SCIENCE AND POLICY INTEGRATION FOR COASTAL SYSTEM ASSESSMENT: AN AMBITIOUS IDEA, THE IMPLEMENTATION IN A GREEK STUDY SITE AND THE PROBLEMS ENCOUNTERED

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Abstract

This paper aims in disseminating the work in progress done for the implementation of the project Science and Policy Integration for Coastal System Assessment, funded from the 6th Research Framework Program (FP6) of the EU, in the Greek Study Site of Thermaikos Gulf and in discussing the problems encountered at the course of materializing the innovating proposed system approach. The broad objective of the project is to develop a common ICZM methodology that can be implemented to various coastal zones through Europe. The aim of the applied methodology is to identify the interactive linkages between the ecological, economical and social components of each system in order to support decision-making processes that are improving the sustainability of Coastal Systems. The specific policy issue selected for the Greek reference area is the sustainable management of mussel culture in the Chalastra region.
Keywords: Integrated Coastal-Zone Management, mussel-farming, stakeholders group, simulation model

1. Introduction

Coastal zones are recognized to be areas of high ecological and economic value. As the majority of human habitations lie in or in a close proximity to the coastal zone (Shi et al., 2001), the intense demand on coastal resources for maintaining human sustainability and economic activities has had adverse effects on the coastal ecosystems around the world. While it is easy to take a biased view and support either economic development or ecological preservation, the challenge in sustainable development lies in fostering measured socio-economic growth, which does not compromise the ecological integrity and value of the area (Varghese et al., 2008).

Integrated Coastal-Zone Management (ICZM) is defined as ‘‘the integrated planning and management of coastal resources and environments in a manner that is based on the physical, socioeconomic, and political interconnections, both within and among the dynamic coastal systems, which when aggregated together define a coastal zone’’(Solway Firth, 2008). The complexity of developing an ICZM plan arises from the fact that there are many stakeholders with diverse and conflicting objectives involved in the procedure. Furthermore, the stakeholders derive from multiple disciplines and are respectively biased in their opinions on the ICZM plans. Hence, a consensus is difficult to achieve and the development of an ICZM plan becomes complicated and iterative (ATKINS, 2004).

The current work is evolving from a joint EU project undertaken by 54 partners across Europe. The broad objective of the project is the building and implementation of a System Approach Framework (SAF) to forecast the outcomes of alternative management policies and carry out scenarios analyses as a tool that will help the stakeholders in visualizing the long-term results of their decisions and help in building consensus among them. The goal of the SPICOSA project is challenging as the

SAF is predestined to be applicable in different areas in Europe varying morphologically, environmentally, socially and economically. In Greece the project is materialized by the Department of Civil Engineering of Aristotle University of Thessaloniki and the Hellenic Center for Marine Research.

2. Methodology

2.1 PROJECT'S SYSTEM APPROACH

The SPICOSA project follows a sequence of certain steps in building and implementing the new methodological approach, in order to test the strong and the weak points of it, to validate it and to identify the alterations that will make it efficient, flexible, easily adaptable and acceptable from the non-scientific policy makers across the European Union.

The first action in the course of the project is the Design Step that is targeting in identifying the structure, function and dynamics of the CZ system under study, comprehending the economical and social components, along with the methods and information needed for this identification to be efficient. Conceptual models of the system are being constructed, in order for the ecological problems to be represented along with the socio-economic interactions in a widely understood manner. In addition a general planning of the policy scenarios under consideration and the desirable outputs of the procedure are built.

The Formulation Step aims to represent the functions of the system in both quantitative and qualitative manner. Based on the Conceptual Models constructed at the previous step, all the processes and interactions, including the controls and constraints of the socio-economic components will be formulated into functional model blocks, in order for this effort to be scientifically critiqued.

The preparations and output of the Formulation Step will initiate the System Appraisal step. The environmental, social and economic assessments will derive from different component models that will be coupled to construct the system simulation model, with different types of linkages. At this point validation of the models will take place and comparison of the modelled variables with historical data in order for iterative improvements to take place. Finally, the Output Step will involve organizing the information gathered during the course of the project for policy deliberation, scientific publication and for dissemination to the non-scientific end-user community.

It is here important to highlight that the previously described procedures are being realized under constant collaboration with the Stakeholders of the area of interest. The ideal situation is that the Stakeholders Group engaged to the procedure, should occupy representatives from all the major human activities (HA's) taking place in the area, causing or being influenced from the impacts, the policy and decision makers holding authority for these activities, the Non–Governmental Organizations acting in the area and the public. The Stakeholders Group must decide about the Policy Issue, the scenarios and the outputs and must be kept informed for the advances and problems concerning the course of the project. This constitutes one of the greatest challenges in the SPICOSA project, because the information given and the presentation done for all the aforementioned aspects must be fully understood from the non-scientific Stakeholders Group in order to keep their interest and engagement to the procedure.

2.2 THE STUDY AREA

The sea area of Chalastra is located NW of the inner Thermaikos Gulf. At the NE side of this area lays the city of Thessaloniki and at the NW the estuaries of Axios-Loudias-Aliakmonas rivers. At this area approximately 200 mussel farms are located, in a surface of 1.350.000 m^2, to a minimum depth of 4m and a maximum of 20m. The land boundary of the system is occupied by agricultural land whereas the channel of the WWTP of western Thessaloniki is discharging in a distance of 4.8km from the area, 2.2km from the coast. Due to the circulation of the Gulf, the inputs from the estuaries do not affect the reference area most of the time. However, it is constantly affected from agricultural run-offs, as well as from the outputs of the WWTP. The vertical structure of the water column is determined from the thermocline and pycnocline seasonally.

2.3 THE POLICY ISSUE

During the stakeholder mapping procedure it was soon realized that the goal of gathering the majority of the stakeholders in Thermaikos Gulf, which is a big and heavily populated area with a great number of HA's taking place, was unrealistic in terms of financial and time limitations. Those constraints along with the need for a Policy Issue with a straightforward connection between the ecological and socioeconomic components, lead in choosing a smaller area inside Thermaikos Gulf, the area of Chalastra, where intense and conflicting HA's are taking place and multiple known problems are identified.

Mussel farming is an activity that takes place in the area for more than 25 years, occupying an important percentage of local population. The average annual mussel production of Chalastra area is exceeding the 10.000tn/yr. It should be also noted that the reference area is part a broader protected area, under the Ramsar convection, where mussel farming is an activity compatible to the current protection status. During the last years, due to several reasons, there has been an important modification of the natural environment of Thermaikos Gulf that leaded to a decline of the mussel production with significant socio-economic impacts to the local population.

Therefore "Sustainable management of mussel culture at the area of Chalastra" is the selected Policy Issue because of the great importance of mussel farming activity in the area. Besides, mussel farmers are a small but important group of stakeholders, facing many environmental and socio-economic pressures. Available data from previous works indicate that the mussel production has been declined during the last ten years in terms of the total length of mussels, but most importantly and most rapidly, in terms of the total weight of production. The market value of mussels is calculated in €/kg, so that the socio-economic impact of the decline can be quantified in a straightforward manner.

3. Results - Implementation in the study area of Chalastra, Thermaikos gulf

3.1 THE STAKEHOLDERS GROUP

After narrowing the area of interest and specifying the Policy Issue, mapping the stakeholders of the area became a more manageable goal. Eleven groups are represented to the consortium of the Stakeholders, eight public bodies, one mussel-farmer's union, one private corporation and local groups with ecological interests. Private interviews were organized with the representatives of the Public Authorities involved to the activity, either by keeping property rights over the land-use or by being

responsible of supervising the activity, in order to outline their opinions about the Issue and their willingness to participate to the consortium. All the representatives of the Authorities acknowledged the problems in the area and expressed their intention to participate to the procedures of the consortium. However, most of them underlined the fact that they are not in a position to make decisions concerning the implemented policies, transferring thus the responsibilities either to hierarchically higher Authorities or to other Public Offices also responsible for the area. This common behaviour highlights an important liability of the Greek Legal System where different laws and legislations indicate multiple authorities in charge of the same issue, with overlaying responsibilities. The result of this is increased bureaucracy and degeneration of the role of authorities into plain transactors not liable to offer solutions to important managing issues.

3.2 THE ENVIRONMENTAL DIMENSION OF THE CZ SYSTEM

In order to achieve the major project's goals it is highly important to identify the main components of the physical system that are affecting the Policy Issue, i.e. the sustainable development of mussel-farming. Mussel growth depends on:

- The availability and concentration of phytoplankton and POM in the water column.
- The environmental conditions (temperature, DO, etc).
- The water circulation in the cultivated area as it is affecting the aforementioned factors.

The environmental analyses under development for the area of Chalastra involves: (a) the separation of the sea area into four spatial compartments, (b) the calculation of the exchange coefficients between them, (c) the simulation of the circulation at the mussel-farming area compartment and how is this circulation affected from the existence and the intensity of mussel activity, (d) the identification and simulation of the sources of nutrients and organic matter into the sea area, (e) the simulation of the phytoplankton growth and the POM cycle into the water column and finally (g) the mussel growth rate, depending on physical variables.

The environmental analysis is kept in a level of simplicity that incorporates the necessary functionality of the physical system, keeping in mind that the provided outcome of this procedure will be a managing tool that must be used and interpreted from non-scientific users. At this point, working on the Formulation Step, the different components of the ecological sub-model are being constructed using a specific software program (EXTEND^{TM}) and soon enough the available data will be used for calibration and validation of the model.

3.3 THE SOCIO-ECONOMIC DIMENSION OF THE CZ SYSTEM

Another important step in model formulation is the identification of the linkages between the environmental and the socio-economic components in the coastal zone system. In order to do so, a number of parameters should be assessed according to the interaction of the main Goods and Services, provided by the physical system, and the Policy Issue of the project. Namely, it is important to assess:

- The optimum environment for the cultivation of mussels.
- The productivity of mussels (considering both the quantity and quality of mussels).
- The working environment for the local population.
- The role of the sea basin and the mussel farming area as the receiver of pollution caused by external HA's.

Concerning now the production of mussels, in aquaculture, there are two distinct levels of economic analysis that should be followed:

- The "farm" level analysis, which will focus on the maximization of the economic output of mussels' production in the boundaries of each farmer's "cultivation" area.
- The "activity" level analysis, which will focus on the maximization of the economic return of the total mussel production in the reference area. This level takes under consideration a number of socioeconomic and environmental constraints of the reference area, in order to attain a sustainable final outcome for the whole region.

Significant dissimilar approaches must be followed in the two levels of analysis. Namely, in the case of an individual mussel-farmer the connection between productivity and stock size effects should not be taken under consideration. This is mainly due to the fact that individual farmers' decisions are always aiming to maximize their profits under the short-time period length. In this period, the annual productivity is primarily influenced by the inputs on mussels' production (seed, labor, capital), the size of the cultivated area and some physical conditions. So, a rational farmer will always harvest the amount that maximizes its revenues in a period (t), as he will be able (ceteris paribus the physical conditions) to reproduce the same stock size for the next period (t_{+1}).

The second level of economic analysis ("activity" level) has a long-time perspective and should further consider the environmental constraints of intense farming activities, not only to the external environment, but also to the population of mussels. On this account, the population dynamics of mussels are going to be explained by means of a specific interpretation of the theoretical model of Schaefer (originally applied in fish populations), which presumes that there is a specific relationship between the stock size of the population and its rate of growth.

The main efforts at the present moment are invested in coupling the ecological components of the model to the economic analyses and then in identifying the data needed for the validation of the final outcome.

3.4 MANAGEMENT AIMS AND OPTIONS

In order to create a tool that will support the decision making process from the stakeholders it was important to discuss with them and set alternative management scenarios that will be tested through the simulation model of the system. After multiple considerations and discussions during the private interviews the following options were prioritized:

- Modification of the management practices to the mussel farms. Larger distances between the farms, different orientation regarding the best water circulation inside the culture area and alteration of the position of the cultivation ropes inside every individual farm. Alteration of the quantities of mussels that are cultivated in order to determine how much the different circulation patterns influence the growth rates of the cultivated organisms.
- Variation (increase or decrease) of nutrients and organic matter inputs into the sea area due to alterations in policies regarding external HA's (e.g. WWTP, agriculture). Major changes of these inputs may cause significant alterations to the phytoplankton biomass and respectively to the growth of mussels.
- Combination of the aforementioned scenarios.

4. Discussion – Limitations & obstacles

It is obvious for the aforementioned description that the SPICOSA project is based in a very ambitious idea: building an ICZM methodology is not an easy goal when localized, far more when this methodology has to be adaptable across all Europe. Through the course of the project it was soon realized that in many European countries ICZM is far more developed than in others. Namely, in those countries, stakeholders' consortiums already exist and communicate, while some well-established monitoring programs provide to the scientific community valuable datasets concerning environmental and socio-economic data. Most importantly, in many EU countries there is a well-organized plan concerning the ICZM and its relevant aspects. In those cases the SPICOSA representatives add their effort in a task already in progress.

In Greece, ICZM is still at a very early stage of implementation. Specifically, there are several remarkable but isolated attempts in different coastal areas for implementation of Integrated Management, deriving mostly from the local communities or the scientists and there is not an organized attempt supported from the official state. Quite often the earlier mentioned bureaucracy created great obstacles in this effort. For instance, the representatives of Public Authorities, although most of the times interested in participating to this attempt, are reluctant to provide data and information. At the same time the most important stakeholders' team, the mussel farmers, have lost trust in authorities and in scientific community through the years, thinking that every approach towards them serves other interests than their own and leading them to face any new attempt with disbelief.

Moreover, in Greece there is a lack of previous experience concerning mussel growth simulation modelling. The data concerning the mussels' growth and production are rare, scattered in time and most of the times unavailable to access. Information concerning important economic aspects is also very rare and not always trustworthy as there isn't any official relevant monitoring program. In addition, there is no official source, which can provide either the necessary social data or the quantitative connection between the social, environmental and economic components.

With SPICOSA still in early progress it is difficult to argue about the expected results and their efficiency, although it is clear that we have to overcome important obstacles in order to meet our goal. The one way or the other it is important to move forward: solving one problem after the other, implementing new methodologies, creating trust and communication linkages between the stakeholders, the Public Authorities and the scientific community.

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