ecomanage
INTEGRATED ECOLOGICAL COASTAL ZONE MANAGEMENT SYSTEM

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FINAL ACTIVITY REPORT

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Contributors:	Marcos Mateus (IST) and José Chambel (HIDROMOD)
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1 Executive summary

This document is the publishable final report of the project ECOMANAGE (Integrated Ecological Coastal Zone Management System, INCO-CT-2004-003715), a research project financed under the European Commission's Sixth Framework Program (FP6). The document introduces the objectives, the project partners, the degree of achievement and the main project results. Further information can be found in the project web site at http://www.ecomanage.info/.

2 Introduction

The fast expansion of socio-economic activities on coastal and estuarine areas over the last decades, such as tourism, industrial and urban development and coastal fisheries has expanded and complicated the management of those areas. In recent years, there has been a growing concern to maintain a steady growth in economical activities and social development in estuarine areas, while preserving their natural features and ecological services and governments and local authorities need management tools for helping them on daily management as well as on strategic decisions.

It is very well known that a sustainable coastal management strategy requires interdisciplinary and integrated approaches, involving combined physic-ecological and socio-economic approaches The ECOMANAGE (Integrated Ecological Coastal Zone Management System) project aimed to provide integrated tools for management of coastal zones following the DPSIR - Driver, Pressure, State, Impact and Response – approach, having in mind that the driver are the anthropogenic activities carried mostly in the catchments and consequently most pressures result from river discharge and direct from discharges carried directly in the coastal water bodies.

The most innovative part of the project arose from the recognition that management of coastal zones management is very much management of the catchments discharging on those coastal areas. As a consequence the study of the estuarine catchments received importance comparable to that given to the coastal water body.

The tools developed in the project were based on mathematical models for the coastal areas forced by loads discharged directly of carried by the rivers. The coastal area models were used for understanding the state and for determining the impact of anthropogenic activities and for assessing the benefits of management responses. The catchment models were used for determining loads associated to each driver and for determining the modification of the drivers required for reducing the pressures to the values determined by the responses.

Three distinct transitional waters systems in South America (Figure 1) were chosen for testing the methodology proposed: Santos Estuary in Brazil, Bahía Blanca Estuary in Argentina and Fjord Aysén in Chile. These coastal systems cover a wide spectrum of environmental conditions due to their geographical location, but also due to their geomorphology and to the local socio-economic activities. The Fjord Aysén has quite pristine conditions, while the Santos Estuary is the most heavily occupied and degraded system.

The Santos Estuary, in Brazil, is home to the biggest port in Latin America. Five hundred years of urban, industrial and port use have highly changed this ecosystem. Originally mangroves extended all over the estuary and the coastal region surrounding it, and even though there are still some well preserved areas the ecosystem is under severe environmental stress due to its

location close to S. Paulo (about 15 million inhabitants located about 70 km apart). Although the estuary is not located in the same catchment as S. Paulo, the local economy is linked to that city, including the port and Cubatão heavy industry. Some S. Paulo wastewater after some treatment is discharged in the estuary benefiting from the more than 500 m level difference that permits turbining that water with high economical benefit.

The Bahia Blanca Estuary is a mesotidal coastal plain estuary in Argentina. It is a much less modified coastal system than Santos estuaruy, but still ports, towns and industries are located mainly in the northern margin of the estuary. The estuary is shallow being divided into quite independent parts by a system of channels and fine sand and silt-clay sediment banks.

The Aysén Fjord is located in one of the largest estuarine areas of the world: the Chilean austral fjords. The fjord supports a large salmon farming industry and receives the wastewater of Puerto Aisén (a town of 37000 people) being also home of a large seaport (Puerto Chacabuco). At the early stage of the project a multinational company requested the Chilean government authorization to install a large industrial complex near the fjord (an aluminum processing plant) but the complex was not installed there.

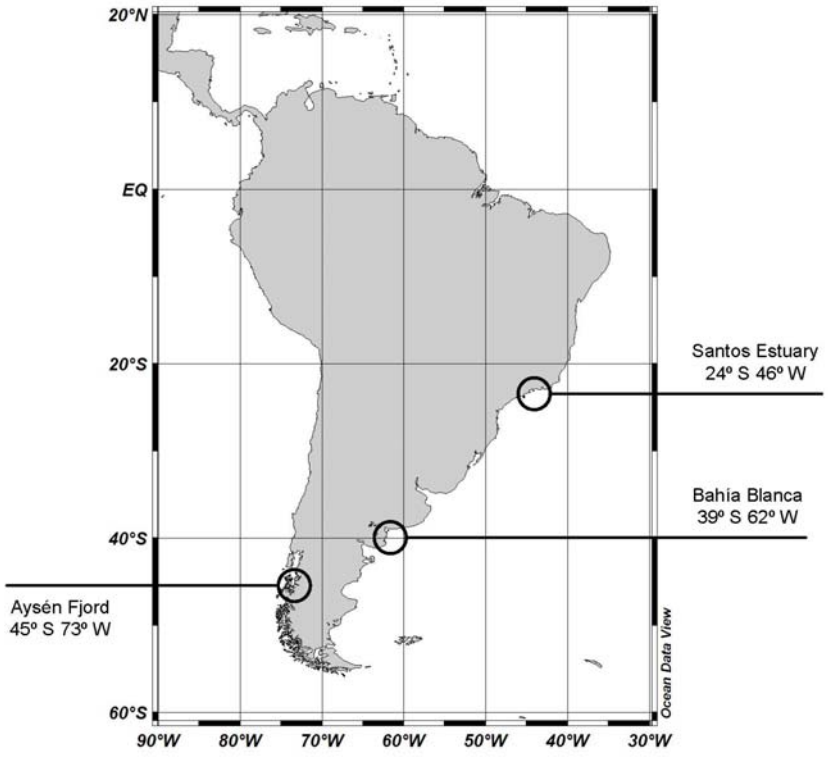

Figure 1 ECOMANAGE study sites in South America: Santos Estuary (Brazil), Bahía Blanca (Argentina) and Aysén Fjord (Chile).

2.1 Project partners

- Instituto Superior Técnico (Portugal), project coordinator,
  Contact: ramiro.neves@ist.utl.pt
- HIDROMOD, Modelação em Engenharia, Lda. (Portugal)
  Contact: cleitao@hidromod.com
- Noctiluca Marien-Wetenschappelijk Adviesbureau (The Netherlands)
  Contact: job.baretta@xs4all.nl
- LNEC -Laboratório Nacional de Engenharia Civil (Portugal)
  Contact: lferreira@lnec.pt
- University of Trieste (Italy)
  Contact: feoli@units.it
- Instituto Oceanográfico da Universidade de São (Brazil)
  Contact: edvinett@usp.br
- Instituto Superior de Educação Santa Cecília (Brazil)
  Contact: aureo@unisanta.br
- Instituto Argentino de Oceanografía (Argentina)
  Contact: jorgemar@criba.edu.ar
- Universidad de Chile (Chile)
  Contact: vmarin@antar.uchile.cl
- Centro de Ecología Aplicada Ltda. (Chile)
  Contact: mcontreras@cea.cl

2.2 Contact

The contact point for any query regarding the project is:

Prof. Ramiro Neves
Instituto Superior Técnico
Mechanical Engineering Dept.
Av. Rovisco Pais, nº 1
1049-001 Lisboa
Portugal
Email: ramiro.neves@ist.utl.pt
Tel: + 351 218417397
Fax: + 351 218417365

3 Project execution

The project outcomes are the most relevant component of the description of the project execution. Their description is preceded by short descriptions of the objectives and methods for simplifying their understanding.

3.1 Project objectives

ECOMANAGE project aimed to push the capacity of assisting managers to join horizontally knowledge from ecological and socio-economic disciplines by developing integrated management tools. The three key aspects of ECOMANAGE were (1) the consideration that a coastal zone depends on local pressures, but also on pressures originated in the drainage basin, transported mostly by rivers and by groundwater, (2) that socio-economic activities are the driving forces of those pressures and that their impacts on the ecosystem have feedback on socio-economics and (3) the impacts depend on physical characteristics of the ecosystem that together with the loads determine its ecological state.

3.2 Principal methodologies

The three coastal zones studied show conflicting interests resulting from urban, industrial and agricultural pressures. Relationships between the drivers and impacts of environmental pressures were described using the Drivers, Pressures, State, Impacts and Responses (DPSIR) framework. Data and mathematical models were used to identify the links between DPSIR elements.

Participatory methods were applied for interacting with stakeholders in order to establish study scenarios and indexes for socio-economic and ecosystem analyses and to measure environmental impacts of management decisions. Field data and modelling results were included into a Spatial Decision Support System (SDSS) for simplifying the assessment of the impact of management scenarios and evaluate their performance.

The project had 3 main components:

- The physical-ecological and socio-economic system (PHES-system), supported by field data and state of the art modelling tools described ecosystem processes and was used to forecast its behavior under different scenarios of socio-economic pressures.

- A Spatial Decision Support System (SDSS) integrated all information and provided tools for giving answers to decision-makers, researchers and stakeholders.
- Index analysis involving spatial and temporal variably were part of the decision support system, focusing and illuminating the significance of environmental changes and the progress to sustainable development in the complex coastal systems studied in the project.

The methods used proved to be adequate to provide answers to the end-users, but also to stimulate the technology and knowledge exchange within the project consortium and between this and other local research teams. Particularly important for the project was the relationship built with IPT (Instituto de Pesquisas Tecnológicas em S. Paulo) and with Universidad del Sur na Argentina.

3.3 Major outcomes

The initial set of objectives of the project was very ambitious, not only because of the complexity of the research objectives and of the socio-economic aspects of each site, but also because of the coordinating challenge with the actors involved. To facilitate this cooperation, different collaboration channels were established, from direct participation in the project meetings, editorial tasks of key documents, to ad-hoc site-specific Task Forces with strong support from the project consortium.

The logo used to identify the project (Figure 2) became well known by the actors involved in each study site. In some particular cases the logo became a trademark for sustainable costal management, reaching nation-wide attention through several media channels.

Figure 2 ECOMANAGE logo

It can be asserted that the degree of fulfillment of the objectives are very high both on the technical and coordination level. The paragraphs below describe the outcomes organized per subject.

Identification of the main drivers and pressures

From heavily populated area of Santos Estuary to the near-pristine water conditions of Aysén Fjord, the work developed in the project covered a wide range of ecological and socio-economical conditions, and their inevitable conflicts and challenges in management. All these systems have been assessed using the same tools, but the relative importance of the processes are very much different. The drivers are major differences between these systems, resulting into different pressures.

The drivers were identified still during the proposal phase. During the implementation of the project a complete list of drivers was prepared for each site and the resulting pressures were computed using catchment models and groundwater models. These models generated fresh water discharges, sediment and nutrient loads, as well as feacal bacteria loads. Accident scenarios have also been designed for each site (e.g. A oil spill in the Bahia Blanca monobuoy).Table 1 displays a synthesis of the main drivers and pressures in each site and the type of impact generated in the estuary.

Set up, calibration and validation of numerical models

The numerical models implemented and validated in each site were a major outcome of ECOMANAGE project. The MOHID modelling system has been used to simulate the major processes of these distinct estuarine systems. This system is public domain (open source) being in fact a set of integrated modules (sometimes alternative) giving to the user the possibility to choose the best model in each case and, if necessary, the possibility to modify them or to include new ones. Also, groundwater and watershed modelling applications were developed based as much as possible on public models as SWAT (Soil Water Assessment Tool). The models have been calibrated and validated with historical field data sets and whenever needed, sampling campaigns were carried on to complement insufficient data. The use of models made possible to clarify causes and effects in environmental processes, the distinction between anthropogenic and natural contamination sources and their respective to the state of each site. In addition, modelling results proved to be important to complement data from traditional experimental research methods, becoming essential tools for understanding the link between catchments and estuarine processes and the complex processes that run across the land-sea interface.

Testing development scenarios / management options with models

Estuarine models have been used for assessing their ecological status and for quantifying the environmental impacts of the most important pressures. As a result of this activity it was possible to design a set of management responses that could improve the situation. Based on

the activities carried out in the catchment and especially on the activities involving the socio-economic assessment, it was possible to design a set of management scenarios acceptable in terms of socio-economics and relevant for improving the status of the estuarine systems.

The scenarios studied have addressed the housing and population growth effects on the Santos Estuarine system and the benefits of alternative wastewater management policies, the benefits of improving the wastewater treatment plant of Bahia Blanca and the benefits of alternative discharge locations and the effect of alternative policies for managing aquaculture waste products on the bottom water of Aysén Fjord. These scenarios were complemented by some risk assessment studies (e.g. oil spills at Bahia Blanca oil terminal).

Stakeholders' involvement

The project has promoted strong public involvement of stakeholders by giving them the opportunity to participate in decision-making processes, leading to the establishment of a straight cooperation between project partners and the main stakeholders in the studied areas. The totally new conceptual framework brought by ECOMANAGE improved the better understanding of the management issues in the three sites and lead to specific answers to local problems with generic methodologies. Outcomes of the project were of significant interest to both scientific and water resources management communities in all sites. ECOMANAGE project has help in the public education and consensus-building processes and has promoted and encouraged public awareness and participation by making information widely available. A significant outcome of including local stakeholders has been a renewed cooperation pointing to future work and development of the work started during the project.

International, cross-disciplinary teamwork

A main achievement of ECOMANAGE is certainly the combined effort to achieve better management strategies for the study areas. Public and private institutions at each site have made part of the effort, working side by side with the scientific staff of the project. The project also provided the opportunity for a significant number of students to pursue their academic degrees benefitting from the collaboration with researchers from other institutions and universities. Many areas of expertise have been blended in the work of ECOMANAGE, including ecology, water pollution, ecotoxicology, hydrodynamics, modeling, groundwater, economics and social sciences.

Table 1. Major socio-economical features of the ECOMANAGE study sites.

Feature	Santos Estuary	Bahía Blanca	Aysén Fjord
Drivers	Industrial and port activities Population growth	Agricultural activity Industrial and port activities Population growth	Salmon Farming
Economic activities	Petrochemical park Refineries and terminals Fertilizer plants Thermoelectric plant Metal industries Port activities	Petrochemical park Refineries and terminals Fertilizer plants Thermoelectric plant Several industries (meat and fish factories, leather and textile plants, etc.) Port activities	Salmon fish farming Artisan fishing Forestry
Pressures	Urban and industrial pollution (wastewater effluents discharges with and without treatment) Dredging	Urban and industrial pollution (wastewater effluents discharges with and without treatment) Dredging	Organic inputs (associated with fish feed and faecal pallets), sediments from terrestrial systems
Major impacts	Eutrophication Habitat degradation (loss)	Eutrophication	Local bottom modification
Human utilization of the system	Occupation (housing) Recreation (bathing in the bay area) Food source	Food source	Habitat Food source Tourism
Overall State	Highly modified Heavily Polluted	Modified Polluted	Near pristine, unpolluted
Key stakeholders	Regional government Industrial consortiums Port authorities NGOs	Regional government Industrial consortiums Port authorities	Regional and national government Salmon farmers

A decision support system

Another major product of the project was a site-specific knowledge base on estuarine and basin management, and a spatial decision support system to provide guidelines for restoration and sustainable development of the sites. Santos estuary was chosen as the main case study because is the system where more conflicts are present and consequently where consensus is more difficult to achieve. The SDSS allows the stakeholders to state their preferences (value-based information) for different outcomes, based on good information (factual or technical information). This system contributes for minimizing subjective discussions permitting an objective ranking of the management scenarios.

The replication of the system for the other sites was not considered as a priority in the project as a consequence of the lower anthropogenic scenarios. .

4 Dissemination and use

The Consortium has identified five groups of target audiences that would potentially benefit from knowing the outcomes of the project:

- **Standard Public Bodies and Organisms** that have in charge the definition of policies and decision-making in the coastal management field at each study site,
- **Consortium Organisations**, which will benefit from the projects products exploitation and are better suited to continue the work after the project's end,
- **Technical and Scientific Audience**, such as scientists and engineers involved in the management of coastal areas, participants in related EU projects, integrate coastal management research community, etc.
- **Target Customers**; such as Companies that may be interested in the use of the technology implemented or developed during the project, as well as in partnership with local project partners.
- **General Public** interested in site-specific coastal management or in broad terms.

The paragraphs below provide a publishable summary of each ECOMANAGE dissemination product.

4.1 ECOMANAGE website

The ECOMANAGE public website is one of the main channels of communication and dissemination. Currently the http://www.ecomanage.info/ site provides a combination of contents with different levels of information for different user's needs. It contains general information about the project and enables users to download the products of the project (books, book chapters, deliverables, thesis, etc.).

4.2 Deliverables

Project deliverables make a considerable pool of knowledge and experience for the end user of the project. They cover a wide range of scientific fields and address many site-specific issues. They can act as tools to understand and integrate the major components of each system, thus helping in the decision making process. Public deliverables are available for download at the project website.

4.3 Publications

Targeting the academic community and local actors, the Consortium has decided to publish the project's main achievements in the form of a book, providing an adequate support for the dissemination of the work developed during the project's timeframe. The book reference is:

> R Neves, J Baretta & M Mateus (eds.), 2008, **Perspectives on Integrated Coastal Zone Management in South America**, IST Press, Lisbon, Portugal, +600p. (ISBN: 978-972-8469-74-0)

An integral version of the book will be fully available for download at the project's web site. 900 hardcopies will be printed and distributed to people that manifested interest on the book (including through the web site). A comprehensive list of other publications (book chapters, papers and thesis) are also available for download at the website.

4.4 Models

Numerical models were one of the major research and management tools used during the project: Model applications and results are available for local actors to use, with local partners acting as product facilitators and consultants. This link between local partners and actors enables the dissemination of the products and may lead to future cooperation.

5 Final Remarks

ECOMANAGE has achieved all the objectives proposed and in some aspects went beyond those objectives. The models were developed and made available for actors use and all deliverables were completed. All contractual obligations were fulfilled and an additional product was added to the project in the form of a book.

The management tools developed in the project are being used for answering to management questions in all the sites and contributed for approaching managers and local research teams and for approaching local and European research teams. The reputation of the project extended beyond the communities involved on the sites addressed in the project and activities are planned for other regions in Brazil (States of Rio de Janeiro and Ceará) and for Equator. A course organized after the terminus of the project in S. Paulo was attended by researchers from 5 States in Brazil located between Santa Catarina in the South up to Ceará in the Northeast.

The project was based on the DPSIR - Driver, Pressure, State, Impact and Response – assessment. The study of the estuary/lagoon/fjord was the key aspect of the project. However, the drainage basins were also studied for assessing the drivers and the pressures and for understanding the socio-economic impact of the responses. The need for this integrated approach is clear, but it is not common. The novelty approach of the project proved to be very useful for building the bridge between researchers and managers, but also for stimulating the collaboration between teams that had never worked together.

The edition of the book was very well applauded by end-users and most local actors and is a very useful product for disseminating the results of the project in the whole region. The book was also a means for giving visibility to research teams not formally involved in the project, but that participated in its implementation, providing data and knowledge and that at the end of the project also contributed with text for the book.