Project no. **INCO-CT2005-015226**

Project acronym **WADI**

Project title **Sustainable management of Mediterranean coastal fresh and transitional water bodies: a socioeconomic and environmental analysis of changes and trends to enhance and sustain stakeholders benefits**

Instrument **SPECIFIC TARGETED RESEARCH OR INNOVATION PROJECT**

Thematic Priority **INCO-2003-B1.1 [Comprehensive water policy and integrated planning]**

DELIVERABLE D175
Final Publishable Report by the coordinator of the WADI Project
Prof. F. Scapini, Department of Evolutionary Biology "Leo Pardi", University of Florence, Italy

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DEPARTMENT OF EVOLUTIONARY BIOLOGY
UNIVERSITY OF FLORENCE
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DEPARTMENT OF EVOLUTIONARY BIOLOGY "LEO PARDI"

Revision [draft 1]

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1. Presentation

"Sustainable management of Mediterranean coastal fresh and transitional water bodies: a socioeconomic and environmental analysis of changes and trends to enhance and sustain stakeholder benefits" - WADI

The project acronym **WADI "WAter Demand Integration"** stresses that integrated water management must meet the needs of all stakeholders; these needs generate a demand for water, and integrated water management should have sustainability of the water supply as its major objective.

The logo of the project is an idealized picture of the overall objective of the project "good quality water for everybody" (Millennium Development Goal No. 1). Weak users, women and children, are in front, backed by traditional agriculture, trade activities and a city; natural elements, vegetation and animals, are integrated in the water-land system, as they contribute to its sustainability.

Project website: http://www.wadi.unifi.it

Project coordinator: Felicita Scapini, Dipartimento di Biologia Evoluzionistica "Leo Pardi", Università di Firenze, via Romana 17, 40125 Firenze, Italy; scapini@unifi.it

Project contractors

1. Università di Firenze – Dipartimento di Biologia Evoluzionistica, Italy - UNIFI
2. Consiglio Nazionale delle Ricerche – Istituto per lo Studio degli Ecosistemi, Italy - CNR.ISE
3. Universidad de Alicante - Departamento de Ecología, Spain - UALI
4. Instituto do Mar –Centro Multidisciplinar de Coimbra, Portugal - IMAR
5. University of Malta - International Environment Institute - UOM
6. Université Mohammed V Agdal - Institut Scientifique, Morocco - UM5A.IS
7. Université Abdelmaled Essaâdi - Faculté des Sciences de Tétouan, Morocco - UESSA
8. Université El Manar - Faculté des Sciences de Tunis, Tunisia - UTUN
9. Agence de Protection et d'Aménagement du Littoral, Tunisia - APAL
10. Centre of Environment and Development for the Arab Region and Europe, Egypt - CEDARE
11. Consejo Superior Investigaciones Cientificas - Centro de Blanes, Spain - CSIC.CEAB

2. Introduction

This consortium was established within the framework of two previous projects: MECO ("Baseline research for the integrated sustainable management of Mediterranean sensitive coastal ecosystems", IC18-CT98-0270, 4th framework program, 1998-2001) focused on Mediterranean beaches and their fragile ecosystems, while MEDCORE ("From river catchment areas to the sea: a comparative and integrated approach to the ecology of Mediterranean coastal zones for sustainable management", ICA3-CT2002-10003, 5th framework project, 2002-2005) considered the whole river basin and the links between inland and coastal zones. The main lesson learnt from the previous experience was that no management strategy can be proposed without taking into account the local population using the resource and their willingness to collaborate in the implementation of management plans. During MECO and MEDCORE, the stakeholders were contacted when their help was needed to assist the field research and then at the end of the activities to communicate the project results. The communication of scientific results to the public was considered a duty, as the stakeholders and local communities offered their support to the researchers, both logistic (hospitality) and financial (taxes), thus contributing directly to the progress of science.

The aim of both those projects was to create a solid scientific basis for sustainable management of fragile ecosystems, threatened by the rapid development of societies around the Mediterranean, particularly the development of international tourism in coastal areas. Therefore, particular attention was paid to the sustainability of ecosystems. Yet, when the subject of the study is such a vital resource as the fresh water supply, the needs of local people must be considered first, and researchers must contribute to help people become aware of the importance of the resource and ensure its sustainability through correct behaviour.

Conflicts over water are common at various scales: international, between neighbouring countries sharing the same watershed; within countries, between arid and wet zones; between the centre (government) and the periphery (local context); between different stakeholders in the same area who are using water to fulfil different needs. Disputes over water can often escalate into bitter conflicts or water wars. In some cases, the water conflicts are only pretexts, and mask cultural and economic conflicts or conflicts over land use.

The prevailing ecological background of the participants in the WADI project favoured an integrated holistic approach to water bodies, taking into account the various elements shaping water body systems and their links. Hence, the WADI project took advantage of the interaction and collaboration of specialists of different disciplines of the natural sciences (animal and plant biodiversity and ecology, geomorphology, marine sciences, hydrology and sedimentology) and human sciences (human geography, socioeconomy, sociology, gender issues), as well as technical disciplines (agronomy, architecture, coastal management). To achieve an integration and true

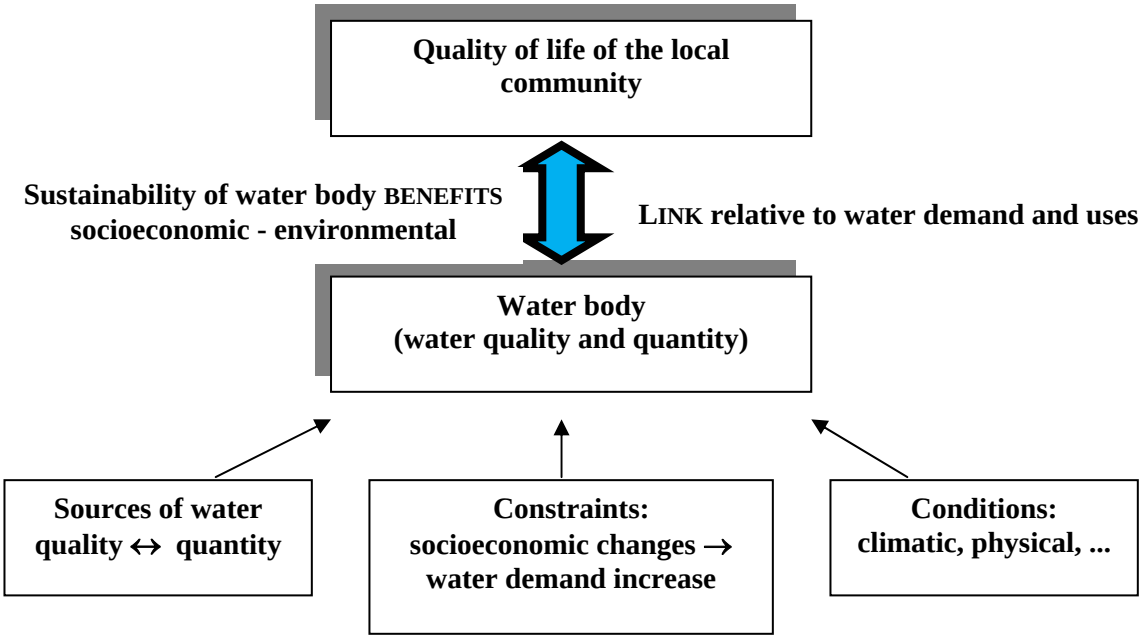
collaboration within the international consortium and among experts, a study site approach was chosen that had proven fruitful in MECO and MEDCORE. The issue of scales, both spatial and temporal, had often generated problems during the implementation of the previous projects, as it was clear that every element of a system had a different scale, from a very small space (a few meters) and short times (days) to a large space (kilometres, topographic to geographic dimension) and long times (years to historical times). The new focus of WADI, i.e. on people, permitted us to choose the relevant scales, which were those of the people's lives and perceptions of changes. However, although the three-year period of the project could be exploited in the best way for ecological research, since an ecosystem undergoes periodic (seasonal-annual) changes, it did not allow for a follow-up of changes at the human level. Changes at this level were observed during the project but they could not be analysed, except for past changes that were studied using historical methods (cartography and photographs, people's memory and tradition, archaeology). Moreover, analysis of the long-term impact of the WADI project on the stakeholders and on their changed willingness to collaborate in sustainable management of the resource was beyond the scope of the project.

The WADI approach was based on and began with contacts with stakeholders (on-site stakeholder meetings), and the outcomes of these meetings helped determine the field research. In the final phases of WADI, researchers came back to the stakeholders with new suggestions on how to solve their problems of sharing water in a sustainable way. This approach allowed us to overcome the issue of how to communicate scientific results to common people, as we established an exchange of information from the start. Language issues in the exchange of information among people with different origin/culture/level of education ware overcome through the facilitation of the local researchers and students. Stakeholder and focus group meetings were project activities and represented part of the scientific research. The communication of science to wider groups, schools and the general public were important activities of the WADI project, which had a specific work package for dissemination of information. Taking advantage of the experience gained in the previous projects, we conducted dissemination activities throughout the WADI project, reaching various stakeholders and local people. Specific activities to enhance awareness of the various threats to the local environment were organized in local schools, and illustrated booklets in the local languages were distributed to the scholars and students and through them to their families. The short-term impact of these activities was analysed through ad hoc questionnaires submitted to the scholars and students.

The WADI project included gender integration as a transverse task. An expert in this field, Dr. Fatiha Bou-Salah, participated in all meetings throughout the project, supervising the issue of gender and its true integration in socio-economic research. Under her supervision and with her advice, original research activities were undertaken at both European and North African study sites to learn more about the context and perceptions of men and women in relation to water and environmental resources at large. Regrettably, Fatiha passed away suddenly near the end of the project. Her expertise and incisive contribution regarding gender integration was amply demonstrated by the fact that the researchers who had collaborated with her and had learnt from her about social issues (being themselves ecologists) were able to carry out and complete the data analysis and produce scientific articles on gender approach applied in the context of the WADI study sites.

3. The approach

Schematic view of the subject and the components of the WADI project



Water bodies around the Mediterranean, where water scarcity and/or unpredictable water supply are common, are very important on account of the benefits they provide to people living in the area. The links relative to water demand and uses in the Mediterranean coastal zones were the main focus of the WADI project. The approach was holistic (systemic), starting from the elements determining and influencing water quality and quantity: sources, conditions and constraints. These change through time as a consequence of socioeconomic and ecological changes. If we focused on water bodies alone, water management would be unsustainable due to the changing conditions. Thus, conditions and their trends were analysed in relation to water quality and quantity to ensure baseline scientific information for sustainable management of the water bodies and the benefits to the local community. Hence, the focus of the WADI project was not on the water bodies *per se* but on their links with people (water demand and uses).

A study site approach was chosen for the WADI project to address real issues, without the risk of underestimating some important elements of the context. We were well aware that decisions were taken at higher levels (national or international) but we wanted to stress the importance of the local contexts, foster awareness of the decision makers on the real contexts, and help to create links for better integrated management of the water bodies. One of the risks of decisions taken at higher levels is the creation of perfect guidelines and management plans that are simply not applicable (or not accepted) in the local contexts, where the constraints are well known and perceived as unavoidable.

Real socio-eco-systems, selected as WADI study sites, are complex. Traditionally, the scientific way of dealing with reality has been its reduction to well-defined, tractable problems, at the expense, of course, of loosing comprehensiveness. For WADI, complexity is not solvable this way, because it had to deal with complex sites in an integrated, not a reductionist, manner. WADI has announced that it will produce, not a juxtaposition of well-defined, sectorial studies on various aspects of the research sites, but integrated assessments of the whole socio-ecological system. And this was not an easy task.

4. Project objectives

The general objective of the project was to encourage the rational and sustainable use of freshwater resources within Mediterranean coastal areas experiencing water scarcity by means of participatory approaches.

The project focused on issues, constraints and conflicts regarding the use of fresh water and other natural resources linked to water, as identified through the active participation of key stakeholders. The aim was to increase awareness and collaboration among the actors for the conservation of freshwater resources and their sustainable use for the benefit of the community at large, particularly of those who have little voice in the local communities.

Specific objectives, which contributed to the achievement of the general objective, were:

1) *To identify conflicts of use among stakeholders arising from improper management of water bodies and related constraints within selected study sites in Mediterranean coastal areas suffering water scarcity and associated constraints.*

A number of significant (on national and regional level case-studies throughout the Mediterranean were selected for assessment and subsequent analysis: El Hondo lagoon (Alicante, Elche and Crevillent, Spain); Maryut Lake (Alexandria, Egypt); Ombrone low plain (Grosseto, Italy); Oued Laou basin (Tétouan and Chefchaouen, Morocco); Oued Tahaddart basin (Tétouan, Tanger Asilah, Morocco); Oued Mejerda low plain and Ghar El Melh lagoon (Bizert, Ariana and Manouba, Tunisia); the estuary area of Mondego River (Coimbra, Portugal). These systems were analysed from the sociocultural, socioeconomic and environmental (geographic, geomorphological, ecological and landscape) perspectives. The sociocultural, socioeconomic and environmental contexts were considered holistically, through an ecosystem approach. Key issues of water demand and sustainability of the selected water bodies were identified during the first project year through meetings with stakeholders at each study site, promoting their reciprocal interactions and an efficient communication between scientists, civil society, managers and policy makers. Information gaps were identified and specific research was conducted at the study sites to provide both qualitative and quantitative databases. During year three, focal meetings were held at the study sites to deal with management issues in particular, and the project results were communicated to the local, intermediate and national stakeholders.

2) *To assess and, where relevant, estimate the impact/s of various water uses and nearby human activities on coastal water bodies, such as fluvial systems, estuaries, marshlands and lagoons.*

Baseline conditions were assessed using available historical and archaeological information and, where applicable, palaeobiological and sedimentary records. Impacts were assessed, indicators of impacts identified and their magnitude estimated according to prevailing conditions at each study site. The results were integrated in geographic information systems (G.I.S.), which provide a suitable interface for management purposes. Databases were constructed by integrating the existing information and that resulting from the project, developing a flexible data system to be used by project participants and interested stakeholders. Quantitative data were geo-referenced and time-referenced, so that the application (developed with visual tools and using object-oriented languages) allowed the creation of regional maps. The information in these maps has been registered to enable a more complete spatial analysis, as well as graphic presentation of the data. Where applicable, models were developed using existing time series to highlight trends of changes, and influential factors were estimated.

3) *To produce interdisciplinary scientific inputs for improved participatory water management strategies and related planning regimes for a rational use of water resources, taking into account economic, sociocultural and environmental constraints at the local level but without losing sight of other broader scales (national, regional and international).*

Soft-system analyses, among which "focus group seminars" for stakeholders, were used at the study sites to identify key issues and constraints for subsequent management of water resources. The progressive strong changes and trade-offs in water allocation among domestic, agricultural, industrial and commercial uses were considered. The results of the analyses conducted in the case-studies helped to develop alternative scenarios of water management, which were presented to the stakeholders in the course of dissemination meetings held locally and at intermediate levels. The project results were presented to managers and collaboration agreements were signed with the researchers and institutions participating in WADI. The local population was also involved through events designed to explain the project results.

4) *To develop and propose alternative management strategies and plans for the selected sites as well as general guidelines for appropriate and sustainable management of water resources in Mediterranean coastal areas.*

The study of impacts, and indicators thereof, resulted in alternative management strategies that were proposed to the stakeholders for the specific cases analysed and also for a wider Mediterranean context. Visibility was given to the alternative scenarios suggested to stakeholders and users. The management strategies developed throughout the project and applicable in local contexts were extended to other similar contexts in Mediterranean coastal areas by means of wide-scale dissemination opportunities (conferences and workshops). Moreover, the databases were used on a wide geographic scale in comparative studies.

5) *To establish a network of scientists, authorities and local communities within the Mediterranean, to enhance local awareness of water quality, use and misuse.*

In the chosen case-studies, the various stakeholders were identified, along with their various forms of contribution to water management according to the specific physical, socio-economic and cultural backgrounds. The contacts established among water managers, local and national authorities and scientists were considered a positive achievement of the project by the stakeholders. They helped in profiling different local communities and defining the roles of men and women in different areas and levels of water management and planning. The specific role of women as end-users of water was a main focus and special attention was paid to gender issues when necessary. Dissemination material was produced to convey easy-to-understand messages about the importance of water, cultural and natural resources and their conservation through correct use. Target audiences were the scientific community, students and scholars at all levels as well as the public at large.

Maggo primary school in the Oued Laou river basin: the distribution of the WADI children book on endemic species (*Aventures au Royame des Amphibiens et de reptiles,* WADI, Firenze, 2008)

5. Project implementation

The following principles guided our work within the framework of the WADI project:

1) The approach was integrative and multidisciplinary, corresponding to a truly environmental and co-operative research project;

2) The approach was participative, promoting real engagement of stakeholders;

3) Technically, this approach was based on scenario analyses and case-studies;

4) The analysis of each site was conducted in such a manner that it could provide advice for sustainable development initiatives promoted in non-European countries around the Mediterranean.

The project activities were subdivided into work packages that were logically linked and successive, each taking advantage of the output of the other work packages, establishing a network of links among work packages rather than a linear succession. At each study site, all the work packages were implemented throughout the period of the WADI project. However, the timing of implementation was not the same for all sites, and, following the meetings with stakeholders carried out at the beginning of the project, stress was given to work packages and activities that had been judged necessary for each particular case. Throughout the project, it appeared that a mass of non-linked activities was implemented at the sites, depending on logistics and seasonal issues. However, the goals of the research had been clearly set and, at the end of the day, progress was made with respect to the starting point at each site.

Many meetings were organized throughout the project, to which all participants were invited to learn about the progress of the others involved and contribute with his/her experience. The meetings were carried out on an equality basis between different countries and academic/non-academic positions; interested stakeholders and researchers not directly involved in the project were invited to the meetings to offer their contribution. The frequency of the meetings, mostly held at the study sites, as well as the enthusiastic participation in the meetings by young researchers, enormously contributed to the integration among the study sites and among stakeholders within the WADI consortium.

The meetings carried out throughout the project were:

General project meetings: Kick-off, February 2006, in Alicante (Spain); Mid-term, June 2007 in Coimbra (Portugal); Consolidating, June 2008 in Elche (Spain); Final, November 2008 in Malta;

Meetings to integrate the research at specific study sites: Rabat, February 2007 and March 2008, for the Oued Tahaddart site;

Meetings with the stakeholders at the study sites to present the WADI project and learn about the issues at the sites: Alicante, Crevillent and Elche, February 2006, for the El Hondo Study site (Spain); Cairo and Alexandria, April 2006, for the Maryut Lake study site (Egypt); Alberese, May 2006, for the La Maremma study site (Italy); Chechaouen, October 2006, for the Oued Laou study site (Morocco); Tunis, November 2006, for the Majerda and Ghar El Melh study sites (Tunisia). These meetings were carefully prepared by the local participants to involve as many different stakeholders as possible; in most cases, the meetings for one study site were held at different venues to reach different stakeholders;

Work-together meetings at the study sites to integrate field research of the WADI participants: Maryut Lake in Egypt, April 2007, for ecological research on the lake; Oued Laou-Chaouen, May 2007 and September 2008, for gender approach; Tetouan-Oued Laou, September 2007, for a pilot project on waste water depuration; Ghar El Melh and Raf raf, November 2007, for socioeconomic and ecological research; Ghar El Melh, April 2008, for ecological research on the lagoon; Oued Laou, March 2008, to prepare materials and strategies for dissemination in the local schools; Oued Laou, June and October 2008, for impact assessment; Maremma, November 2008, for impact

assessment. These work-togethers were highly demanding in terms of organizational efforts; however, the working together in the field of international teams was not only fruitful for the project participants, especially the young researchers involved, but also gave visibility to the project vis-à-vis the stakeholders and allowed the researchers to live at the site and get acquainted with local issues.

Verification meetings with the stakeholders: Maremma (Italy), October 2008, with the participation of Spanish and Maltese researchers; Elche (Spain), December 2008, with the participation of Italian stakeholders. During the first round of stakeholder meetings, the WADI participants had promised that they would come back to the stakeholders to present the project results. This was carried out successfully in the cases where contacts were not interrupted throughout the project and are being maintained beyond WADI. However, contexts have been changing rapidly and new problems have arisen, or a better understanding of the issues has changed the relationships. Where conflicts already existed, e.g. around the El Hondo water body and the sandy littoral of the Maremma Park, they have increased and escalated. Moreover, the local researchers could not remain neutral when they witnessed bad management of the environmental resources. The strategy of involving WADI researchers or stakeholders from other countries allowed for smoother exchanges, while enhancing awareness of the issues.

Meetings to disseminate the project beyond the WADI study sites: The CSIC.CEAB team held an informative session about the WADI project approach to conflicts in wetland ecosystems at the Aiguamolls de L'Empordà Natural Park (PNAE; Wetlands of the Empordà, a region in northern Catalonia, Spain) on 17 December 2007 (month 24). More meetings of this kind are envisaged in the future, beyond the WADI project;

Participation in international meetings and in meetings of related projects on IWRM (e.g. GEWAMED)

Work Package 1 (*Qualitative system description of the core study sites)* developed conceptual models of the case-studies. The players or actors (stakeholders) were identified at the local, intermediate and national levels and invited to meetings at the sites. At the meetings, the local issues concerning the uses of water and natural resources were presented, as well as existing plans of mitigation. Discussions were conducted about the relevant issues and collaborations established between project participants and stakeholders. Visits to the sites were guided by the local participants, and plans were developed for *in situ* quantitative analyses to be conducted throughout the project within the framework of the subsequent work packages. The information on each case-study was made available in booklets and CDs with images and PowerPoint presentations, as well as on the project website. This information was updated throughout the project, particularly regarding existing information (including grey literature). Key stakeholders were contacted again during field activities, thus maintaining a flow of communication. In year three, a new round of meetings was organized by the local participants to present the project results, discuss the issues and scenarios, and establish co-operation between researchers and stakeholders to be maintained beyond the project.

Work Package 2 (*Quantitative system description*): Important variables were chosen for the case-studies with regard to feasibility, measurability, replicability and comparability with other sites and scenarios in the Mediterranean. Guidelines for socio-economic analyses were developed (integrating the gender dimension) and questionnaires to be submitted to the stakeholders were agreed for the various contexts. These questionnaires were made available on the Internet, tested at the sites, refined and applied in the various contexts. Research protocols were established to analyse relevant issues at the sites, applied to the real cases, and also made available on the Internet. This

work package developed quantified system descriptions for the case-studies regarding various compartments: water, soil, biodiversity, landscape, socio-economic context and management. Tables were developed for the various case-studies, and they were made available to all project participants and updated throughout the project. Meetings were held locally to co-ordinate field research. Collaborations were established among participants and work-together field activities were held at the sites. The results were displayed on the Internet, presented in meetings and conferences, and published when applicable.

Work Package 3 (*Assessment of impacts on the different compartments: sociocultural, economic, environmental, ecological*) was carried out to develop indicators of impacts on water quality and quantity, on exploitable biological resources and on socioeconomic conditions in the different case-studies, and to model their trends. Geographic information systems were developed when relevant to the case-studies. Tables and maps to define and locate impacts on different compartments at the study sites were prepared by the participants and discussed in the course of on-site meetings with the stakeholders.

Work Package 4 (*Developing alternative desirable socioeconomic and ecological scenarios, and guidelines on how to manage water bodies*): An assessment of existing management plans was conducted, assigning a weight to the decision making capacity of each stakeholder in the selection and implementation of alternative management plans. Alternative scenarios were developed for the case-studies and compared. Ecological, economic and technical models and scenarios were developed and applied to the range of values observed for the different state variables identified for the case-studies, and they were spatially analysed through G.I.S.

Work Package 5 (*Dissemination of results*) involved cross-cutting activities and was carried out throughout the project. Books on study sites were published to collect and disseminate research results as a baseline for future research and management: *Il Parco regionale della Maremma e il suo territorio. Una guida per conoscere e capire* (Scapini, Nardi eds., Pisa 2007); *Du bassin versant vers la mer: Analyse multidisciplinaire pour une gestion durable. Cas du bassin mediterranèen de Oued Laou.* (Bayed A. & Ater M. (éditeurs), Travaux de l'Institut Scientifique, Rabat, série générale, 2008, n°5). The Proceedings of the WADI International Conference, Malta 5-8 November 2008, were published by Firenze University Press and made freely available on the Internet: *Sustainable management of Mediterranean coastal fresh and transitional water bodies: a socio-economic and environmental analysis of changes and trends to enhance and sustain stakeholder benefits* (editors: F. Scapini, J.-M. Boffa, E. Conrad, M. Nardi). A project manual, the WADI BOOK, includes the project framework and results of interest to an international audience of scientists. Special attention was paid to the local dissemination of information; in order to reach the local public in the best way, we produced an illustrated book for children in Morocco: *Aventure au Royame des Amphibiens et des Reptiles* (S. Fahd, L. Bertelli, Y. Rayani, L. Fanini, A. Oumoussa, Firenze 2008). The book, written in both French and Arabic, describes the local environment to the children, so as to encourage them in the conservation of natural ecosystems and biodiversity. Dissemination of the project results included events held at the study sites focused on specific social groups: scholars and students, women's associations, farmers' associations, environmental managers and policy makers at the local, intermediate, national and international levels. Increased awareness of the cultural, sociocultural and environmental resources was fostered by the WADI project participants through the preparation and diffusion of CDs for the local public: *El cultivo de Arroz en el entorno del Hondo*, University of Alicante; *Valores ecologicos y culturales de la parte sur del término municipal de Crevillent,* University of Alicante; *La memoria dell'acqua*, ISE-CNR; *Le zone umide nella pianura grossetana*, ISE-CNR.

6. Project major achievements

According to the study site approach and the relationships among work packages, in the following sections we present the WADI project study sites and the major achievements at each site, as well as the perspectives beyond WADI. When describing the study sites, we follow an east-west gradient to avoid the traditional north-south or developed-developing countries subdivision. In fact, all the coastal study sites are rapidly changing and subjected to similar pressures of urbanization, economic growth and climatic constraints. Moreover, their history is common, and we have learnt to recognise our common Mediterranean roots despite apparent diversities.

6.1 The Egyptian site: Maryut Lake

Introduction. In Egypt, in the eastern part of the Nile Delta, the beautiful historicalcity of Alexandria is backed by Lake Maryut, a coastal fresh water lagoon that belongs to a network of coastal lakes and collects water from the Nile, also buffering the floods thereof. The lake also has a high landscape value due to its geographical position. However, water flow into the lake has decreased as a consequence of upstream managements of the Nile River. Lake Maryut also collects discharge and waste waters from agriculture, urban and industrial uses. Its pollution has been aggravated by the recent development of the city of Alexandria and has dramatically increased since the deviation of its discharge channels from the Mediterranean Sea to the lake, so as to keep the coastal waters of tourist resorts clean. From that moment on the situation of the lake has become worse with a sudden decline in fish catches. The lake supports a numerous population of fishermen. This population is getting poorer and poorer as fish stocks in the lake decline. From a holistic (watershed) point of view we should also consider the effect of increased nutrient discharge from agriculture to be a consequence of decreased fresh water supply from the Nile. Income generating activities around the lake are also the sorting of solid urban wastes and the cutting of reeds in the lake for several uses, e.g. building. Women and children participate in these activities. The solutions proposed by the local administration include the filling up of the lake to gain ground for buildings and their infrastructures. Such measures will hardly favour the local population around the lake, the "lagoon people". A large amount of money from the World Bank has been earmarked to analyse the current situation, without showing a real willingness to improve it in favour of the local people.
Description. Lake Maryut is one of the northern Egyptian lakes, located south west of Alexandria. The lake extends between 31° 01′ 48″ and 31° 10′ 30″ North and 29° 49′ 48″ and 29° 57′ 00″ East. The lake is artificially divided by Alexandria-Cairo Desert Road, El-Umum Drain and Nubaria Navigation Canal into four basins, namely: Main Basin, Aquaculture Basin, Northwest Basin, and Southwest Basin. Each of these basins has different characteristics in terms of depth, vegetation cover and water quality. In contrast to other northern lakes in Egypt, the lake is not naturally connected to Mediterranean Sea. Yet, Lake Maryut is artificially connected to the sea through El Max pumping station, which discharges the overflow from the lake directly to Mediterranean Sea via El-Umum Drain. The present Lake Maryut represents a small portion of a large lake that was known during the Roman Era by "Lake Mariutus". It was connected by a branch of the River Nile called Kanobi Branch through small canals. The sediments of the lake indicated that it was received both sea water and freshwater in the course of its history as they consist of fluvial deltaic formations and brackish lagoon mud. It seems that marine sediments were deposited during periods of high sea level when sea water invaded the lake depressions.
Lake Maryut plays a crucial role in fish production, preventing intrusion of salt water to the agricultural land in its surrounding and adjusting the climate of Alexandria city. Also, the lake has

great potentials for recreational and tourism activities. Moreover, from environmental perspective, the lake is considered as an ecosystem, which is a habitat for various species.
The average water depth in the lake is about 120 cm. The bottom elevation varies between 3.7 to 4.0 meters below sea level. The main sources of water that feed the lake include El Qallaa Drain, El-Umum Drain and Nubaria Canal. Also, there are a number of outfalls that discharge sewage water after primary treatment, and untreated industrial wastewater. The main basin is suffering much, at present, from the intensive pollutants entering it through all kinds of discharges.
Wide areas of the lake are covered by vegetative masses principally Phragmites and Hyacinths. For example, these vegetative masses cover about 60% and 40% of the Main Basin and South-east Basin, respectively. Also, the bottom of some parts of main basin is covered by submerged aquatic vegetation. It should be noted that such a vegetation cover may accelerate sedimentation of particles of sand and constrains the water circulation in the lake. Furthermore, such vegetation cover may restrict fish production in the lake as it reduces the dissolved Oxygen in the water body.
Socioeconomic and cultural aspects. In general, fishing activities is one the most dominant economic activities in the lake. Fisheries of Lake Maryut were characterized, historically, by large fish production in terms of quantity and quality. There's, also, the aquacultures, which occupy wide areas of the lake. However, fishing activities have been decreasing steadily due to deterioration of environmental quality and declining area of the lake. In this respect it was estimated that fish production from Lake Maryut has decreased from 11,365 tons in 1981 to 4,861 tons in 2003 and the share of fish production from Lake Maryut has declined from 8.2% to 1.1% of the total fish production in Egypt during the same period. It should be noted that, despite fluctuation of fish production during the last decade, fish catch from the lake is apparently declined. In addition to decreasing fish production, it was argued that due to the deteriorating water quality in the lake during the last period, some kinds of fish production disappeared as Mullets (Mugil), eals, cat fish, etc… Recently, it was estimated that the total fish production, including fish catch and aquacultures was 5,000 tons annually, which means an annual production value of EGP 35 million. According to recent statistics, there are 2,073 fishing boats in the lake and 20,000 fishermen. Taking into consideration that the average family size is 4-5 persons, this means that about 100,000 inhabitants rely on fishing activities in the lake to earn their livelihood.
Nearby the lake there is a wide area of newly-reclaimed land which includes a number of human settlements, mainly rural. Most of these settlements discharge their domestic wastewater (sewage) into irrigation and drainage canals, which discharge their water ultimately into the lake through El Qallah drain. Also there is an industrial complex nearby the lake (mainly petrochemical industries), these industries discharge industrial wastewater into the lake after some sort of treatment.
The preliminary socioeconomic assessment highlighted that the impacts on farmers seemed to be insignificant and thus could be eliminated from the field survey. Moreover, the local residents of the area of Lake Maryut have low level of awareness about the lake and its deteriorating conditions.
Legal framework. The area of the lake is managed according to Law 124 of 1983, which organizes the fishing activities in the Egyptian lakes. According to this law: The General Authority of fisheries, Ministry of Agriculture, is the main agency that is responsible for managing the lake (Article 2); It is forbidden to discharge industrial waste water, pesticides or any similar toxic or radioactive compounds into the water (Article 15); It is not forbidden to fill in or drying any parts of the lake (Article 20); In addition, Law 4 of 1994 "Law of Environment", assigns the responsibility of protecting the environment and monitoring the discharges of various activities into the environment to the Ministry of state for Environment.
Main issues in Lake Maryut. The preliminary assessment of the current situation of Lake Maryut highlighting a number of areas of interest including: a. Deteriorating water quality: Due to the discharging of industrial, agricultural wastewater and some municipal wastewater into the lake, the water quality of the lake has declined considerably. This decline in water quality is continuing despite partial treatment of some discharged industrial and municipal wastewater. b. Declining area of the lake: The area of the lake has decreased due to filling in activities to acquire land for urban

development of Alexandria city. In this context, it was estimated that the area of the lake decreased from 38,000 Feddans in 1952 to 17,000 Feddans in 2000. This means that during the 2nd half of 20th century the area of the lake has declined to 50% of its original area. c. Spreading of vegetation: Due to increasing concentration of organic matter in the lake, the vegetation cover has increased, covering wide areas of the lake. Such an increase in vegetation cover affects adversely the fishing activities. It should be noted also that the increasing vegetation cover affects adversely the fish production in the lake as it reduces water circulation in the lake. Furthermore, such large vegetation cover speeds up the process of sedimentation. d. Declining fish production: As a result of continuous deterioration of water quality of the lake, the fishing production has considerably declined during the past two decades in terms of both quality and quantity. The fish caught is usually contaminated with heavy metals and other pollutants affecting it suitability for human consumption. e. Aesthetic problems: The high levels of pollution cause bad smell and odor from the lake.

Stakeholders' consultations. The case of Lake Maryut involves a large number of stakeholders at both national and local levels with sometimes conflicting interests. Such a conflict among various stakeholders has adverse impacts on the environmental quality in the lake and its surroundings. The stakeholders' consultation showed that the main real issues can be summarised in two main issues. The first issue represented in pollution problems in the lake due to discharging of waste water from different sources into the lake; Meanwhile, the second issue represented in declining area of the lake due to land filling and illegal encroachment on the lake vicinity. The main causes of these problems can be summarized in: mismanagement, misinformed decisions, and unclear Institutional setup as the lake is currently managed by a wide range of authorities at both local and national levels. Moreover, there is a large number of stakeholders with conflicting interests and lack of financial resources & misallocation of what exist.

Tools developed: GIS and suitability analysis. The work during WADI project included building a comprehensive and detailed geo-database and developing GIS for Lake Maryut. The developed GIS provided detailed information on various variables of water quality in three basins of the lake. Accordingly, the system was employed in conducting suitability analysis of water quality in different parts of the three basins for aquaculture and irrigation. Such a GIS is useful for future monitoring activities and support decisions concerning the management of natural resources in the Lake. The suitability analysis, which covers three basins of the lake; namely Main Basin, Aquaculture Basin and Southwest Basin, employed two main techniques: computer-assisted overlay and weighed liner combination. The results of the suitability analysis identified those parts of the three basins that have water quality is suitable for aquaculture and irrigation activities. Those parts that were found to have water quality suitable for aquaculture and irrigation activities, according to weighed linear combination technique, refer to those parts that have a relatively improved water quality within the lake. Thus, water in these parts could not actually be used in these aquaculture or irrigation activities until several corrective measures are taken.

The most serious problem concerns the lead concentration in the water. Lead, in all parts of the lake, is higher than the recommended levels. The main source of the problem was El Qalla Drain with more than 400,000 m^3 of raw sewage discharged into the lake on daily basis. In this context, there is an urgent need to take an action for system reversal to rehabilitate the water quality in the lake to be suitable for some human uses.

Economic valuation of the Lake. More attention will be devoted also to the Economic valuation, though the lake is expected to be undervalued, e.g. 17% of cases preferred land filling as the best alternative. The economic valuation of the environmental deterioration in Lake Maryut, would include estimate of value the loss in fish production, cost of worsening health conditions of the residents, value of acre of wetlands (using vegetation cover for animal feeding) and value of leisure (enjoying). The area of Lake Maryut has decreased during the period from 1984 to 2002. Such a decline in the area of the lake was mainly due to urban development. The economic valuation of some economic goods provided by Lake Maryut, in particular fish production, indicated that the

total economic value of fish production from the lake, based on certain estimates, assuming 5%, 7.5% and 10% discount rates, equals to EGP 84,000,000; 56,000,000; and 420,000,000, respectively. The present value of the foregone fish production due to landfilling and drying activities, assuming again 5%, 7.5% and 10% discount rates, equals EGP 100,580,000; 67,040,000 and 50,290,000, respectively. This means that the total economic value of returns on fish production, including lost production due to landfilling and drying activities, assuming 5% and 10% discount rate, range between EGP 470,029,000 and 940,578,000. It is worth mentioning in this respect that these estimations undervalue the value of fish production from the lake, which could have been higher if optimum conditions in the lake, in terms of water quality and depth, were maintained. It is worth mentioning in this respect that these estimations undervalue the value of fish production from the lake, which could have been higher if optimum conditions in the lake, in terms of water quality and depth, were maintained. The location of Lake Maryut may have acted as a deterrent to expansion of the city of Alexandria in that direction and thus protected agricultural land from urban encroachment. Accordingly, the potentials for urban expansion in the direction of the lake were assessed and it was found that urban expansion in the vicinity of the lake, despite its relative proximity to city centre, has been constrained by the presence of the lake. Also, the lake presence, it could be suggested, has assisted in saving considerable agricultural area in its vicinity from urban encroachment. Nevertheless, it is estimated, assuming that the lake did not exist; an area of about 6.44 km^2, which is about 1465 Feddans (1533 Acres), could have been encroached upon by urban expansion. The market value of this area, assuming a price per Feddan of EGP 100,000, is estimated to be about EGP 147 million. It is worth mentioning that this value does not include the value of the lake area itself, but rather its function as a barrier to urban expansion.

Conclusions drawn from the results of project WADI. The assessment of Lake Maryut conditions and context suggested that existing water management measures are seriously affecting the viability and sustainable resources production by the Lake ecosystem. This in turn is having negative impacts on local population, potentials for economic utilisation of lake resources and economic development. The studies conducted in this site, within the WADI project, because of their holistic and sound scientific base, can have an added value. They can provide stakeholders with the appropriate tools for the application of alternative management strategies that can support conflict resolution as well as funding initiatives. Moreover, further analysis should be emphasized on assessing the role of women in the economies of the area and identifying the main groups that are mostly affected by the deterioration of the environmental conditions in the area and analyzing the poverty incidence in the area.

In conclusion, it could be suggested that existing conditions in the lake require the adaptation of cooperative actions by all stakeholders, so that the whole potentials of the lake could be realised. Otherwise, if current status would let to continue, it would be a matter of time that the real environmental value of the lake would seriously diminish. Ultimately, this could lead to an irreversible situation where the damage could undermine the integrity of the whole ecosystem of the Lake.

Figures: A) Typical Lake Maryut landscape. The small dock of the aquaculture basin. B) Sampling work in Lake Maryut, Measuring the density of the vegetation;

6.2 The Tunisian site: Low Plain of Oued Majerda and Ghar El Melh lagoon

Introduction. In Tunisia WADI participants have chosen an area located on the northern coast of the country, including the low basin of Oued Mejerda and Ghar El Melh lagoon. This area is of high economic, environmental, landscape value, although threatened by floods and droughts, coastal erosion and silting up of the lagoon and its outlets. The risks are aggravated by the recent construction of a highway, the development of intensive agriculture, urbanisation and management of irrigation water to supply agriculture in the arid central regions of Tunisia. These activities are in many cases managed by international enterprises, which act sectorially with scarce consideration of the local needs. Also, intervention in one sector (e.g. tourism) may have negative effects on another (e.g. agriculture). Coastal management projects are being developed to enhance tourism activities in the region, while the needs of the lagoon population who depend on fishing and traditional agriculture are scarcely taken into account by the intermediate and national level decision makers.

Site description. The Oued Majerda, the biggest river in Tunisia has formed an alluvional plain, exploited both for intensive agriculture and cattle breeding as well as bathin tourism being located not far from the cities of Tunis and Bizert. A highway was recently constructed to foster the development of the region. However this infrastructure has recently causes floods by stopping the water and sediments coming down from the sourrounding hills in the occasion of heavy rainfalls. The plain is rich of waters, surface water of the river and underground water. Wetlands and coastal lagoons represent a reserve of biodiversity, a ground fo hibernating birds and a resource of fish and sea food for the local population. In the plain an intensive agriculture has developed thanks to the irrigation facilities.

Hibernating water birds in the wetlands and lagoon of north-eastern Tunisia. The humid zones of the study area were studied for their importance for water birds, namely the hibernating ones. The aims of the study were: to obtain a list of rares and threatened species visiting the site in winter; to estimate the potentiality of the site to host hibernating birds; to estimate population changes during the three project years; to infer possible threats to the bird populations and to suggest protection measures. Given the importance of water bodies in the area, the study was limited to the aquatic birds Podicipédiformes, Pélécaniformes, Ciconiiformes, Phoenicoptériformes, Ansériformes, Gruiformes and Charadriiformes. In total 49 species subdivided into 16 families and 8 orders, were observed in the area during the winters 2006/2007, 2007/2008 and 2008/2009, which is half the number reported for Tunisia. The distribution maily depends on the position of the migratory routes of the birds. Ecologically water birds are key stone species for humid areas.

Following the data collected the site has an international importance for migrating birds, according to the RAMSAR CONVENTION BUREAU (1995) : 1) *Oxyura leucocephala*, species globally threatened (criterium 2A) is frequent at sebkhet Ariana; 2)two species visit the site with more than 1% of their regional population size (criterium 6B), *Phoenicopterus roseus* and *Tadorna tadorna* at sebkhet Ariana; 3)this site regularly hosts more than 20000 individuals (criterium 5B).

Assessment of water resources regarding the quantity, quality and distribution. Surface and underground waters are very important for the region and they are mobilized mainly for agriculture and urban uses. The sources of potential impacts, such as urban and industrial pollution, were identified along the Majerda river and its main affluents, and water quality was assessed monthly at twelve stations chosen for potential impacts of nearby activities. Physico-chemical parameters measured: pH, MES, Turbidity, soluted Oxygen, DCO, DBO, Nitrates, Nitrites, Phosphates, Salinity, Clorures, Solphates as well as heavy metals. The results on water quality showed a quality from Bad to Medium, along the low course of the river depending on the existing sources of pollution. The suitability of the water was then analysed for urban uses (drinking water), agriculture (crop irrigation) and cattle. The results indicated that for the high contents in salts and Nitrates/Nitrites it is not usable for drinking; for the high salinity is only partly usable for irrigation;

however in half of the stations it was good for cattle breeding. The last activity is currently underexploited.

Ecologycal description of Ghar El Melh lagoon. The lagoon may be subdivided into three sectors determined by abiotic factors (water quality). The northern sector is rich in nutrients (urban wastes from the village Ghar El Melh) is rich in the green alga *Ulva rigida;* the central and western sectors are dominated by *Ruppia cirrhosa* (70% of the surface) and green algae of the gender *Cladophora* (80% of the surface with a low density) are dominante in the central and western lagoon; the highest biodiversity was found near the outlet with 18 species. *Cymodocea nodosa* is the most abundant species, while the invasive alga *Caulerpa racemosa* has been observed for the first time in this lagoon. Also plantulae of *Posidonia oceanica* have been oserved at the outlet of the lagoon.

A population study of *Pinna nobilis* and *Cymodocea nodosa* in the Ghar El Melh lagoon was conducted during the project WADI time lapse to analyse the trend of change. The populations analysed were found in the sector near the lagoon outlet, where clean oxygenated water exists. Descriptors of growth and density were utilized both in situ and in the laboratory. The densities and the production rates dramatically decrease in the interior of the lagoon, despite the low water depth. Animal and plant diversity linked to this ecosystem were also studied.

A work-together field mission took place at the two lagoons to collect the data needed to ecologically describe and chart both ecosystems. This kind of work will allow to develop a global idea of the ecosystem functioning and its ecological status. We adopted an extensive sampling plan in both the lake and the lagoon. The variables considered in the lake and lagoon field prospective were: Water analysis (Depth, Oxygen concentration, Conductivity, Salinity, pH, Water transparency, Solar irradiance); Sediment analysis (Redox potential); Vegetation analysis (Visual measures: Cover, Density). Two fish species (an eel and another abundant fish species that will be further identified) were bought in a small store near the harbour. Eels are the main resource in Ghar el Melh lagoon, as explained by the Director of the Fishery School of Ghar el Melh. The extensive and intensive survey of the Ghar El Melh Lake and the Sidi Ali El Mekki Lagoon have already allowed elaborating some preliminar conclusions. From it has been seen, both the lake and the lagoon were shallow (0.3-1.9 meters) aquatic ecosystems with oligotrophic water conditions. Salinity values (37-42‰) were high in all lake and lagoon studied areas, due the existing wide connection with the sea. A muddy anoxic sediment constituted the bottom of both the Lake and the Lagoon, where different algal (i.e. *Ulva* sp, *Enteromorpha intestinalis*) and aquatic phanerogams (i.e. *Ruppia cirrhosa*, *Cymodocea nodosa*) species grew with high cover and density rates. An extremely well developed vegetation mass, together with low water depths could probably be the cause of the high water oxygen concentration values found (79-120%). The first impression that could be taken from these observations would be that changes in the kind of vegetation may be responding to salinity and water turbidity variations found between the different areas of the Lake and the Lagoon. So the vegetation changed from the eastern zone, strongly influenced by the sea connection, to the west. Beside salinity, water turbidity seemed to be the other variable determining the type of vegetation found in the Lake: the low depth values, accompanied with the muddy sediment and the strong wind conditions, gave high water turbidity rates. This low water transparency could be limiting the presence of vegetation to the shallower zones of the lake, where light extinction was low all along the water column. In Sidi Ali El Mekki lagoon, the conditions were similar to the ones found in Ghar El Melh, although small differences were present, such as higher salinity values (40-60‰) and lower depth values (10-55 cm). The sediment was similar to the one from the eastern parts of the Lake, anoxic and sandy. The vegetation found (*Ruppia maritima*, *Enteromorpha sp.* and green algae) seemed to follow a similar pattern than the one found in the Lake, although the green algae species were different. In general terms, water quality both in Ghar El Melh Lake and Sidi Ali El Mekki Lagoon were good, performing ecosystems in good environmental health.

The socio-economic context. Despite the apparent development of intensive agriculture in the area, several issues and constraints were highlighted by the socio-economic analysis conducted in the

agriculture area in the framework of WADI. Firstly, the costs of mantainance of the irrigation canals is high, as well as that of chemical manure, insecticide and labour, and farmers ask for more financial aids. Most of the farmers have loaned the ground they cultivate and are by no means aware of the risks linked to the un-controlled use of pesticides and chemical manure. These issues are preventing further development of agriculture in the area.

The socio-cultural context around the coastal lagoons of Ghar El Melh and Sidi Ali El Mekki. On the borders of these lagoons and in the back dune littoral area, a traditional agriculture on sand ground is made, named *ramli*. This is an intensive horticulture that does not need irrigation. It exploits the underground water and the tides, so that the roots of the plants are irrigated twice a day by the increasing level of the watertable at high tide. The watertable is seasonally recharged by the rain water flowing down from the sourrounding hills. The sand on which the plants grow is periodically changed and in some cases sand from the sandy beach is illegally taken. Also the chemical products used are often thrown directly into the lagoon, thus contributing to its pollution in case of low circulation of water. Nevertheless, the research carried out by the WADI project has highlighted the socio-cultural interest of this traditional agriculture and the risk of loosing it as a consequence of the development of bathing tourism in the area.

Figures: Fellahs at work in the *Ramli* during the presentation of the questionnaires

Impact assessment on Ghar El Melh and Sidi Ali El Mekki lagoons

Geomorphological changes were analysed throughout time, using historical documentation (marine and terrestrial carthography, aerial photographs and satellite images), particularly around the Sidi Ali El Mekki lagoon that has been subject to recent changes after the construction of the new port that opened the lagoon seaward. The changes of the shoreline linked to sedimentary mobility as well to the afforestation of the hills sourrounding the lagoon, were documented throughout the last decades. Moreover, the construction of holiday houses on the hills and the dunes has accentuated the decrease in sedimentary supply of the beach. The sand blown downhill by the wind threatenes these houses instead of supplying the beach and dunes of sediments.

The importance of the *Ramli* cultures has not been considered in the management plans developed to contrast the erosion of the coast. The WADI research highlighted the uniqueness and relevance of this traditional activity. The socioeconomic data obtained from the analysis of the 81 questionnaires given to the *Ramli* farmers around the lagoon (all small land pieces around the lagoons and backing the littoral were visited) highlighted the socio-demographic and professional characteristics of these farmers; the characterstics of the *Ramli* exploitations, property, crops, work and production; the techniques used; the risks and the perception of risks as well as the link to this traditional agriculture. The perceived changes concern the position of the littoral as a consequence of the construction of the fishing port and consequently of the *Ramli* area. The perceived treats are: the population getting older, at risk of loosing the expertise and tradition and the substitution of traditional activities with activities linked to tourism. No young farmers nor children or women

were encountered during the survey. The old farmers crain that they will not be replaced by young people, who have different interests and lack specific know-how. In some cases the *Ramli* cultivation is a pretext for soil occupation. On the littoral side of the lagoon small wooded houses are constructed and gradually transformed in beton constructions, so that the law aginst these can be overcome. Another threat is the enhanced connection of the lagoon to the sea and its salinization. As a consequence of sea level rise, a possible evolution of the lagoon would be to become an open marine bay, and the biodiversity typical of sand marshes and coastal lagoons is at risk of loss.

New perspectives. Currently the management of the area is by no means integrated (different stakeholders have power at different levels). The holistic (ecosystem) approach of WADI has highlighted new relationships that should be considered in the management plans of the area. Following the research carried out within the WADI project, the Tunisian participant APAL, the governmental agency for the littoral zone, has recently declared the coastal area and the Sidi-Ali El Mekki lagoon an area at risk (fragile) and fostered protection measures according to their mandate. However, their action has induced conflicts with the resident population and those who own second houses in the area. In the coastal area many illegal houses have been built for holiday making purposes, and a regulamentation is urgently needed. This new approach of protection will likely foster a better management of this interesting area.

Figures: A)The old port of Ghar El Melh; B)Fisher boats in the lagoon

6.3 The Grosseto Plain (Italy): a recent landscape with an age-old history

Introduction. In Italy our chosen case study was the lower the Ombrone River valley in southern Tuscany where we tried to increase awareness on the issues related to water use and abuse. As surface water becomes scarce during the dry Mediterranean summer and its quality consequently worsens, ground water is increasingly used to irrigate crops. In the coastal zone the water table is generally near the surface and the exploitation of wells for domestic use and irrigation of small landholdings is easier and more economic than the management of a canalization from the river. The consequence of this practice by the local farmers is a lowering of the water table, which aggravates the effect of droughts. The intense use of fresh water from the wells for crop irrigation has also deteriorated the quality of ground water and increased soil salinity. The lowering of the water table in the coastal zone may cause an intrusion of marine water with a consequent increase in the salinity of ground water. This has had a dramatic impact on the viability and growth of pine trees and on biodiversity within the natural park, which is part of the area and represents an additional value for the region. There is a demand for new tools to monitor the impacts of climatic change and come to grips with the problems of increasing soil salinity as well as coastal erosion.

Site description. A broad plain dotted with houses, crossed by roads and furrowed by channels that define a myriad of cultivated fields (in most cases irrigated), with small patches of marshland preserved because of their historical and environmental value: this is the current image of the Grosseto Plain, the most intensely cultivated and anthropized part of Maremma, a coastal alluvial plain of about 390 km^2 south of the city of Grosseto between the Bruna River and the Ombrone River, mainly surrounded by low woody hills and separated from the sea by a band of coastal vegetation. Today's Grosseto Plain is a recent, evolving landscape, the result of exceptional human activity. Centuries of reclamation work have transformed and managed the water and soil, the basic elements that constitute and define the Maremma landscape. Through the control and management of water-courses (Hydraulic Reclamation) and the drainage and permanent increase of soil depth (Soil Reclamation), man has continuously acted on the water and soil of Maremma to transform the landscape and improve the living conditions of its inhabitants.

Agriculture and salinity hazard

The Grosseto Plain is now a highly impacted landscape, a large agro-ecosystem where the main economic activities are agriculture and tourism (also combined in recent decades). The agricultural activity is carried out in a dense network of highly productive farms spread over a total cultivated area of about 29.000 hectares. Agriculture also allows a flourishing and widespread activity of in-farm tourism (*agriturismo*) and the production of forage crops supports an important cattle breeding industry. Therefore, the agro-ecosystem is the main environmental feature of the Grosseto Plain, and the rural landscape is important in determining the economic and social welfare of its inhabitants.

The Grosseto Plain is a dynamic, always evolving landscape, and its sustainability requires a balance between human activities and uses of environmental resources. For a long time, the continuous work of reclamation and the "good" management of natural resources resulted in environmental sustainability of the agro-ecosystem. However, the economic and environmental balance of the rural landscape has become endangered in the last 10-15 years because of mismanagement of the resources (above all water and soil). The most evident and dangerous threat to sustainability of the agricultural activity in Maremma is the salinization of groundwaters and cultivated fields.

Soil salinization is one of the main soil degradation processes in the Grosseto Plain and in the irrigated areas of the Mediterranean Basin: when considered in relation to persistence and permanence, the sustainability of irrigated agriculture depends mainly on salinity and salinization of the irrigated soils. All irrigation water contains soluble salts, and when the irrigation water is applied, the water (which acts as a solvent) is largely removed from the soil or the plant by evapotranspiration, while the salt (the solute) remains in the soil. Thus, salt accumulation occurs

after repeated applications and it is only a matter of time until a salinity regime is established, unless measures are taken to prevent it. Salt accumulation is a very dangerous soil degradation process since it reduces the physical, chemical and biological soil fertility due to three types of adverse effects: osmotic or total salt effects, which affect the ability of the plant to absorb water from the soil (reduction of water availability for plants); specific-ion effects, i.e. the toxicity of specific ions to various plant physiological processes; specific-ion effects of sodium, i.e. the excess of exchangeable sodium can lead to soil swelling and/or dispersion, causing water infiltration, aeration and root penetration problems.

As part of the WADI Project, we carried out a soil survey of the Grosseto Plain: samples of each type of soil in the area were taken for laboratory analyses to determine the chemical, physical and hydropedological characteristics in relation to salinity and salinization. The results were used to create a "Map of the potential salinization risk of soils". However, the soil survey revealed that most of the soils of the Grosseto Plain are exposed to a high potential risk of salinization because of their fine texture and low permeability. In addition, the quality of irrigation water is expected to decrease because of strong competition for different uses of the water resources, and scenarios developed to assess the hydrological impact of expected climate changes predict a major impact on irrigation water demand and the potential leaching action of climate over much of the Mediterranean. Therefore, soil salinization of the irrigated land of the Grosseto Plain is predicted to get worse and the sustainability of agriculture activities will be compromised unless proper agronomic measures are taken to prevent it.

At present, the irrigated farms of the Grosseto Plain carry out highly specialized, intensive agriculture, and their farming systems are too rigid and inflexible for a timely response to the severe, rapid and widespread soil degradation induced by the use of saline irrigation water. As a consequence, in comparison with the secondary soil salinization scenario, the farmers follow two main strategies: either they accept lower crop yields and continue with saline water irrigation or they change crop and cultivate more salt-tolerant plants and continue with saline water irrigation. However, the end result of this behaviour is "*agricultural desertification*": from irrigation season to irrigation season, the farmers promote salinization of the soil, and it is only a matter of time before the soil salt content reaches a level incompatible with agriculture.

Suggested measures to prevent the risk. To avoid soil salinization of the irrigated fields in the Grosseto Plain, the irrigation strategy must introduce the lowest possible amount of salt into the soil. The starting points are: 1) to know the salt content of the irrigation water; 2) on the basis of the specific soil characteristics, to carry out crop rotations which reduce the amount of irrigation water applied to the soil during the crop season; 3) above all, to ensure sufficient salt leaching during the rainy season (rotation of irrigated and non-irrigated crops, autumn-winter and spring-summer crops, leafy and grain crops, *etc*.).

For continued crop production, the irrigated farms of the Grosseto Plain require agronomic management practices involving the farming systems as a whole rather than a focusing on single crops and/or single cultivation techniques.

Coastal erosion. Nowadays, the delta of the Ombrone river is undergoing a strong erosion process that began during the second half of the XIX century after a long period of accretion that occurred more or less rapidly according to the different climatic conditions and to the historical. The relatively recent change in this trend was triggered by the beginning of the land reclamation process, through artificial aggradation (filling up technique). This process continued until the Fifties of the last century and resulted in a great decrease of fluvial sediments to the sea. However, the phenomenon of erosion continued even after the end of the land reclamation processes and today, it is still affecting wider and wider areas of the delta. The sedimentary deficit of the littoral can be attributed to the low quantity of sediments that are now carried by the Ombrone river caused by human interventions on the river banks and bed. In fact, river bed quarrying is an important activity still going on in several locations along the river. As a result of the strong erosion, the advancing sea has caused marine water intrusion into coastal groundwater and has invaded the surface of vast

bordering areas. In the Grosseto plain, the salinisation of the water table is a complex phenomenon. In fact, marine water intrusion is seasonal (proceeding in summer and receding in winter) and progressive, as it tends to advance towards land through time. Also pumping groundwater for crop irrigation worsens the situation and attracts marine water to wells. Furthermore, in some areas mineral water of deep layers naturally reaches the surface and mixes with sea water. Another phenomenon contributing to ground water salinisation is the extraction of salt water from clay layers of marine and lagoon origin.

General considerations on management strategies

Before the European directives on wetlands, issued in the last decades of the last century which provided for the protection of particular environments, a small group of scientists had become aware of the enormous environmental value still existing in the low Grosseto plain. The group was able to convince a more or less uninterested management community to make plans and take actions for the protection and conservation of this particular habitat. However, this decision by the local administration to enact conservation measures probably arose from an opportunistic idea that envisaged future economic benefits rather than from a real belief in a conservation strategy. In fact, today the environment is considered a good economic investment in the long term as it attracts tourism for both leisure and educational activities. At the beginning, the wilderness of this area became an attraction for an elite of cultured individuals and in particular for people with a major influence over the masses. In fact, the whole Province of Grosseto became a hot spot, a glamour locality for politicians, entrepreneurs, actors and famous people highly educated people that frequently visited and spent their summer holidays in this area. As a consequence this led to great economic benefits for the locals, who were literally invaded by tourists and also to a great boom in in-farm tourism. Today, this activity is not only restricted to the summer but extends over a longer period of time, bringing additional revenues to local farming families. However, the massive invasion of summer tourist has strongly impacted the environment as it has led to landscape changes through the construction of visitor centres, parking lots and other residential settlements.

Along the southern coast of Tuscany there is a system of protected wetlands, all included in the Grosseto Province. These wetlands, to which the Maremma Regional Park and the Provincial Nature Reserve of the Orbetello Lake also belong, occupy almost two thirds of the entire territory, with a coastline of 60 km. However, the "Maremma wetland complex" should not be considered a mosaic of wetlands, important only for birds (sometimes ornithologists are somewhat fundamentalists) or for plant species but its importance should be based on the contemporary existence of both abiotic and biotic components. Furthermore, the Maremma wetland complex is best considered as a whole rather than as a series of different sites and thus should be managed as one. Centralised management should be carried out by experienced personnel and local managers should take into account and respect the opinion of experts such as biologists, ecologists, engineers, economists, geographers, etc. Also local farmers and tourist operators should be informed and involved in decision making processes and their needs should be considered by managers without involving destructive political conditioning. A centralised management of the wetland complex, besides aiding in protecting the environment, could also guarantee the sustainable use of natural resources, by redistributing tourist loads in space and time and it could address tourists to cultural and natural sites as an alternative to leisure activities (sunbathing and swimming).

Existing plans to contrast coastal erosion. In the Grosseto plain the management of protected areas and of wetland areas in particular, presents an array of many other different problems ranging from foreseen interventions to contrast coastal erosion, to project management for conservation purposes, to conflicts among local authorities and for achieving the correct use of the natural resources. Today, the erosion process the mouth of the Ombrone river is undergoing, is undoubtedly a fact. The foreseen actions to contrast or slow down the process are, in our opinion, inadequate and can severely damage the natural environment. These actions are targeted to contrast surface marine water intrusion in areas where soils have already saline characteristics, as demonstrated by the

place-names (Campo Salino, Saline di San Paolo) and by the presence of an halophilous natural vegetation and where, nowadays, pasture lands are only partially exploited.
In the Maremma Regional Park a project of beach nourishment to rebuild a beach and improve the site for tourist has not been been approved because of the severe impacts that sand withdrawal from the marine deposits or, worse, from the areas close to the promontory of Collelungo would have caused on the entire coastal ecosystem. However, the foreseen construction of a revetment parallel to the sea line will in any case severely modify the wetland area at the mouth of the Ombrone river. This embankment will prevent sea water from reaching the saline low-lying grounds during the occasional storms and the areas will soon be transformed into a freshwater environment or, in the worse of cases, will dry up. Among the foreseen interventions, there is a plan to desalinate the marshland near the mouth of the Ombrone river (the area is an Integral Reserve according to the Park's legislation and has been proposed as a Ramsar site by the Region of Tuscany) by introducing freshwater in the existing channels. According to the water managers in charge of the project, this operation will probably recharge the water table with freshwater and lower the salt water in the water table. All these interventions will cause a severe modification of the wetland habitat and will lead to the loss of another wetland area of international importance going against EU directives. Furthermore, for the construction of the revetment the existing roads will be enlarged and consolidated. These will permit trucks to bring into the Park the necessary material coming from inland area mines and the whole ecosystem will be further impacted by the construction of the construction yard itself. Perhaps in order to stop or at least slow down the erosion process, it might have been sufficient to forbid river bed quarrying from the Ombrone, which today represents one of the main factors causing the decrease in sediment loads. An off-shore breakwater, parallel to the shore, to dissipate part of the incident wave energy before it reaches the shore, might also have slowed down the erosion process.
For the moment only several submerged concrete groynes perpendicular to the shore line will be installed with the hope of giving rise to a local beach reconstruction process whereas no beach nourishment process is foreseen. However, impacts of coastal armouring structures may cause significant habitat changes with attendant ecological changes. The changes in the sea water currents caused by the submerged groynes will likely severely impact the wetlands and the beach dune ecosystem to the south of Collelungo. Consequently, there will be the loss of one of the best preserved coastal ecosystem and local endemic plants and animals will disappear. The erosion process will not be stopped by these interventions and will probably occur to the north of the Ombrone river mouth.
But why go on with such actions? What are the real aims of the Park? There are quite a few motivations that have led Park authorities to these choices. First of all there is the fact that the Park aims at maximising economic income from tourist activities. The beauty of the beach of the Maremma Regional Park has always been the main attraction for a large number of summer tourists that exploit the beach for recreational activities. During the last two decades the erosion process occurring at the mouth of the Ombrone river has destroyed large sections of the beach and has caused protests among the local community. In fact several in-farm tourisms within and bordering the Maremma Regional Park have great interests in that the Park authorities take actions to reconstruct and stabilise the beach so that hundreds of tourists, mainly concentrated during the summer, have continuous access to the beach. Local stakeholders also see rapid economic investments in all those activities (bars, shops, restaurants etc) connected to tourism and strongly support the initiative. Therefore, on the one hand, there is the need to satisfy pressures coming from the local population and to take "politically correct" actions and on the other there are large funds, already allocated in this direction, that need to be shared out among local authorities, enterprises and persons of interest. Through the media (local television, web page, brochures etc) there is a large publicity that all actions undertaken will have the benefit of saving the beach and stopping the erosion process. Unfortunately, no announcements are made on what will be the overall costs to the natural environment and on how unique habitats will be irreparably lost.

The absence of centralised management of the wetlands that are still to be found today along the coastal littoral of the Grosseto plain (also including those of the southern part of the Grosseto Province and bordering on the Latium Province) can bring to dangerous conflicts among local authorities and stakeholders (Region, Province, Municipalities, Land Reclamation Consortium, River Basin Authorities, Environmental associations, NGOs, Ownerships). These conflicts lead to a total absence of actions or to disorganised and sometimes contrasting initiatives. For example, in the case of the Maremma Regional Park, the Region of Tuscany is both owner of the local farm (Azienda Regionale Agricola di Alberese) and manager of the Park itself and frequently the actions planned by the Azienda do not have nature maintenance or biodiversity protection as a priority. On the other hand, actions undertaken by the Park to reach its objectives do not always coincide with the interests of the Azienda.

The WADI project has developeped research and dissemination activities in the area aiming at attracting the attention of local and regional authorities to the environmental issues, and unconspicous values, such as the endemic plant living only in the retrodunal area of the natural park *Limonium etruscum*, or the arthropod populations adapted to sandy soils and marsh lands. These represent biodiversity reserve, typical of the Mediterranean coastal areas, currently under threat of complete disappearance. A natural beach-dune system, gradually connected landward through salt marshes and the Mediterranean maquis, to the agricultural landscape formed by human activities along with human historical changes, is worth of conservation *per se.* We were convinced that the numerous tourists visiting the area should be made aware of the values of the areas, historical, cultural as well as natural. So we decided to produce a book on the area, targeting the environment-aware tourists (*Il Parco Regionale della Maremma e il suo territorio. Una guida per conoscere e capire)*. This book is sold in the bookshops and was presented in several occasions locally, particularly to the farmer associations, also involved in hosting activities (in-farm tourism). However, the authorities managing the Park felt it as a provocation, maybe an invasion of their field of competence, and have discouraged the selling of the book in the bookshop at the park office. This poses the question on the effectiveness of knowledge transfer from researchers to environmental mangers and to the public.

Figures: A) the sandy littoral under threat (by sea erosion or mis-management?); B) the endemic plant *Limonium etruscum*, under threat of extinction; C and D) consultations of WADI researchers with local stakeholklders




6.4 The Spanish site: El Hondo Lagoon

Introduction. In Spain WADI has focused on El Hondo lagoon (Alicante province), an artificial water reserve for irrigation needs, recently developed into a natural reserve. When water supply is scarce, as happens throughout most of the year and was especially severe during the recent years of drought, the stakeholders' water demands come into conflict. The association of irrigators owns the water, the farmers are the users and pay for the water, and the environment is represented by the regional environmental agency. The economic, cultural and natural values of the area are unquestionable and all stakeholders claim their own part in the exploitation of the water body. The WADI participants organised joint meetings of the various stakeholders, including the least represented such as rural women and schoolteachers, and set up a discussion table on El Hondo. The local and regional press participated in this process of promoting awareness of the El Hondo problems along with the area's value, as well as people's expectations of the project. The conflict between protection and exploitation of the natural goods has escalated to an exhacerbated conflict around the water body, causing the closure of the natural reserve of El Hondo.

The description of a complex case study. In the case of El Hondo, complexity is considerable. Physically, the water system is of an enormous complexity, partly as a result of its long history of gradual human control of water fluxes in the area. The El Hondo water system mainly comprises two large ponds of fresh irrigation water taken from the mouth of river Segura and five drainage canals, about ten smaller hunting/fishing ponds (with brackish water of different characteristics, since the provenance of these waters is very diverse), four ponds dedicated to ecological conservation (three owned by the environmental administration and the fourth by a conservationist NGO), the salines of Santa Pola (connected to the sea) and thousands of kilometers of drainage and irrigation canals, connecting all above-mentioned ponds and water reservoirs.

Stakeholders and management aspects. Many different administrations, from the national (i.e. Water Administration) to the regional (i.e. Environmental administration) and local levels (10 town councils directly involved) have some degree of responsibility on the system's management. Every level of management involves multiple actors. For instance, El Hondo falls within two national Water Administrations, that of the Segura river (Confederación Hidrográfica del Segura) and that of the Vinalopó River (corresponding to the Confederación Hidrográfica del Júcar). At the local level, 20 communities of irrigators have the direct responsibility for the day-to-day operation of the water system. There are also many agricultural associations, civic platforms and conservationist groups, cultural associations, etc. with relevant influence on the social system. Any research at El Hondo aiming to provide a comprehensive picture of the system faces the problem of complexity. Perhaps this is the reason why such a comprehensive picture has been never drawn.

Narratives as necessary results of WADI. How can different data, both quantitative and qualitative, originate from different disciplines and sources of information be merged into a coherent image? Which format should WADI reports take in order to offer, not a hotchpotch of different, unrelated issues, but an integrated case analysis? The ultimate instrument for addressing complexity is narratives. Narratives are not irrelevant and inconsistent tales, but stories telling the meaning of acquired knowledge. Stories combine both quantitative and qualitative data and explain them. Scenarios, the ultimate aim of WADI, are also a method for producing plausible narratives – narratives of possible futures. Narratives not only allow a meaningful treatment of complexity, they are also the necessary channel for communicating it to different readers, due to their capacity for promoting shared meanings of exposed facts. And this is so because stories, if properly built, generate commensurate experience amongst independent listeners. Independently of its scientific quality, a typical research report does not help people to change their behavior, since it normally does not reach them at a deep level of understanding. Since the final purpose of WADI is not to obtain information, but to enhance stakeholder benefits, our final written product should not be a document containing data, but a well-constructed narrative offering the reader access to the case at different levels, and thus promoting social learning.

Analyzing a conflict: the case of malvasia. The relevance of the white-headed duck (*Oxyura leucocephala,* malvasia, in Spanish) for the El Hondo Nature Park is undeniable. From a conservationist point of view, it is perhaps, along with the marbled duck (*Marmaronetta angustirostris*), one the most important animal species – and undoubtedly the most widely known, and has almost become the symbol of the Nature Park. El Hondo is an essential site for the conservation of the species in the Iberian Peninsula and the Western Mediterranean area. Data are conclusive. In 2002, for example, 70% of the Spanish population of white-headed duck inhabited El Hondo. Objectively, thus, the maintenance of malvasia populations is a management priority. The malvasia is internationally protected by the Bern Convention, the Bonn Convention, the Ramsar Convention and the European Directive 79/409/ECC. Contrary to other examples, a lot of scientific information is available on this species. In fact, a specific LIFE project was carried out from 1st January 2001 to 1st January 2005 on malvasia's ecology, populational status and present risks in order to prepare the Management Plan for the species in the Valencian Region.
The malvasia is a duck which needs deep waters, so the water level of El Hondo ponds are of great importance for its conservation. Moreover, rapid changes in water levels can cause the destruction of nests and broods. Additionally, the report recommended the prohibition or limitation of hunting and fishing, due to the deaths of adult malvasia ducks caused by these activities. Here environmental decision-makers paid close attention to the results of this well-funded and rigorous research project. The decree 93/2005 of the Regional Government (popularly known as the malvasia's decree) endorsed all these considerations. In fact, the decree has a very ecological style, even considering its vocabulary and richness of scientific details. Hunting and fishing were prohibited or seriously limited. And especially no "sudden" variation in the water level was permitted during the breeding period of the white-headed duck, from first February to the end of August. This includes the prohibition of any important discharge of water from the ponds or any introduction of water into them during this period. In the very dry summer 2005, in order to save crops the executive assembly of Riegos de Levante decided to release water from the ponds in order to irrigate fields, despite the legal prohibition imposed by the malvasia's decree. Green groups immediately denounced this transgression of the Malvasia's decree and damages caused to protected fauna of the Nature Park in court. As a consequence, the executive manager of Riegos de Levante was legally charged with environmental crime and a lawsuit was brought against him. An official report by the Environmental Administration, requested by the legal court, which documented the loss of malvasia's broods, was used as the main incriminating evidence. The tension between Riegos de Levante and the Environmental Administration reached its peak during the formal start of WADI project (January 2006). However, the project, whose approach and aims, and especially its participatory character, had been extensively presented to all parties during the previous year, was apparently felt as providing new possibilities for each position. In fact, despite the tension, all contacted parties attended the official presentation meeting of WADI in February 2006, and participated actively, offering their collaboration for the development of the project. The situation remained stationary during the following months. Evidently, given legal consequences, Riegos de Levante did not release any more water from the ponds during the periods in which such discharges are prohibited by the malvasia's decree. The feeling of grievance grew among irrigators and generally among rural sectors of the area. Political aspects were also present, creating a quite explosive situation. The presentation by the environmental administration during the last months of 2006 of the drafts of new management plans for the Nature Park, which endorse a series of use limitations, and barely contain any proactive or compensatory measure for affected sectors was felt as another cause of resentment, as manifested angrily during the WADI general meeting with stakeholders held in February 2007. During the summer of 2007, and after complaining several times that agricultural fields had not been irrigated due to the malvasia's decree, Riegos de Levante also denounced that they could not even pump up to the ponds of El Hondo the much-needed and relatively good water that, thanks to some strong rains, were available in the Segura river at the end of summer, and which ended up running into the sea. In the context of the local traditional water

culture, this loss of water is radically incomprehensible, and thus a very sensitive popular argument against the administration's decisions. As a result of this conflict, in order to manifest its feeling of grievance, in January 2008 Riegos de Levante took the decision to close the entrance to their property and thus, to impede access of the general public, environmental managers and of researchers to the most important part of the Nature Park (the two large ponds owned by Riegos de Levante). Despite the importance of the decision, no public declaration was made by the Environmental Administration, and no measure was taken against this situation by any other institution. Moreover, no repercussion was noted in the social environment of the area, even after months had passed and the closing of the ponds was maintained. In August 2008 Riegos de Levante denounced an outbreak of botulism and a massive mortality of waterfowl due to immobilization of poor quality waters, and publicly demanded from the Environmental administration the drainage of the two ponds for sanitary and environmental reasons. After some reluctance (extraction of water in spring and summer was precisely the cause of the conflict, due to its interdiction by the Malvasia's Decree), the environmental administration, when the epizootic outbreak was confirmed by its technicians, finally authorized the drainage of the ponds. Once dried, Riegos de Levante publicly declared that they would not pump up new water into the ponds until the malvasia's decree was derogated or drastically changed according to irrigator's demands. Despite the fact that the most important part of the Nature Park was not only closed, but had also dried out, no public declaration was made during these months neither by the environmental administration nor by any other stakeholder, except, as usual, by green groups. After months of inactivity, Riegos de Levante took up the initiative again. On 19th December 2008, a large public demonstration organized by Riegos de Levante, in collaboration with other local agricultural associations, marched through the streets of Elche in order to reclaim irrigation rights in El Hondo and the derogation of the malvasia's decree. Riegos de Levante succeeded at mobilising, not only agrarian associations, but also other Elche's civic organizations and even town authorities. Their capacity to mobilise local forces was confirmed by the fact that all political parties represented in the town council, including the political party heading the Regional Administration (and thus the Environmental Administration) supported the demonstration more or less enthusiastically. This demonstration was the final act which obliged the Environmental Administration to call for a dialog. Apparently the success in mobilising such a range of very disparate local forces (except green groups), including groups not normally sympathetic to the positions of Riegos de Levante, surprised and preoccupied the political decision makers showing they had lost control of the situation. The way in which administration normally ignores how things go at local levels, and specifically in the rural or agricultural world, i.e., the emotional charge in discourses, the importance of informal relations, the more-or-less generalized sense of grievance (which acts always as a common ground against administration), etc is a typical example of what sociologists have pointed out regarding similar environmental conflicts. At this moment (January 2009), the environmental regional minister and the chiefs of Riegos de Levante have formally initiated negotiations in order to put an end to the conflict. The final form of the agreement is not yet known, but it is clear that this story will not go without serious consequences for El Hondo, affecting not only the ponds of Riegos de Levante, but potentially the whole system. Some data indicate that recent events have probably strengthened moves towards a sub-optimal future scenario.

Lessons learnt. In our opinion, the malvasia lesson is that even an ideal situation from a researcher point of view where scientific findings have successfully influenced management decisions can generate unexpected, dramatic consequences. In this case, scientific research was of good quality and gave a clear counsel to decision makers, this counsel was endorsed by decision makers to the extent that a protection law was passed and a considerable economic effort was made through campaigns and environmental education activities, as recommended, in order to raise public awareness about the white-headed duck and the soundness of protection decisions. What has gone wrong then? One could simplistically think that the failure of the malvasia story cannot be attributed to scientific research, and that the complex mixture of social, political and cultural

problems responsible for such a turbulent situation has more strictly to do with managerial (or political) problems than with scientific questions. According to this, scientists have done their job giving decision makers clear recommendations, based on objective and scientifically sound argumentation. The rest, could we think, is a question of the "savoir-faire" of managers. For us, the question is more complex. In relation to the malvasia's case, it is probably appropriate to recall the affirmation of Boehmer-Christiansen (1994): "Science is often more comfortable in providing advice on what ought to be done and why, rather than practical advice on how it might be achieved". It is obvious that in our case, researchers have clearly said what ought to be done in order to conserve malvasia's populations and why. In fact, a considerable part of written reports, published materials and even legal documents was dedicated to explaining the importance of the white-headed duck and, thus maintaining certain water levels and ruling out traditional activities that might endanger malvasia's wellbeing. Given the objectivity of scientific evidence and measures proposed, the Administration simply adopted and legally ratified them integrally. At face value, this may constitue a perfect success story for scientific research and the rarely attained dream of environmental researchers. Managers do not need pure scientific information, obtained through normal disciplinary constraints, but rather the integration of data into their real context where they find practical sense. Being also a research activity, WADI tried to take research as a starting point for advancing towards the so badly needed integration in the management of our systems, as the case of the malvasia at El Hondo dramatically documents. Although the plausibility of obtaining economic incentives is necessary for social engagement, it is simplistic to think only in terms of mere economic profits. The temptation of taking subsidies as a way of solving conflicts is certainly important for many environmental administrations. But subsidies alone, without proper consideration to the real social concerns (and this implies again the generation of truly integrated information) are rarely effective. The fact is also illustrated by the malvasia affair. Although Riegos de Levante has been generously subsidized by the Regional administration during past years, this did not prevent the outburst of the conflict to the surprise and irritation of the subsidizing administration. All the initiatives presented above include an economic face, but socio-cultural questions have also been taken seriously into account. Despite the enormous complexity of the El Hondo socio-ecosystem, and despite the magnitude of the problems it faces, including the conflicting situation inherent to its structure, we think that the usefulness of WADI approach has been positively tested, in the demanding laboratory of the real world. From merely scientific considerations, we do think that it has also offered important lessons. Specifically, it has shown the importance of integrated, participatory socio-ecological research in order to provide decision makers and stakeholders with the appropriate scientific advice they need for the sustainable management of this system.

Figures: starting WADI on February 2006: A)discussions with the stakeholders; B)visit to the Park Centre; C)a rare image of El Hondo rich of water



6.5 The Moroccan site of Oued Laou basin

Introduction. The north-western Mediterranean coast of Morocco is currently developing its tourism and infrastructures, such as the construction of the new harbour of Tangier and the coastal highway. This is in apparent contrast with the rural mountain environment where the settlements are mostly sparse *douars* administered by rural municipalities, around the historical city of Chefchaouen. The high altitude natural forests conserve endemic arboreal species as well as a rich diversity of fauna and flora. Both are threatened by an intense use of ground for traditional agricultural practices and the illegal kif crop. The latter represents an important source of income for the resident rural population integrating the money sent by the emigrants to the cities and Europe. The site is therefore in an unstable equilibrium between a traditional way of living and rapid developments. Problems are perceived as such only when they concern the short term, and the local people have apparently no interest in future developments. Regarding water, there is a deterioration of water quality from upstream to the coast caused by the absence of any regulation in waste discharge.

Site description. The area is characterised by the highest diversity of landscapes, biological and cultural diversity, thanks to its morphology and position, up to calcareous picks at 2000 meters hosting a natural forest of coniferous trees, down to the sea side, along a river of about 60 km length. The Oued Laou river basin, as the whole North-West area of Morocco, is experiencing a massive increase in infrastructure building. Together with the infrastructure improvement, a pressure towards tourism development is acting, and tourism is proposed as driving force towards rural areas development. At Oued Laou valley level, the main part of the inhabitants (around 300,000) is settled in rural zones, while urban zones are represented by Chefchaouen (the only historical urban settlement) and the new urban zones of Oued Laou (still on the increase mainly due to seaside tourism improvement) and Bab Taza, for a total amount of 200,000 inhabitants in urban settlements, the rest living in sparse family houses and group of houses, *douars*. The river Laou flows through the valley and there are multiple sources at all altitudinal levels, ensuring water availability. The landscape in the valley is heterogeneous, and the human activities developed in this framework are consequently various, ranging from traditional fishery to agriculture and traditional handicraft (e.g. taraza hats, mendil tissues, pottery) is highly characteristic of the zone. In the same area, it was established in 2006 the Talassemtane National Park, mainly to protect the endemic coniferous species *Abies maroccana* (included within the UNESCO Man and Biosphere Program, launched in 1970), but indirectly protecting other endemic species of the area including birds and reptiles.

In this interesting area several researches were carried out in the framework of the WADI project, aiming at obtaining a complete picture of the values, potentialities, issues and threats.

Biological quality of water along the river basin. This study was carried out throughout the four seasons at 15 stations and the following results could be drawn:

Waters are not mineralised in the upper Laou river, while Talambot and Tassikesté rivers have saline waters due to the depth of the underground water; high contents of calcium are found in the lower Laou river; down of human settlements ammonium contents become high; turbidity fluctuates with the seasons and the stations, maintaining high values in all cases; organic pollution is high in the low basin, while in the upper basin water quality is acceptable.

A)Talaât Adhrousse, Laou basin (20/08/2008). The geologic formations of the catchement area include mountains, hills and plains. In the main valley, the calcareous chain regulates the water resources of the catchment, also including several water falls.
B)Ounsar aghbalou, Douar Talambot, Laou basin (20-08-2007). *Ounsar* is the Arabic word for water source, frequently found as toponym in northern Morocco, while *aghbalou* means great source in Berber.

A)Rural centre of Bab Taza, Laou basin (25-08-2007), founded by the Spanish colonization. It is rich in water resource and host numerous activities linked to water.
B)Douar Talambot, Laou basin (20-08-2007). It lies in proximity of a dam, within an irrigated area.

The socio-economic context and cultural (tradition) regarding water were analysed both using existing information on demography (1960-2004) and through questionnaires given to the local people (50 families were contacted in the rural and urban areas). The population in the area is increasing and the sparse settlements tend to converge in villages or get closer to the main road. In both cases the access to services gets easier. Regarding the activities, also in bigger villages the population is still rural. So the only really urban settlement is the historical city of Chefchauen. The agriculture is characterised by pluriculture, including crops that need irrigation, namely the highly rentable cannabis, and crops that grow in arid soils, typical of Mediterranean environments.
The area hosts a rich and diverse hydraulic material heritage, most of which is still in use because the recent infrastructures and network of work distribution generally do not involve the local people, as they must be paid. Part of the hydraulic material heritage is authoctonous, while another part dates back to the Spanish colonization, namely the irrigation channels. These need maintenance and it is not clear who (the administration, the farmers or the enterprise in charge of water distribution) must do it. Besides, soins are paid by local people for the maintainance of springs, wells and sources, and a complex of non written regulations exists for water usages and sharing water for irrigation. In this respect the diversity is interesting among *douars* that are in fact families' and tribes' settlements.

We documented the material heritage, made of points of provision or storage of water both for people and domestic animals, networks to distribute water, mills, as well as natural hydraulic sites, such as springs, lagoons, waterfalls and rivers. Wells are the most used means to get water all year round. Only at family level, other strategies are found, such as collecting water from the roofs or exploiting the gravity of running waters. Bridges are found along the main roads, while footbridges are very unstable.
We also documented the non-material cultural heritage of traditions around water uses and irrigation. This is very complex, as traditions exist besides institutional regulations. So the women have rare if no access to decisions regarding waters. They only cooperate in the transport and stockage of water, while the maintainance of the points of provision is mainly made by men, according to the Coranic tradition. Particularly irrigation turns are decided and made by men, probably because of conflicts between neighboroughs. Children of both sexes aid in all the tasks linked to water, and are happy to meet each other around the wells while making water provisions for the household.
The risk of loosing all this traditional heritage is high due to the rapid development of the area and the trend of young men to migrate in the cities and abroad.
Regarding therapeutic traditions, local people are convinced of the strict link between good water quality and health. Also a knowledge exists on the hillness caused by contamined water (cholera, thyphus, meningitis and dysentery) and those caused by animal vectors, such as flies and mosquitos, very frequent in the low plains. People living near the coast are aware of the risk of water contamination caused by a lack of depuration systems in the settlements upstream.

New perspectives. WADI researchers developed and proposed a waste waters' sanitation project for the coastal village of Ouel Laou. The sanitation project was presented to the local municipality of Oued Laou by the WADI participants and a collaboration discussed between researchers and managers. A sanitation of the water is urgently needed in the town of Oued Laou located on the coast and collecting all wastes from the river basin as well as a continuous monitoring of the water of the river and its affluents. An issue for the application of the project is the unpredictable seasonal population increase in the village for holiday making. We have suggested to implement a pilot project to the local prison that hosts about 100 persons throughout the year.
Measures of rehabilitation of the network of distribution of water are also strongly needed. There is also a need to encourage a cooperation between local people in the management of the local resource, without loosing the traditional know-how.

6.6 The Moroccan site of Oued Tahaddart and Oued Ghrifa basins

This basin has a surface of 2,740 Km^2 , it is located in northern Morocco and the river estuary of about 100 meters flows into the Atlantic. The waters of the estuary are also exploited to produce salt, for bathing tourism, for fisheries and to cool the turbines of a thermo-electric station.

The geographic aspects of the site were analysed to achieve a complete and integrated description of the system, with regards to water flows and sedimentary budgets.
The evolution of coastline was studied by means of time series of cartography, aerial photographs and satellite photos: the right site of the estuary is subject to strong energy (eroding) while the left side is accreting. The low plain is periodically subject to submersion and soil salinisation, as well as salt intrusion in the groundwater. In the long term, due to climate change and consequent sea level rise, this trend may aggravate and impact the coastal morphology, natural ecosystems, water resources and coastal infrastructures.
A quantitative system description on various compartments was made for this site to provide a data base for a future sustainable management of this rapidly developing area, as a consequence of the construction of the new port of Tangier.
Geochemistry of sediments in the Tahaddart basin and estuary
Heavy metals' (Pb, Zn, Cu, Cr, Cd) and Arsenic content was monitored throughout the year in the stations chosen along the river. Small contents and small variations were found in dependence with water quantity in the river. The indices calculated (I-Geo, index of geo-accumulation) showed tha the estuary is non/very little polluted.
Hydrogeology of the low Tahaddart.
Electric measures were made to estimate the lateral variations of the level of water table and the influence of marine water ingression. This is most relevant near the littoral with some variation in mineral composition in the southern part of the estuary.
Benthic macrofauna of the Tahaddart estuary.
While in 2006-2007 the intertidal zone was analysed, in 2008 the sublittoral zone was investigated. According to the index of Bray-Curtis and the results of the similarity analysis MDS, two groups of stations could be identified depending on the distance from the sea. In the subtidal zone no zonation was identified nor ecological gradients as were identified in the intertidal zone. The diversity indices (species richness, abundance, Shannon H', equitality J') show a clear gradient towards inland. The richest and best structured stations were those at the confluence of Oueds El Hachef and Mharhar. According to the AMBI calculation, the ecological status of the subtidal zone oscillates between non perturbed and little perturbed, while the M-AMBI (multivariate) indicates a very good ecological quality at the river mouth.
The main conclusion from the analysis of the results obtained was that the Oued Tahaddart estuary seems to be in a good ecological state: anaerobic conditions were only detected in two sub-stations, while the rest of stations studied appear to be well oxidized; no large organic matter accumulations were observed suggesting that the recycling of nutrients is complete. This hypothesis is supported by the presence of a high faunal diversity and high secondary production.
Benthic macrofauna of the estuary of Oued Ghrifa
The analysis was completed of the samples collected along 14 stations throughout a year. Dominant species ar polichaete anellides and amphipods, marine amphipodes near the river mouth, while mollusks are absent due to the mobile and drained sandy sediments. The macrofauna of Oued Ghrifa was compared with that of other estuary ecosystems in Morocco. Species richness and composition are similar, despite some species and population differences. In particular at Oued Ghrifa algae and seagrasses are absent, thus determining a low abundance at difference with the Tahaddart estuary, where *Zostera noltii* is present.

Assessment of terrestrial macroinvertebrates in relation to the environmental characteristics occurring along the Oued Ghrifa.

A comprehensive assessment of how abundance, species richness and diversity of terrestrial macroinvertebrates change along the Oued Ghrifa in relation to the vegetation and to the substrate characteristics was carried out during May 2008. Abundance, species richness and alpha diversity were calculated at each station to verify how changes occurred along the Oued and what were the factors influencing species composition. Diversity indices were calculated; Hierarchical cluster analysis was employed to group stations according to the chemical and physical parameters of the substrate (moisture, pH, conductivity, organic content, soil texture), to the type of vegetation and to the faunal composition. The study at Oued Grifa indicated a well structured habitat with a high alpha diversity value. Substrate texture and composition seemed to be the most important environmental parameter structuring the habitat. A similar result was obtained when studying the macrobenthic community where it was clearly shown that salinity and the different sedimentary habitats (marine sand, sand mixed with mud, mud with some sand, pure mud) were the key factors determining the distribution of the fauna. As a consequence the type of vegetation present along the banks changed according to the substrate characteristics with the presence of a dune vegetation closer to the oued's mouth that progressively gave way to a typical salt marsh vegetation in more muddy areas. Quantitatively terrestrial macroinvertebrates were dominated by crustacean species and amphipods were most abundant. Five different species were recorded with *Talitrus* and *Talorchestia* genus occurring in intertidal marine areas at the mouth of the Oued and *Orchestia* genus at the base of the vegetation in more inland areas along the banks of the river. Species richness was dominated by coleopteran species with carabids mostly represented and it increased at increasing distance from the mouth of the Oued Ghrifa. The positive correlation occurring with plant biomass and species number showed that as the complexity of the habitat increased there was a linear increase in the number of macroinvertebrate species.

Macroinvertebrates of fresh and transition waters in the Tahaddart river basin

Species richness was analysed along the river basin including the immissaries, marshes and lagoons. This is a good bioindicator of polluted waters. In the salt marshes and salines a very low species diversity was found. Coleopteran species are dominant in running waters; ephemeropterans, heterpterans and odonates vary between habitats, while in the most polluted stations crustaceans are dominant species. The water quality of the stations was assessed using the BVZCT, based on animal and vegetal bioindication, where sensible species disappear from polluted waters or robust species dominate. The index of Verneaux and Tuffery (1967) was used. In summary the prospected waters were of good biological quality; some stations were degraded due to domestic pollution.

Bird populations in the Tahaddart low plain

Hibernating water birds have been recorded for 25 years (2006-2007 within WADI) and their evolution with time analysed. The populations size has decreased since 2002, likely as a consequence of the construction of infrastructures (tourism, agriculture, industry) in the area.

Impact assessment

At the moment the beach and other sections of Oued Ghrifa show a well preserved habitat with apparently a low human impact even if the area is exploited for the production of salt. However the WADI data bases represent a benchmark for future studies as this coastal environment is rapidly undergoing changes. As a matter of fact just a few kilometers north of Asilah a new residential area is now being constructed directly on the littoral. This has already destroyed large sections of the beach ecosystem and will further affect the catchment area of Oued Ghrifa. The presence of such a massive settlement will increase the needs of water both for sanitary uses and drinking. At the moment Oued Tahaddard and the other Oueds nearby supply drinking water to the cities of Asilah and Tangier but soon such an increasing coastal urbanisation will impose further exploitations that will disrupt the environmental equilibrium. Lower quantities of water flowing across the oued will strongly affect the salt marsh vegetation and its associated fauna. Furthermore a massive presence

of beach tourists directly trampling over the beach dune area will cause severe impacts. At the moment access to the beach is not restricted and use off-road vehicles to reach other sections of the beach is quite common. This will disturb the physical attributes and stability of the dunes and will destroy its vegetation. The direct construction of tourism infrastructures on the dune (bars, parking lots etc) will definitively change the whole environment. It would be important to determine the ecological carrying capacity of beach ecosystems and water catchment areas in terms of their direct use for the implementation of plans for their sustainable development. Furthermore there is a project to set an aquaculture plantation in the area. This will cause severe impacts both in water use and waste disposal. Generally speaking there will be pressures on all the water resources of the entire region and this will bring to dramatic changes to the coastal environment and in particular to the Oued Ghrifa.

Future perspectives. The socioeconomic aspects of the Oued Tahaddart basin were analysed regarding the management of water resources and a GIRE (gestion integrèe des resources en eau) developed to suggest a reform of the actual complex situation and enhance efficiency and coherence through the integration of different departments. Territorial actions consider the changes of population, agriculture, industry, turism and urbanization and their effects on the natural environments (soils, forests, continental, littoral and marine waters): protection and saving of water resource against pollution and floods as well as the improvement of the network of potable water; protection od ecosystems, including groundwater (CharfAl Akab), the site of biological interest (SIBE Tahaddart estuary) and acquifers; a plan of integrated protection of water resources acting on infrastructures and agriculture through their modernization; the institutional reinforcement of the Agence du Bassin Hydraulique de Loukkos; a good governance is necessary with the participation of local actors (ONG, local people), the reinforcement of participation through associations that would correct the passive tendency of local people, the introduction of the concept of "territorial responsibility". The realization of a geographic information system (G.I.S.) is proposed to analyse the system in terms of ecosystem functioning and socioeconomy and the interaction of different elements. Also the information and environmental education of the public of different levels, local authorities and scholars is a desirable measure to achieve a GIRE, and various measures of dissemination are proposed tuned to the local situation. The issue of poverty is addressed through the proposal of applying a reasonably low price to water and a compensation to rural people for preserving the environmental good (farmers living in the forested area that are environmentally concerned could be re-paid from the taxes obtained from those who pollute water near the sea and have a gain from the preservation of the environmental goods).

The estuary of Oued Tahaddart, an old port in the northern Morocco (22-07-2008)

6.7 The Portuguese site: Mondego estuary

This site was added to the WADI study sites because, having been subject to intense ecological research in the last 20 years, it offered the possibility to test the ecosystem goods and services' approach in the case of an estuarine area.

Testing tools for ecological quality status assessment: environmental quality, management and evolutive scenarios in the Mondego estuary

Mondego river begins in the "Estrela" range of mountains and extends along 227 Km, draining a hydrological basin of approximately 6,670 Km^2, the largest one entirely comprised in Portuguese territory. The Mondego valley is considerably deep upstream from Coimbra, but spreads downstream from this town to form a vast alluvial plain, the Lower Mondego Region, which consists of 15,000 hectares of good agricultural land. The Mondego river basin plays an important role regarding the activities and day-by-day life of more than half a million people. Nevertheless, in the early sixties, the basin was still sub-utilised. From 1962, the "Direcção Geral de Recursos e Aproveitamentos Hidráulicos", as it was called at that time, prepared a hydro-agricultural plan aiming to improve the use of the basin water resources. The main objectives were to control the river flow, regarding the water and sediments, provide water to populations, industries, and agriculture, and produce electric power. As a whole, this plan was only partially accomplished. Nevertheless, floods control was made possible through river regularisation and by the construction of several dams, which had doubtless a considerable environmental impact, namely in the Mondego hydrological regimen.

The Lower Mondego river valley, at the present, consists essentially of agricultural land where the main production is rice (60% of the valley). Other significant productions are corn and beans (18.1% of the area). Non-cultivated areas, such as swamps, are usually located in the perimeter of the valley and exhibit a flourishing natural fauna and flora. Drainage channels, which are widespread across the whole valley, also constitute a biological reservoir. The drainage from all this area obviously contributes with an important discharge of nutrients and several chemical compounds into the Mondego estuary. Besides, the estuary itself constitutes an important system to support human activities, correspond to a considerable concentration of people and goods. Actually, the estuary is the location of a mercantile harbour, "Figueira da Foz", which has considerable regional importance, namely regarding the export of wood pulp for paper production. Urban waste waters are still let out into the Mondego with deficient treatment, and besides the harbour facilities, the estuary supports industrial activities, saltworks, and aquaculture farms. Additionally, the city of "Figueira da Foz" constitutes an important centre for tourism activities, which implies a seasonal increase of the human pressure on the system.

The eutrophication of coastal waters, characterised mainly by an increase in nutrients, is currently recognised as one of the main problems felt at global level. One of the chief symptoms of eutrophication in these areas is the replacement of plants with roots (i.e. *Zostera sp*.) and slow-growing macroalgae (i.e. *Fucus spp*,) with quick-growing opportunistic marcroalgae (i.e. *Ulva sp*.) and phytoplankton. The loss of these meadows also leads to changes in the associated biological communities and to considerable changes in the functions, services and materials that these rooted plants provide to their surroundings.

It is well known that the disturbances which these coastal areas like the Mondego estuary suffer are very much anthropogenic in origin. They are due to the development of urban agglomerations and human activities that are usually associated with bodies of water and water courses. These procedures lead to excessive increases in nutrients and changes in the flow regimes of water courses, giving rise to countless ecological problems. On the whole, initiatives that contemplate only reducing the entry of nutrients into the systems are less successful and inadequate, on their own, to ensure the satisfactory recovery of these degraded areas, especially the macrophyte banks. It is extremely important to consider all the other aspects, too, including hydrodynamism, the physical protection of the meadows and the possibility of transplanting plants from areas where they

are thriving. Bearing all these aspects in mind, the ecological quality of the Mondego estuary was characterised over time, assessing the water quality, macrophyte cover in the south arm and ecological quality based on the intertidal and subtidal benthic macroinvertebrates. Supported by historic knowledge of the area and by data from mathematical simulations, suggestions were proposed to implement management measures that would help to eliminate the eutrophication symptoms (green macroalgal blooms) seen in the south arm of the Mondego estuary. These measures indicated that widening the communication between the two arms of the river and reducing the discharges of nutrients coming directly to the south arm were the most urgent actions to be taken. Three basic time periods were considered in the analysis: "before the interruption", "during the interruption" and "after the experimental opening". The first period would supply information on the initial status of the system (or when the degree of disturbance was less-well documented), the second would indicate the impact of the interventions, and the third would have important pointers for the likely effectiveness of the planned measures in terms of improving the environmental quality of the south arm (opening the communication between the arms). After analysing all the data, it was found that in the "during the interruption" period there was an overall worsening of all the factors studied (i.e. water quality, plant cover, benthic macroinvertebrates), and a general improvement in the physical-chemical parameters that characterise the ecological state of the estuary, "after the experimental opening". But is should be stressed that the concentration of some nutrients remained high in the "after the experimental opening" period. This fact is related to the upstream sitting of the origin of the nutrients, and to the fact that they are released gradually (basically the phosphorus) from the sediment. This is why the classification in terms of water quality did not noticeably improve. The morphological alterations have led to hydrodynamic changes in the estuary, and these in turn, together with the ready supply of nutrients from the water for agricultural, urban and industrial use (with little subsequent treatment), have encouraged the appearance of eutrophication symptoms in some parts of the system, and the gradual replacement of the primary producers occurred, with all the consequences already described. In these circumstances, an intervention plan was drawn up, with the aim of putting right the problems experienced in the system. After the minor experimental intervention in 1997/1998, the plant cover made a clear recovery and the community of benthic macroinvertebrates is steadily approaching the estuarine community as it was in the 1980s, in structural terms. A positive evolution of the ecological status (macrophytes and plant cover) was observed. In addition, with the aid of mathematical simulations, it was found that widening the communication between the two arms would lead to a faster current in the south arm, which would help to cut the residence time of the water and increase the load capacity for the water mass. The benefit would be better transport power for the south arm, enabling larger amounts of dissolved or suspended materials to be exported, and so prevent their build-up within the system. It was therefore deemed appropriate to intervene in the system by re-establishing the communication between the two main channels. And so the reopening of the connection between the two arms of the Mondego went ahead. The work was carried out in May 2006, by INAG.

Towards ecological sustainability: application of the ecosystems goods and services approach to the Mondego estuary basin

Overall, human activities cause a sequence of environmental damages and stresses, which may alter the ecosystems' natural processes. The most important problems in aquatic environments are related with nutrients input (eutrophication), erosion, input of land swept away materials (increase of water turbidity), sewage drain, water quality alteration, microbiological pollution, changes in the communities original structure, input of alloctone species, pollution in general, habitat destruction and loss of diversity. A dynamic society requires monitoring and adjusting these ecosystem services blend as society's priorities change to insure that the highest valued combination of services is produced. Since some services are not priced (e.g. fish habitat and recreation), this raises a challenge to water managers. In the Mondego River Basin, the population pressure drives the

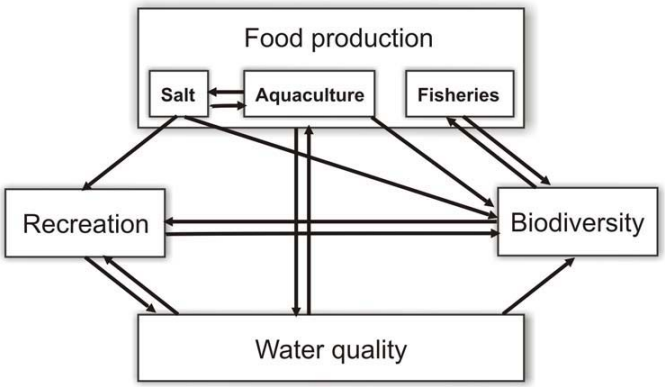
observed changes in water uses. Shipping, fishing, agriculture and recreation were the most important uses reported. Nevertheless, the water industrial use and the water extraction for domestic usages and irrigation appear also to play an important role in each of the three scales analysed in the system. Land use and water resources are obviously linked. The impact and pressure of land use practice and intensity on either the water quantity or quality can be substantial. Currently, the water quality service seems to require the higher attention as, in a large extent, influences the evolution of all the others. It appears that agricultural activities are responsible for the eutrophication symptoms observable in the estuary. On the other hand, is important to keep in mind that this activity is economically essential in the Low Mondego River Valley area. All the measures that might be undertaken to solve this environmental problem must take into account the socioeconomic reality.

It is important to take in consideration that the present work was not an exhaustive valuation study. The Mondego catchment full value cannot be calculated without taking into account all the direct and indirect uses' values, and without estimating the real wetlands value not focusing solely on market prices, since these may underestimate the real value. Our preliminary values may provide a starting point for a more exhaustive and detailed Mondego wetlands's valuation. Nevertheless, regarding the Mondego River Basin, seven main conclusions may be drawn:

1. Population growth have been pushing ecosystems' structure and functions into a 'services-society' system;
2. A progressive loss of natural and agricultural lands to development and services provision has been taking place;
3. Demands on ecosystems for recreational activities and aquaculture production have been increasing;
4. The introduction of exotic species showed potentially able to cause substantial undesirable environmental effects (e.g. threats to biodiversity) or production values;
5. There is a clear need to evaluate the crucial link between land uses and water quality and quantity, in order to achieve a good resources management;
6. Broader scales tended to mask local patterns (scale-dependency effect on ecosystem services evaluation);
7. It will be necessary to develop accurate benefit-cost analysis, taking also into consideration the ecosystems' indirect use values (through Net Present Value estimation).

Moreover, water management has a crucial role in the provision and delivery of all the considered services and goods. It is a vital parameter to obtain economic efficiency, environmental protection, and sustainability. Along with water management and protection, an accurate biodiversity asset evaluation is required in order to better understand what ecosystem services and goods essential for human populations' wellbeing can be supplied. Indeed, both resources are fundamental to an ecologically sustainable social and economic growth and development.

Figure: Interrelations between the different services in the Mondego estuary



7. Cross-cutting issues

The rapid economic development of the Mediterranean coastal areas involves all the WADI study sites, negatively affecting the services and goods provided by the water bodies and the ecosystems they host. The water bodies are affected by industrial and agricultural water discharge causing eutrophication of the transitional (Mondego estuary, Portugal) and fresh waters (Lake Maryut, Egypt) and increased salinity for diminished water supply (El Hondo lagoon, Spain, and Maremma water table, Italy); scarce water circulation or water stagnation is an issue at Ghar Melh-Sidi El Mekki (Tunisia) and Maryut (Egypt) lagoons, and the water bodies are at risk of land filling both for reduced communication with the sea and for land claiming. Rapidly increasing urbanisation is an issue particularly at Lake Maryut that borders a city, but also in other places where touristic infrastructures are built, e.g. in Tunisia and Morocco. There is a trade-off between tourism and urban development, and the protection of natural and cultural heritage. This has become particularly critical in the developed sites of Spain and Italy, where awareness has developed in the loss in biodiversity and cultural heritage. On the northern coasts, our survey on cultural heritage was a "water archaeology" that analysed material remains more than an anthropologic study. On the other hand, in the Moroccan case studies, the material heritage around water was still in use, and the local people was hardly aware of having a cultural heritage linked to water, as this represented the real life (not just "memory"). In some cases, like at El Hondo, the trade-off between economy (agriculture) and nature conservation has developed into overt conflicts among different stakeholders. Water and water management as well as changes in land uses are the main issues of these conflicts. On the other hand, in more pristine study sites (Moroccan and Tunisian sites) protected natural areas are being established that may increase the tourist appeal of the areas. In these cases, the issue is the lack of environmental awareness of the local people and their critical attitude towards novelty and measures that restrict the exploitation of the natural goods.
Gender differences in the attitude vis-à-vis the issues above have been documented at Oued Laou (Morocco) and in lower measure in Spain and Italy. In Tunisia and Egypt the participation of women in economic activities (fishing and agriculture) has turned out very scarce; no awareness of changes and possible loss of environmental goods was expressed by local women.

8. Gender integration in the socioeconomic research

On methodology. The WADI project was based on the case-study approach, which implies an intrinsic variety to be taken into account, reflecting the Mediterranean variety in traditions and cultural aspects. The challenge was consequently to match the socioeconomic gender approach with the peculiar aspects characterising each study site to reach a representation of a complex system starting from a bottom-up information collection. Data collected had to go beyond gender-disaggregated data, as these latter approaches are often biased, due to methodology and timing of data collection. This issue was faced throughout the SEAGA methodology (1993), aimed to facilitate the representation of women's voice at three main levels: field, regional, macro. The water issue was the main driver of the analysis, connecting the different agro-ecosystems considered, by using the SEAGA methodology for field level. Such background for the integration of gender aspects was tested on field to achieve a proper adaptation to each study site, while the socioeconomic background was used to establish the strata and the categories, such as urban vs. rural population, the main sources of income, etc., to be represented in the surveys. The households were considered sampling units, with a twofold perspective towards the activities carried out inside the household and outside the household. The access to services was analysed and the perception of water-related problems was investigated as a proxy of willingness to change. This complex set of characteristics conducted us to nonprobabilistic methodologies for the data analysis. Moreover, as some major differences between genders are the role in tradition transmission (typically feminine)

and the carrying out of rentable activities (typically masculine), we included into each site considered one traditional rentable activity. The presence of a natural area often had, or is claimed to have, a positive influence on the whole issue, by securing environmental goods quality, improving traditions and making the protected area rentable. The case-studies analysed were: Italy: the Ombrone river low plain and the *agriturismo* (hosting in farms) activity; Morocco: the Oued Laou valley and the pottery of Fran Ali; and Tunisia: the Majerda river low plain and the *Ramli* agriculture. From the local frameworks, we can derive an overall perspective, at WADI level, including common issues and driving forces.

Common issues. The ecological characteristics are changing at really small scales, thus defining the scale of traditional activities and ecological resources use, strictly linked to the environment as well: the Fran ali pottery cannot exist without local clay reservoirs, traditional ovens working with firewood,etc; the *Ramli* agriculture cannot exist without the lagoon ecosystem, and the *agriturismo* activity won't be successful if taken away from the landscape which generates its attractiveness. Such patchiness, found at case study level but consistent with the whole Mediterranean context, represents a high diversity content, which is a resource, but at the same time makes difficult to manage the whole framework on an higher level. The lack of communication between stakeholders can be highlighted by indicators such as the absence of networking activities and organisation in associations. Moreover, the scarce confidence often found in answering the questionnaires reinforces the idea of an "island" behaviour, which implies a scarce habit in self-organisation towards mainstreaming and empowerment, due to multiple possible reasons, from historical to ecological ones. There is an emerging need of an education in this sense too. The achievement of a representation on those decisional levels required to help for problem solving, was here found to be a need beyond the gender perspective, defining a twofold exclusion of women from decisional levels, as the example of the Moroccoan case: women are not represented at the *Jma'a* but both men and women felt to be not represented at higher levels of management and policy-making.

It emerged that the land ownership is not automatically leading to a control on the decision-making processes, even if property rights have been pointed out as a key determinant of women's household management: women were found in all cases to have property rights with respect to land and households, but from our direct observations this was often not enough to avoid their segregation out of rentable activities. The market and policy-makers are driving the trends of change, but feminine representation is scarce in these two frameworks, creating a loop and leaving the gender issues marginal. Often such phenomenon was found paired with a scarce willingness to be involved, and a general distrust.

Throughout the case-studies, the phenomenon of men migration to urban areas was not found relevant, if we except two households sampled at Oued Laou. A common problem resulted rather to be the aging of the resident population in rural zones. The paradigm of a feminine role in biodiversity conservation in agriculture was found not to be applicable throughout our case-studies, as women are carrying out the whole set of duties and share with men the work in agriculture (as the cases of Morocco and Italy), or are segregated outside the agriculture context (as the case of Tunisia). Good practices are however maintained by women within the domestic sphere, when they are efficient or economically rentable, for example, rainwater collection to wash clothes or tools to save water applied in the agriturismi.

Common driving forces. The market pressures resulted to drive some choices regarding the activities of local people, as the case of the swimming pools (not needed by the inhabitants but required by the visitors) for the Italian study site. From this emerging point, we could derive an indication for the need of valuation of the existing traditional knowledge, also through the valuation of products obtained by the application of the knowledge self. Throughout the case-studies analysed, we can derive that women are maintaining the traditional knowledge related to the domestic sphere and its connection to the external environment, as the case of handicraft products and traditional food, and they show to be able to integrate the traditions in use of ecosystem resources with the uptake of new good practices. The valuation of traditions and good practices

could therefore represent not only a tool for local people welfare, but a sound tool for bottom-up women empowerment, towards the achievement of equality conditions, in the consideration of gender aspects. In the case of tradition valuation, however, attention should be paid to avoid the risk of romanticizing Nature and traditional knowledge, far away from the real systems and no more fitted to the ecological local peculiarities: in a changing framework, the challenge is to appreciate traditional societies for what they really are (i.e. coevolved together with the environmental conditions to which they are fitted) and not what we want them to be. In this respect, tourism is often seen, or claimed to be, a solution for development of marginal zones and poverty alleviation; however, before raising expectancy, a cautious analysis of the framework should be carried out, by involving local women and men from the very beginning, to propose and develop activities in the respect of the network of relationships between people and environment. The integrated rural tourism, which already was chosen at some of our case-study level, may represent a development strategy, taking into account and improving local cultural, social, environmental and economic resources. The role of natural protected areas could also be extended, from the old-style model of "areas without people" to a service for local empowerment, through the preservation of the environment and the improvement of natural resources quality, on which the attractiveness self is based. This is particularly true in the case of "young" protected natural areas, such as the Talassemtane National Park, in which links between landscape and inhabitants are still to be built, offering an intrinsic chance to reinforce such interconnection and ensure sustainability of ecological resources management.

Oued Laou basin: women carrying goods; little girls encouraging interactions with visiting researchers

9. Lessons learnt from WADI

WADI was a great experience during which the participants got acquainted with different environmental and socio-cultural contexts. Moreover, a reciprocal learning occurred between researchers of different disciplines and stakeholders. We also succeded in encouraging different stakeholders to engage in common projects on the case-studies analysed. WADI initiatives have not finished, but are continuing beyond the project lapse. However, some communication issues are still unsolved. Besides the contexts are ever changing and it will be interesting to come back to the study-sites again to analyse how things have evolved.

We can summarise the lessons learnt from the WADI experience up to now.

1) A holistic approach has proven very useful for an adaptive management of environmental resources, including fresh water. In this way we avoid staying blocked within a simplified ideal world, composed of a few elements only that can be easily managed, although with unpredictable and unapplicable outcomes. The spatial and temporal scales of the approach should include not only the current components of the system subject to the management, but also the scales of the influencing factors and actions. A system is like it is because of its past history and the general context in which it is inserted.

2) The management should consider and include all the sectors and stakeholders as well as the links between them and the relations between the various sectors. There is always the risk of neglecting important elements of the systems and threaten the sustainability of the system self.

3) The conflicts among stakeholders should be analysed prior to any management, and all the parts listened to. Otherwise there is the risk of neglecting the weak social sectors and starting vicious circles of environmental degradation and poverty.

4) The points indicated above can be addressed only at the local level. However issues can never be entirely localized and impacts often derive from changes occurring elsewhere. The concept of open systems is a key concept in this respect.

5) The problem of communicating advices to powerful stakeholders who do not welcome them still remains. We are well aware that most of the powerful stakeholders have already precise ideas on what they want to do using their power. We are also aware of the difficulty of intercultural and interdisciplinary communication.

6) We are persuaded that scientists have to be transparent with respect to the public, that pays taxes to support scientific research and is the eventual receiver of the results obtained through scientific research at their site.

The results developed by the WADI project are like a diamond, with many facets, each throwing a different light to the complex reality around water bodies in Mediterranean coastal areas.