Implementing participatory coastal management:
e-COAST (electronic-COllaborative Assessment Support Tools)

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1. Introduction: the coastal zone and integrated coastal management

Coasts are unique natural heritage with irreplaceable ecological, cultural and economic resources. These spaces function as protective corridors of land and water and concentrate population, economic activities, and resources in a complex and fragile environment. Coastal spaces can be seen as a dynamic, unpredictable and interdependent set of subsystems in which the land-sea interactions are at the origin of very specific environments such as wetlands, estuaries, and open seas areas.

The coastal zone does not have a rigid definition, and the delimitation of its boundaries in a given area (*zoning)* varies according to political and administrative considerations. The main components of coastal systems, natural processes and human activities, interact in these spaces in a complex manner. In the last decades the combination of increasing human and natural pressures have resulted in jeopardised coastal areas in terms of their ecological integrity, and regions at risk in terms of socio-economic welfare (Ledoux and Turner 2002; Sarda 2005; Jickells 2005; Nicholls 2004).

Decision making for coastal area management implies dealing with uncertain conditions related to variations in socio-economic parameters (demand on coastal resources, demography, etc.) and environmental factors (geomorphologic changes, ecological processes, climate change, etc.). Traditional methods of coastal planning have shown limitations in managing this uncertainty and the complexity of choices surrounding an appropriate and wise use of coastal resources. The

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intrinsic dynamic nature of coastal spaces has been largely ignored by traditional approaches, together with a narrowed vision of problems due to sectoral management practices. The result is decades of uncoordinated management and inappropriate decision making.

The term "*coastal management*" came into common use with the implementation of the United States Coastal Zone Management Act of 1972. The Act recognised that a new coastal management approach was needed. Since then, it has been widely acknowledged that a simple juxtaposition of sectoral approaches to management and land use planning is not appropriate to guarantee the sustainable use of natural resources. Coastal areas require specific management approaches involving a system of relationships among actors who operate directly or indirectly in the coastal zones:

1) individuals who live, use, or are concerned otherwise (in their beliefs or behaviours) with the coastal environment,

2) policy makers and managers whose decisions and actions affect the behaviour of coastal people, and members of the scientific community.

Integrated Coastal Zone Management after 3 decades or so of history, has emerged as the most available appropriate process for dealing with current and long term coastal problems (e.g IPCC, 1996; WCC, 1993; EC, 1999). ICZM is a "*process of governance and consists of the legal and institutional framework necessary to ensure that development and management plans are integrated with environmental goals and are made with the participation of all affected*"(Post and Ludin, 1996).

Experiences undertaken worldwide show that overall benefits from addressing and managing sectoral issues simultaneously are greater than pursuing sector-driven development plans (Pernetta and Elder, 1993; Scialabba, 1998). ICZM is not designed to replace specialised sectoral management but rather to harmonise and complement it (Cicin-Sain and Knecht, 1998).

Moreover, ICZM aims at strengthening institutional and legal frameworks and implementing issue-driven action plans through the co-ordinated application of a series of case-specific elements:

- set of principles;
- set of measures (structural, institutional, economical, legal, financial);
- set of mechanisms (for linking responsible agencies and organisations, for public involvement);
- set of technological tools and instruments (information systems, cost-benefit analyses, scientific models, surveys, environmental impact assessments, etc.).

Nevertheless, "ICZM has not yet fully demonstrated its potential" (World Bank 2003). Although ICZM should be designed to catch the complexity of coastal socio-ecological system, very often a reductionist approach, where complex systems are assumed to be capable of being taken apart, studied in their elements and then reassembled, is applied.

In order to address the need of applying a systems approach to coastal management, the e-COAST (COllaborative Assessment Support Tools) framework is proposed. The selection of methods and tools for the development of this framework has been made adopting a transdisciplinary approach.

2. The COAST methodology

Tools like Decision Support System (DSS) have been developed under the belief that these systems can provide a better understanding of the inter-relationships between natural and socio-economic variables, and hence resulting in improved decision-making (Te'eni and Ginzberg 1991; Fabbri 1998). While the name 'decision support system' suggest a system capable of improving decision-making, there is a danger that misapplication of models and tools can lead to

unrealistic and misleading outputs (Parker et al. 1995). Furthermore, most models end up buried and forgotten in academic reports, after, perhaps, serving as the focus of a few debates (Pearse and Walters, 1987). A DSS specifically developed for ICZM has to deal with the complexity of the decision-making environment, where multi-social actors and multiple levels of competence exist. (Figure 1).

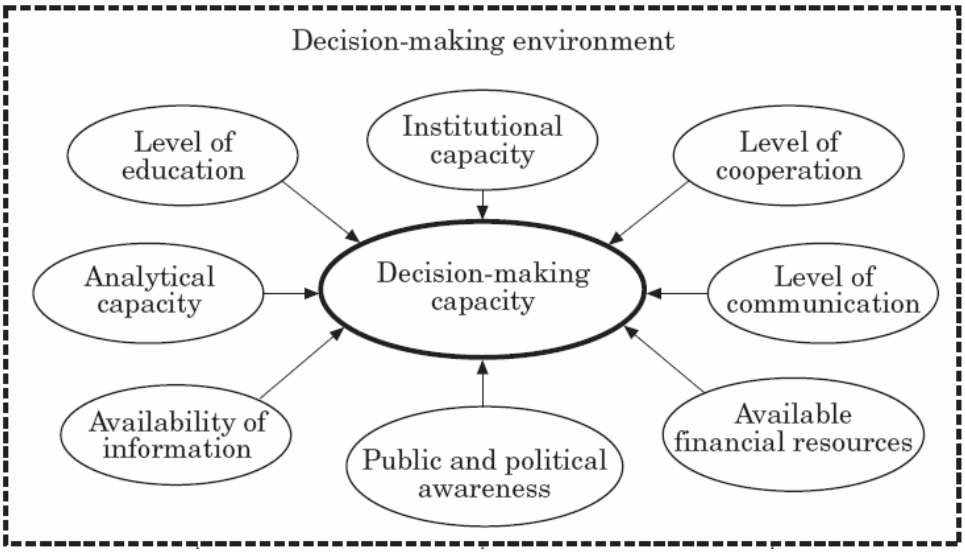

Figure 1 The ICZM decision-making environment (adapted from Westmacott 2001)

Acknowledging the need for a more accountable and inclusive governance style, where there is more than one decision-maker, Guimarães Pereira et al. have proposed a new kind of tool. The Tool to Inform Debates, Dialogue & Deliberation[†] (TIDDD or TID^3; © European Communities) deploys new Information and Communication Technology, designed for the context and audience where they are meant to be used, featuring progressive *disclosure of information*, and therefore, stimulating and encouraging debates and dialogues among social actors, creating new

[†] TIDDD was developed during the GOUVERNe project: Guidelines for the Organization, Use and Validation of Information Systems for Evaluating Aquifer Resources and Needs. Shared Cost Action funded by DG RTD, under Framework Programme 5 of Research Contract No. EVK1-1999-00032; coordinated by the University of Versailles, Saint-Quentin-en-Yvelines.
http://neptune.c3ed.uvsq.fr/gouverne/ and http://alba.jrc.it/gouverne.

settings for the inclusion of different types of *knowledge and wisdom (*Guimarães Pereira et al. 2005). The methodology proposed in this paper adopt, as well, the idea of cooperation and inclusion of the different social actors, for the creation of a *learning community,* where a diverse group of people work together to nurture and sustain a knowledge creating system (Senge and Scharmer 2001). e-COAST is designed to be an explorative and learning cycle integrating social research methods with 'soft' and 'hard' operation research (OR) methods[‡].

The framework proposed (see figure 2) is divided into three main phases, inspired by the Herbert Simon's model in decision theory (Simon, 1960) . These phases are: intelligence, design, and choice phase:

- *Intelligence phase* which includes defining and describing the system, understanding the system behaviour, assessing the current situation and formulating the objectives;
- *Design phase* which includes the formulation of planning models and the generation of alternatives;
- *Choice Phase* which includes the assessment of the impacts of the different alternatives, the evaluation and visualisation of them, the selection of the best alternative and the communication of results.

[‡] *'Operations research, operational research, or simply OR, it can be described as a scientific approach to the solution of problems in the management of complex systems. In a rapidly changing environment an understanding is sought which will facilitate the choice and the implementation of more effective solutions which, typically, may involve complex interactions among people, materials and money'* (The Association of European Operational Research Societies-EURO).

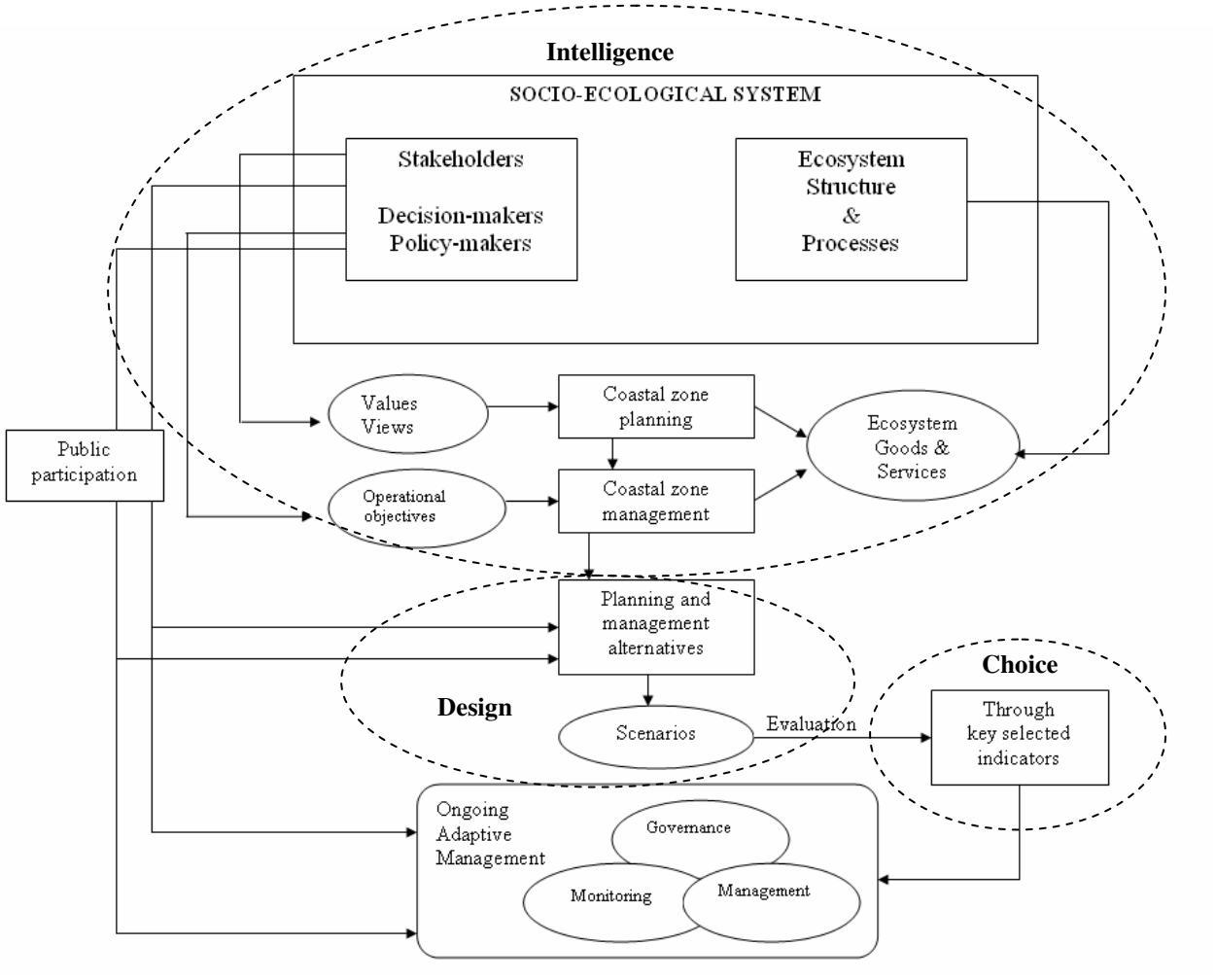

Figure 2 The methodological framework proposed

3. e-COAST

Building on this conceptual framework, a tool-box has been developed with the specific aim of facilitating stakeholders dialogue. The two main elements are a cognitive mapping module and a scenario builder module. Mapping mental models assesses tacit knowledge, broadens the narrow understanding of a problem by confronting one social actors' map with the map of others, makes aware of alternative perspectives on the problem, encourages negotiation and helps to reduce

destructive conflict. The basic idea is to elicit a person's knowledge and consequently open it up to discussion. Examples of methodologies for developing mental models are Soft System Methodologies (Checkland et al. 1990) and fuzzy cognitive mapping (Kosko 1992a, b; Özesmi U. and Özesmi S. 2004, Hoobs et al. 2002). In this case cognitive map (Figure 3) is used to explore and represent individuals' assumptions and belief systems. A cognitive map represents an individual's understanding of causal relationships among interacting factors. It has two basic types of elements: concepts (nodes) and causal assertions (links). A person's cognitive map can be used to derive explanations of the past, make predictions for the future, and choose policies in the present. The cognitive mapping provides the user with a graphical tool to represent and analyse his/her mental model.

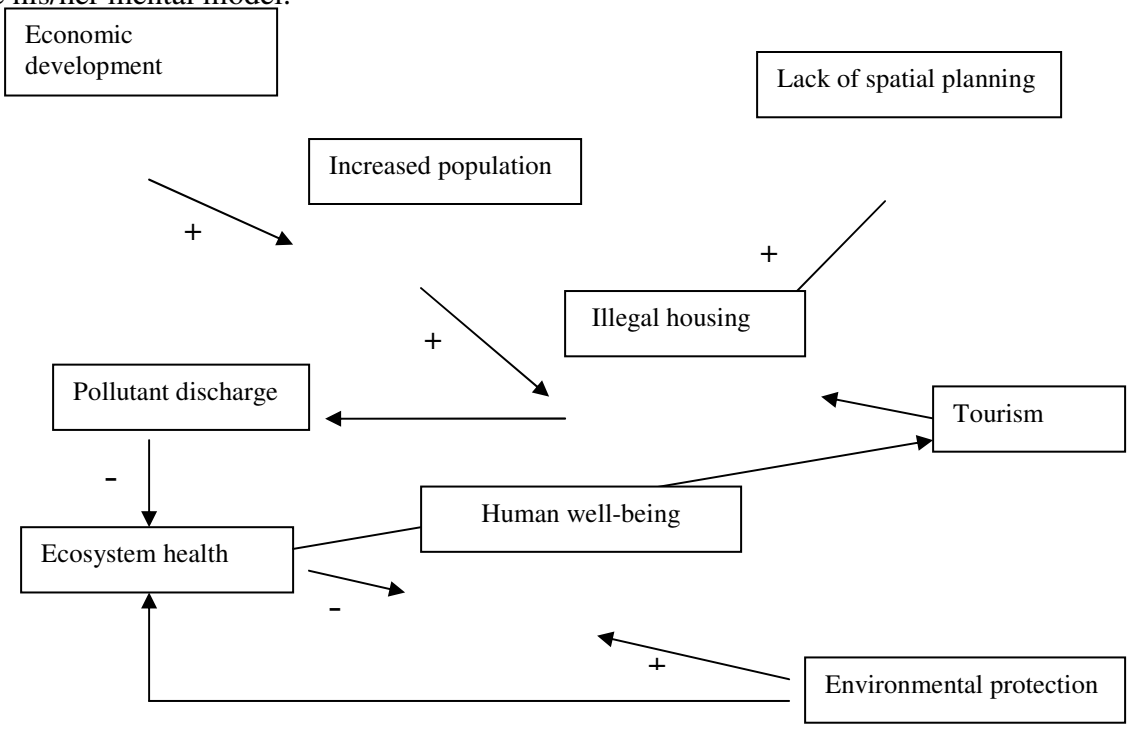

Figure 3 A cognitive map

In this module every user is able to insert issues and causal links between them, either positive or negative. A query function is available as well, allowing the user to navigate through different

cognitive maps and answering to questions like:

1. What are the causes of a particular problem?

2. What are the consequences of a particular problem?

In the scenarios builder module, drawing from a knowledge base database with economic, societal, political, environmental trends and key uncertainties, the user idea on possible futures is elicited. A GIS based data management module is also used to provide geo-referenced information.

Scenarios are tools for ordering one's perceptions about alternative future environments in which today's decisions might be played out. In practice, scenarios resemble a set of stories, written or spoken, built around carefully constructed plots. Stories are an old way of organizing knowledge; stories can express multiple perspectives on complex events; scenarios give meaning to these events. *Scenario planning is a discipline for rediscovering the original entrepreneurial power of creative foresight in contexts of accelerated change, greater complexity, and genuine uncertainty* (Wack 1985).

Scenarios are powerful planning tools precisely because the future is unpredictable. Unlike traditional forecasting, scenarios present alternative images instead of extrapolating current trends from the present. Scenarios also embrace qualitative perspectives and the potential for sharp discontinuities. Consequently, creating scenarios requires decision-makers to question their broadest assumptions about the way the world works so they can foresee decisions that might be missed or denied.

Once the scenarios, as possible alternatives, are developed in a collaborative manner, multi-criteria tool is used to evaluate them.

Multi-criteria analysis is a method of choosing between a set of alternative options on the basis of a set of defined evaluation criteria. It is a tool that is often used to support decisions where there

are conflicting management objectives and conflicting stakeholder preferences.

Multi-criteria analysis (MCA) requires an identification of the possible development options and an assessment of the impacts of those options on a set of management criteria. Once identified, multi-criteria analysis can be used to rank the development options in terms of their impacts on the criteria. Multiple users' preferences for different management priorities can be included through the use of weights. The weighted ranking of development options can be compared with the unweighted rankings to inform decision-makers about the level of support for and the possible impact of their decisions.

Different methodologies of MCA exist such as Analytical Hierarchy Process (Saaty), ELECTRE, Delphi. NAIADE (Novel Approach to Imprecise Assessment and Decision Environments) is a multiple criteria evaluation method which allows the use of information affected by different types of uncertainty, allowing the use of crisp, stochastic, fuzzy numbers or linguistic expression to assign the values to different criteria (Munda 1995). Very often the applications of MCA are desktop exercises, however in the last decade a shift from a technocratic to a participatory approach has led to the implementation of Social Multi-Criteria Analysis (SMCA), proposed by Munda (2004) in substitution of participative multi-criteria evaluation (PMCE) or stakeholder multi-criteria decision aid (SMCDA) (Banville et al., 1998).

The aim of this framework is not to provide an optimal solution but, accordingly to the theoretical background of SMCA, to stimulate a debate among different social actors, where more importance is given to the process undertaken instead to possible outcomes.

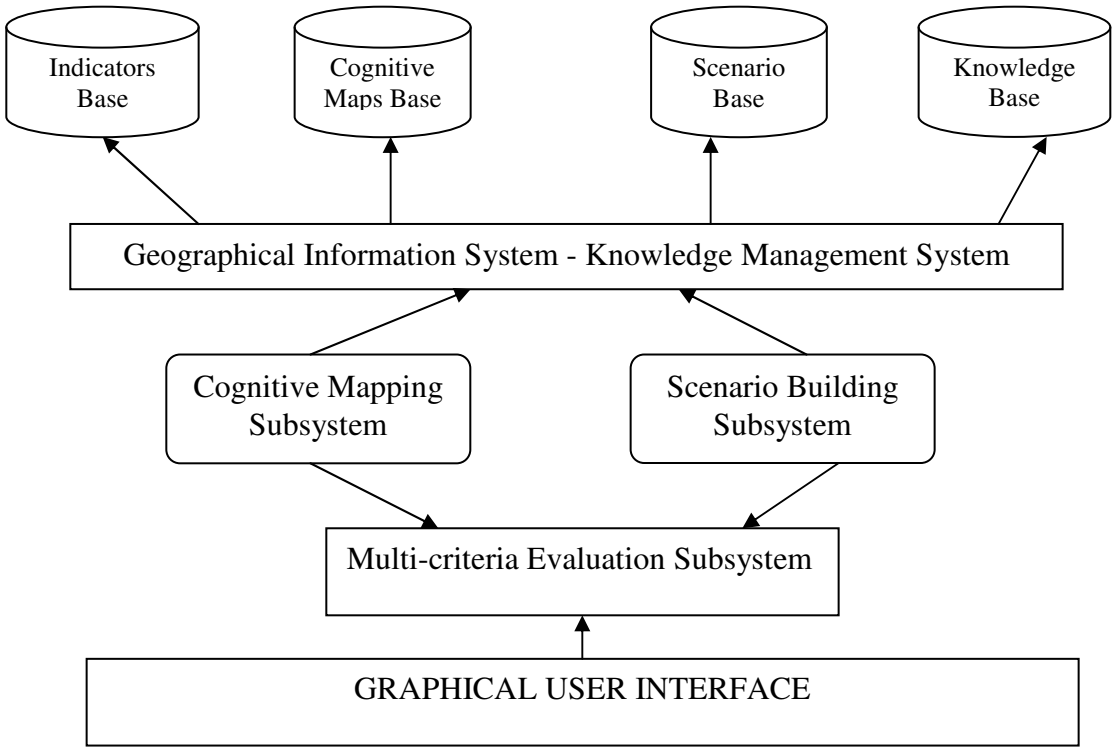

Figure 4 e-COAST system architecture

4. Conclusions

The complex nature of the ICZM decision-making environment require the development of methodologies able to consider the existence of multiple decision-makers and the of multiple issues traditionally tackled from the point of view of different disciplines, belonging either to the natural or to the social sciences spheres. This paper has illustrated the development of the COAST framework, which proposes the use of methods, tools, and conceptual frameworks to *examine issues between disciplines, across disciplines, and beyond all disciplines* (Nicolescu 2001). In particular great emphasis has been put on the role of public participation and on the search of common communication level between the scientific community and the non-scientific social actors. This can be done in the phases of a planning process, understanding of the system

behaviour, proposition of alternatives, and evaluation of them.

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