result, we are unable to collect all the available ideas or alternative viewpoints of how to minimize human impacts (Bell et al., 2013). Scientific knowledge is hardly explicitly used in the decision-making arena (e.g. Cvitanovic et al., (2014)). Particular types of quantitative models, including all the related restrictions when used, are presently ubiquitous in environmental impact explorations (Schuttelaars et al., 2013; this paper). These environment-oriented models ignore the myriad social and ecological complexities that also play a role in its condition. Despite all the EU Directives, it is technically still quite difficult to measure in a reproducible way the overall condition of entire ecosystems because most proxies do not well represent the structure and functioning of the entire ecosystem (de Jonge et al., 2012). The importance of the social and the ecological 'complexity' is underestimated (Holling, 1973; Gallopín et al., 2001). New scientific developments in the academic community are applied too slowly because the gap between disciplines, practitioners and decision-makers is too large (de Jonge, 2007). On top of the above we also

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encounter what we call in this paper the 'Environmental Knowledge Paradox' or EKP.

A number of the above-mentioned issues are so closely interwoven that we will handle them in this paper in the same manner. This approach will necessarily lead to a bit of a multifocal opinion paper in which we will suggest potential improvements in the decision making process and the use of selected technical tools.

The attempts to meet sustainable development, in our view a somewhat entrepreneurial- and engineering-based optimism (constructible society and environment), became partially overshadowed by the increasing recognition of the complexity that characterizes environmental problems. As Gallopín et al. (2001, page 6) wrote: *"It is becoming increasingly clear that the quest for sustainable development requires integrating economic, social, cultural, political, and ecological factors. It requires the constructive articulation of the top-down approaches to development with the bottom-up or grassroots initiatives. It requires the simultaneous consideration of the local and the global dimensions and the way they interact. And it requires broadening space and time horizons to accommodate the need for intra-generational as well as inter-generational equity. In other words, what is needed is nothing less than a fundamental shift in the way we approach development and the relations between society and nature."* These views or perceptions are certainly not completely new because as early as the 1970s debates arose regarding the many problems related to planning issues within a societal context (Rittel and Webber, 1973) and on complex ecological issues like the resilience and stability of ecological systems (Holling, 1973).

Since the dawn of the 21st century, progress has been made in the conceptual thinking and development of approaches incorporating socio-ecological complexities. Probably the most prominent approach is known under the name of the Social Ecological System approach (Ostrom, 1998; Berkes et al., 2003; Walker et al., 2004). But also other views, tools and techniques (de Jonge et al., 2003) have been developed to assist public managers operating under complex context conditions. Worldwide, Geographical Information Systems (GIS) are used for many applications to facilitate environmental management. Quite different, but only partly operational, environmental or biological indicators have been developed (Borja et al., 2000; Salas, 2002 as also cited in de Jonge et al., 2012; Simboura and Zenetos, 2002; Rosenberg et al., 2004; Dauvin and Ruellet, 2007), applied (Belfiore et al., 2003; Dale and Beyeler, 2001; Hellawell, 1986; Marques et al., 2009) and their value as proxy evaluated (Naeem et al., 2009; Patrício et al., 2009; Pinto et al., 2009; Salas et al., 2006; de Jonge et al., 2012). Parallel to these technical developments, mathematical models incorporating ecological as well as economic and cultural elements and processes were also conceptually assembled and discussed (e.g. de Jonge et al., 2012).

In the social sciences and management literature, new concepts, tools and working formats were developed. Gibbons et al. (1994) already identified a shift from a fundamental science approach towards a more context-driven, problem-focused and interdisciplinary science approach that had emerged by the mid-20th Century. In the social sciences, this approach was indicated as "Mode 2" knowledge production (Gibbons et al., 1994). New in the Mode 2 knowledge production is that during a relatively short period of time multidisciplinary teams are brought together to develop knowledge related to specific real-world problems, instead of following the conventional and discipline organised "Mode 1" approach. Examples include co-management (Pinkerton, 1989), joint knowledge production (Pohl et al., 2010; Van den Hove, 2007) and the application of multiple decision criteria (Belton and Stewart, 2002; Figueira et al., 2005). Recently, arguments towards and methods for more effective 'interfaces' between the available (scientific) knowledge and practitioners have also been made (Puente-Rodríguez et al., 2015; van Enst et al., 2014).

Despite the conceptual and the technical progress made, it is questionable whether the 'actual' decision-making related to human interventions in our estuarine and coastal environment has become easier. Although more advanced knowledge sources, tools, and techniques are available, we need to question whether we have been successful in their actual application. The interrelatedness of ecological, economic, and socio-cultural systems – together representing the Integral System (see Holling, 2001 for understanding the interactions and de Jonge et al., 2003, 2012 for respectively the concept and its potential application) – suggests that we should produce more and better knowledge. However, a higher volume and even higher quality of the available knowledge, achieved by refining model grids or by improving data mining and data collection of existing programs for example, does not necessarily decrease the present uncertainty and debate within the decision-making process in a significant manner. In our view, these complications directly point us to the phenomenon that environmental decision-making might have begun to suffer from what we call the 'Environmental Knowledge Paradox' (EKP). This EKP can be defined as the realization that merely more of the same kind of knowledge that explores the possible impacts of any human intervention will not necessarily contribute to a reduction of the uncertainty in the outcomes and settle competing truth-claims. This shortcoming can be attributed to the combined effect of the inherent complexity of the Integral System and the insufficiency and limitations of how we are able to interpret and describe the abstracted reality in our mathematical models.

Complexity, debate, and knowledge paradoxes are not only caused by the process and the technical tools we use, but also by individual actors. Especially if actors are not willing or able to redefine their personal knowledge constructs as captured by Bell and Lane (1998) expression '*the more you know, the more your surface area of ignorance expands*'. A higher amount of participating actors may therefore easily result into both more ideas and more disagreement, since every actor will argue from own knowledge, views and perceptions (van Buuren, 2009). Such a situation might easily result into deficient knowledge spillovers. This was identified by Audretsch and Keilbach (2008) as an explanatory factor causing knowledge paradoxes in the economic sector. In their paper, the concept of the Knowledge Paradox was used to describe the phenomenon of investments in knowledge infrastructure that did not trigger the expected economic growth.

When occurring in decision-making processes, the EKP is easily maintained because in formal 'top-down' governed processes, incorporating perceptions, knowledges, and ideas that come from external actors is rarely practiced, if at all. Agents not belonging to the existent social network', are likely not to play any direct role in the process (Hommes et al., 2009; Bell et al., 2013). Indeed, most often the possibility to bring in new or additional relevant information or knowledge from actors other than those formally integrated in the process as participants (usually institutional affiliates) may happen towards the end of the decision-making process, when alternative options cannot be judiciously weighed. Although in some cases there might be a possibility for presenting a different view during a hearing, or by means of a written proposition, these out-of-network claims are not easily appreciated or considered if they deviate too far from the established proposal, often because of an increased apprehension of potential failure - or simply the frustration of the decision-making process itself.

The diversity of forces and contra-productive forces as identified under the EKP, confirms to us that it is now time to broaden the focus and to contribute to the improvement of the decision-making process as well as to a narrow scientific support via the use of only