



Integration of Biodiversity in the Decision-Making Process: Lessons Learnt from the Moulouya Projects

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INTRODUCTION

Of all natural resources, water has been recognised as the key environmental resource for social welfare, health security, economic growth and prosperity. Human security can therefore be directly linked to environmental conservation (of water, ecosystems and biodiversity) and to socio-economic stability and sustainable development (Ganoulis, 2004).

Aware of the importance of their common heritage, the Mediterranean countries and the European Union have been working out joint programmes and policies for the sustainable development and conservation of coastal regions since 1975. These regional initiatives include in particular the Mediterranean Action Plan (part of the UNEP Regional Seas Programme and the central element of the Barcelona Convention), the Mediterranean Commission for Sustainable Development, and specific programmes or initiatives such as METAP, LIFE, MedWet, Natura 2000 and MEDA (EU).



The Moulouya river mouth. Photo © FADESA Maroc.

The MedWet programme for the conservation of Mediterranean wetlands resulted from the conference in Grado (Italy) in 1991. It has been recently enlarged (Venice, 1996) following an agreement between all the Mediterranean states represented, with the aim of developing a common strategy for the conservation of wetlands. Despite these efforts, most wetland development projects are not based on a solid foundation of biodiversity information. The countries of the Mediterranean region have reached different stages of economic and institutional development. Therefore they do not have the same ability to address issues concerning biodiversity in the context of sustainable development. Incremental support for less developed countries is then necessary to enable them to implement agreed regional policy.

In this context, in accordance with Morocco's commitments as a contracting party to the Convention on Biological Diversity (CBD), and based on its willingness to adhere actively to the concept of Integrated Water Resources Management, the IUCN Centre for Mediterranean Cooperation (IUCN-Med) and the Moulouya River Basin Agency (*Agence du Bassin Hydraulique de la Moulouya-ABHM*) in Morocco set up the present project for the *Integration of aquatic biodiversity considerations in the planning and management of the Moulouya River Basin*. The Moulouya river basin is a suitable site to evaluate the effectiveness of management strategies in order to integrate biodiversity knowledge in wetland development projects. The Moulouya basin is the largest basin in the Maghreb (Figure 1) and located in one of the driest areas of Morocco. Water supplies are limited due to the arid climate and dependence on a single river basin located almost entirely in an area of low rainfall, where recurrent droughts have occurred in the past 20 years. Water scarcity and its impact on natural resources in the Moulouya basin are increasing due to the rise in pollution from domestic, industrial and agricultural sources. Major projects have been implemented in recent years to study local issues; they include, in particular PBREM, MWC, SMAP III Moulouya, SMAP III Nador, ACCMA, DELIO and IUCN -Med/ABHM.

The main aim of this report is to demonstrate how biodiversity information can be effectively integrated based on the experience and results of the various European projects concerning the Moulouya basin. This could serve as a reference for the development of other projects in Morocco or other North African countries. Such an evaluation was also an important element when the national authorities were drawing up the National Charter for Environment and Sustainable Development (April 2010), based on extensive public involvement. This document reflects the importance of rational management of natural resources and draws on contributions from the above-mentioned projects, the Department of Environment, the Water and Forestry Administration and the Moulouya River Basin Agency. It examines the lessons to be learnt from the various projects and their impact on the management of natural areas in this Mediterranean region of Morocco. It also considers lessons learnt from previous projects in the region, as regards development strategies and action plans for the rational and sustainable management of natural resources.



Moulouya River downstream from the Mechra Hammadi Dam. Photo © M. Melhaoui

I OVERVIEW OF THE MOULOUYA RIVER BASIN

I.1. General situation

The Moulouya River, one of the largest permanent rivers in Morocco, rises in Alemssid (Area of Aghbala), close to Midelt province at the junction of the Middle and High Atlas, at an elevation of 2,000m. The watershed extends over 74,000km², and drains the high plateau in the east, the High Atlas in the south, the Middle Atlas in the west and the eastern Rif in the north-west, to reach the eastern Mediterranean coast of Morocco. The Moulouya has a length of about 650km and is the second longest river in North Africa after the Nile (Figure 2).

The Moulouya River Basin Agency's activities extend over four regions and nine provinces (Oujda, Berkane, Taourirt, Jerada, Nador, Taza, Boulemane, Figuig and Khénifra). This area has 3,371,000 inhabitants according to the latest census (2004), or 11.2% of the population of Morocco, at a low density of about 46.2 inhabitants per km². The four urban areas of Oujda, Greater Nador, Greater Berkane and Khénifra represent two thirds of this population (ABHM, 2008).

The economy of the Moulouya basin depends mainly on agriculture and cattle, but also on industrial activities concentrated in the urban centres, mining and some tourism activities.

Agriculture is really dominant in the northern part of the basin, where cereal farming takes place alongside some industries related to agriculture, as well as market gardening and fruit growing. In the southern part, pastoralism dominates the rural areas. On the Mediterranean coastline, fishing is witnessing considerable growth due to the increase in production in the harbours of Béni N'sar and Ras Kebdana.

I.2 Surface waters of the Moulouya basin

The surface water resources of the Moulouya basin (Figure 1) consist of four main rivers: the *Oued Moulouya* and its three major tributaries, the *Oued Kert* on its west bank and the *Oueds Kiss* and *Isly* on the east, the latter forming the border between Morocco and Algeria.

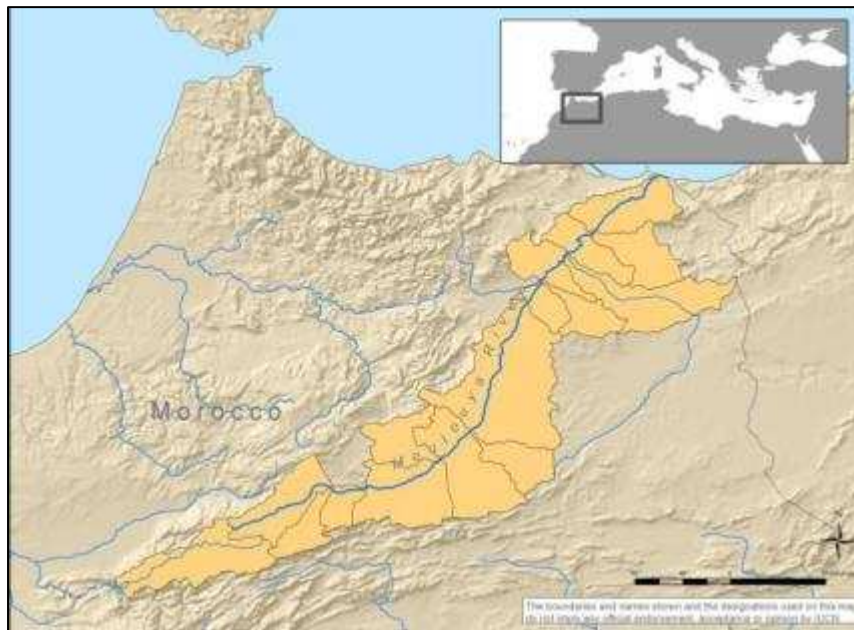


Figure 1. The Moulouya river basin (IUCN 2010)

The Moulouya river basin is characterized by low water levels from August to September, associated with widespread pumping for irrigation. In its lower course, the river follows a winding path ('Moulouya' means 'winding' in Arabic). Initially flowing in a south-westerly direction, it changes after the village of Béni-Snassen to a north-easterly direction until it reaches the sea. The Moulouya river mouth is often blocked by a sand bar preventing salt water intrusion upstream when the water level is at its lowest. The mouth of the Moulouya has moved about one kilometre westward in recent history. The former bed is now occupied by brackish expanses of water with large populations of eels and water birds (Melhaoui and Sbai, 2009).

I.3 Dams and reservoirs in the Moulouya river basin

Since 1955, at least 52 dams have been built in the Moulouya basin, and their current storage capacity is estimated at several billion cubic metres. These dams are mainly intended to meet the needs of the population as well as industrial and agricultural activities, including livestock (ABHM, 2008). The policy of small dams launched at the beginning of the 1980s to promote the socioeconomic development of disadvantaged regions in the Moulouya basin resulted in the building of 42 dams and mountain reservoirs with a storage volume totalling 22 million cubic metres. In addition, there are five major dams with important reservoirs (Figure 2):

The Mechrâa Hammadi dam became operational in 1956. It serves the plains of Sebra-

Triffa (Berkane region) and of Gareb and Bou-Areg (Nador region).



The Mechrâa Hammadi Dam. Photo © ABHM

The Mohamed V dam at Mechraa Klila has been operational since 1967 and had an initial storage capacity of 730 million cubic metres. Located 70km from the Mediterranean Sea at an elevation of 218m, this dam created a reservoir high enough to irrigate the Lower Moulouya region, which is one of the main centres of agricultural development in Morocco. This dam also supplies drinking water for the cities of Berkane, Nador and its region via the Bouareg canal, and the hydroelectric plant installed at the foot of the dam produces electricity. Silting, as a result of soil erosion, is reducing the capacity of this dam by an average of 10 million cubic metres per year. Consequently, the water required to irrigate 65,000ha of agricultural land in the lower Moulouya region is no longer guaranteed, while regional needs for drinking water are growing.

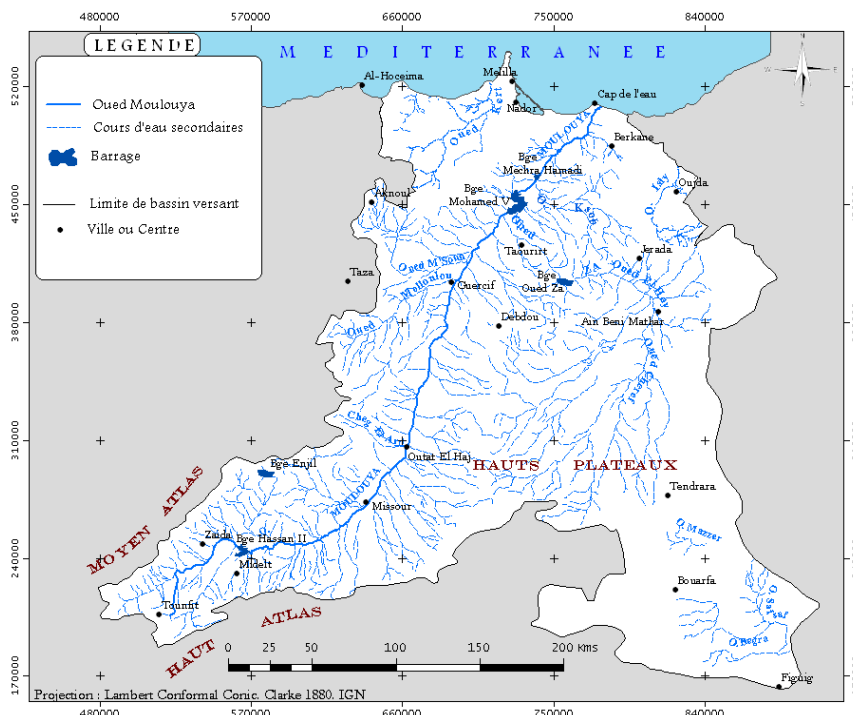


Figure 2. The Moulouya river basin and the main dams constructed in the region (Melhaoui and Sbai, 2009)

The dam on the Oued Za (formerly Laghrass), a right-bank tributary of the Moulouya, 54km south-east of the city of Taourirt, allows for the regularization of small and medium-sized irrigated areas in the Oued Za valley, covering an area of about 2,750ha. It also protects the valley against floods, contributes to the irrigation of the lower Moulouya region and ensures future drinking water supplies to the cities of Oujda, Taourirt and El Aioune. It also helps to reduce silting in the Mohamed V dam.

The Hassan II dam, formerly called Sidi Said, is located in the Midelt plain. It has a storage capacity of 400 million cubic metres and was inaugurated in 2009. This dam is intended to supplement irrigation in the lower Moulouya region, to protect against floods, to supply the region of Missouri with drinking water and to produce electric power.

The Enjil dam is located on the **Oued Taghoucht** (Oued Enjil) a left-bank tributary of the upper Moulouya, 16km south of the city of Boulmane. It became operational in 1996 and has a capacity of 12 million cubic metres. It is mainly intended for supplying drinking water and for irrigation.

I.4 Length profile of the Moulouya river and biological zoning

The profile of the Moulouya river varies from a steep gradient in its upper course from its source to Midlet, then a rather shallow gradient and weak flow from Midlet to Guercif. The average width of the lower Moulouya is 40 metres from the Mechraa Hammadi reservoir to the mouth of the river. The physiographical features (width, gradient) of the lower Moulouya places it in the cyprinid faunal zone, equivalent to the lower barbel zone defined by Huet (1949) for medium-sized waterways in Europe.

Upstream of the Mohamed V dam, the annual flow of the Moulouya is irregular. According to ABHM, the mean annual flow is 34m³/s, which does not reflect large monthly and seasonal variations. The maximum flow—80m³/s—is attained during the spring, especially in April, and coincides with the melting of snow in the High and Middle Atlas. Downstream, the flow is reduced to 5m³/s and sometimes less. In the lower part of the Moulouya, the flow rate depends partly on rainfall in the Béni-Snassen area. Autumn and winter floods generally last 24 to 48 hours.

I.5 Climatic conditions of the Moulouya river basin

The Moulouya basin is characterized by an arid to very arid climate, tending towards a Mediterranean climate in the northeast. It is continental in the middle Moulouya, with montane influences in the upper reaches. Winters are often hard, long and cold, with minimum temperatures well below freezing. Summers are very hot but tolerable because of the dryness of the air. The mean annual temperatures vary with elevation and continentality, ranging between 7.5 and 26°C. Temperatures reach a maximum in July and August and are minimum in January. Rainfall varies between the upper, middle and lower reaches of the Moulouya.

Drought periods are common with only very weak fluctuations. However, total rainfall does vary from year to year, and the annual average of top rainfall aggregates is 250 mm (Figure 3).

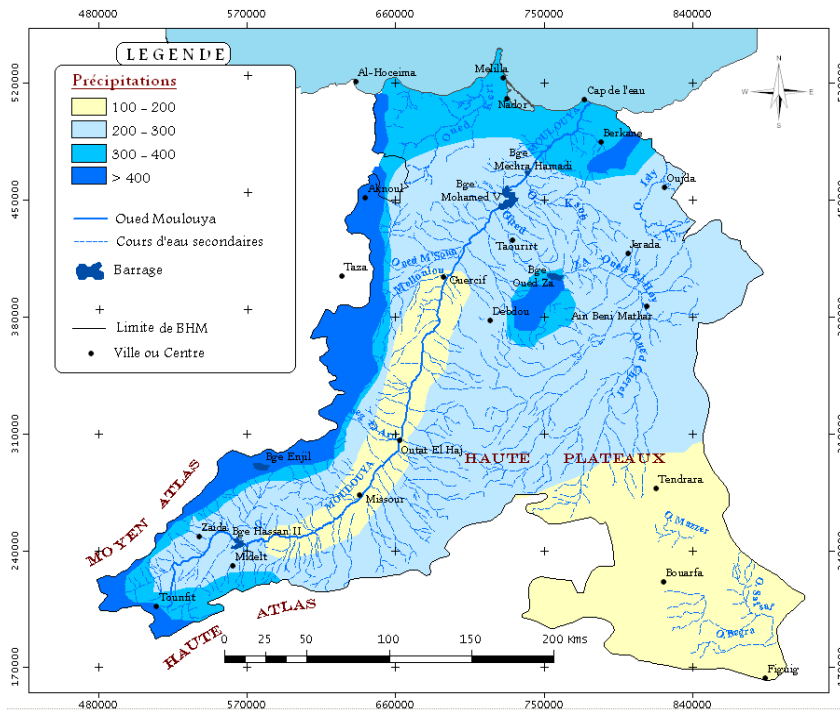


Figure 3 Annual rainfall in the Moulouya river basin (Melhaoui and Sbai 2008)

II METHODOLOGICAL APPROACH

Background to the IUCN/ABHM project (2007–2010): *Integration of aquatic biodiversity considerations in the planning of water management in Africa.*

Since 2007, the IUCN Mediterranean office has been managing the northern Africa component of a project funded by the European Union on the Integration of aquatic biodiversity considerations in the planning of management in Africa.

The first part of this initiative involved data collection and assessment of the conservation status of 5 taxonomic groups (freshwater fishes, aquatic plants, freshwater molluscs and crabs, and dragonflies) across northern Africa and the whole Mediterranean. This resulted in the identification of some important (endemic or threatened) species. The second part consisted of an appraisal of knowledge about the species considered important, as well as integration of these data in the management of hydraulic resources at four demonstration sites across Africa, including the Moulouya basin. A site project was developed there in collaboration with the Moulouya River Basin Agency (ABHM, abbreviation from its name in French) to integrate these data on the Moulouya basin and to develop management plans.

The water resources in the Moulouya river basin are degraded due to water pollution of domestic, industrial or agricultural origin, aggravated by periods of drought, resulting in a loss of water resources and a severe impact on aquatic biodiversity.

The main objective of the project is to set up a pilot integrated management process for aquatic biodiversity at the level of the Moulouya river basin, by involving stakeholders in setting up common objectives for the conservation and integration of fresh water biodiversity data in the decision-making process and management plans for the basin.

The lessons learnt from biodiversity conservation projects in the Moulouya basin were approached in three steps:

II.1 Review of selected projects previously implemented in the region,

II.2 Identification of influential stakeholders engaged in past or future projects,

II.3 Project assessment using Project Cycle Management analysis (PCM).

In order to complement and enrich the lessons learnt on integrating biodiversity in decision making and resource management, other projects were also considered.

II.1 Review of selected projects previously implemented in the region

The selection of projects to be evaluated was based on the following criteria:

- Projects with continuity over time;
- Originality, complementarities between projects, mode of project management, availability of final documents and possibility of contact with managers and persons involved;
- Availability of a list of partners and beneficiaries at the level of the cities of Oujda, Madagh-Berkane, Rabat, Kénitra and Missour. Involvement of the consultant, Mohamed Melhaoui, in the implementation of these projects.

Based on these criteria, three main projects were identified for evaluation:

- **PBREM Moulouya project** (2003–2005): *Protection of biodiversity and water resources in the Moulouya river basin;*
- **MedWetCoast (MWC) Moulouya project** (2004–2006): *Conservation and rational use of wetland biodiversity in the Mediterranean;*
- **SMAP III Moulouya project** (2006–2009): *Integrated Coastal Zone Management of sensitive wetlands.*



Mining area of Mibladen in the Upper Moulouya river basin. Photo © M. Melhaoui

The documents relating to these projects were consulted and reviewed in order to record the main objectives, results and end products. The following sources were consulted:

- Documents of the PBREM project were consulted at the ABHM in Oujda and the ENDA Maghreb library in Rabat;
- Documents of the MWC project were consulted at the Environment Department in the province of Berkane, the research department of the Regional Directorate of Forestry in Oujda (DREFO), the regional Department of the Environment in Oujda and the ENDA Maghreb Library in Rabat. Some documents were downloaded from the MedWetCoast project Website;
- Documents of the SMAP III Moulouya project were consulted at the Environment Department of the province of Berkane and the regional Department of the Environment in Oujda. Some documents were downloaded from the website <http://www.minenv.gov.ma>, which hosts the SMAP III Moulouya project website.

A summary of the objectives, main outcomes, strengths, difficulties and lessons learnt from previous projects implemented in the region can be found in section V of this report: *Review and lessons learnt from previous projects in the Moulouya river basin.*

II.2 Identification of influential stakeholders engaged in past or future projects

The identification of influential stakeholders was based on a review of experts, researchers, institutions and administrations involved in the preparation of the reports, the training sessions and the communication workshops.

The following stakeholders and key persons were identified:

Key people in the PBREM Moulouya project

Mr Ryad Bensouiah, formerly of ENDA Maghreb, Rabat

Mr Boubker El Houadi, ABHM

Prof. Ahmed Douira, Ibn Tofail University Kénitra

Prof. Aicha Benmohammadi, Ibn Tofail University Kénitra

Key people in the MedWetCoast Moulouya project

Mr Youssef Slaoui, national manager of the MWC project

Miss Sanae Jemili, national secretary of the MWC project

Prof. Guy Chavanon, expert

Prof. Benyounes Haloui, expert

Prof. Mohamed Menioui, expert

Prof. Mohamed Dakki, expert

Prof. Aziz El Agbani, expert

Prof. Soumia Fahd, expert

Prof. El Ayachi Sehhar, expert

Prof. Aziz Benhoussa, expert

Prof. Ahmed Khattabi, expert

Prof. Mohammed Melhaoui, local coordinator of the MWC project (2nd phase)

Mr Youssef Faqihi, formerly of ENDA Maghreb

Mr Mohamed Seddiki, formerly of ENDA Maghreb

Mr Ryad Bensouiah, formerly of ENDA Maghreb, Rabat

Mr Abderrahim Boutaleb, local coordinator of the MWC project

Mr Najib Bachiri, Homme et Environnement Association

Mr Abderrahman Chelali, APROCIB (white stork protection association)

Mr Mohamed Khalloufi, Forestry authority (DREFO) research department

Mr Mohamed Mokhtari, Province of Berkane Environment Department

Mr Mohamed El Yousfi, Province of Berkane Environment Department

Mr Ahmed Essaidi, President of the local community of Madagh

Key people in the SMAP III Moulouya project

Mr Brahim Zyani, national manager of the SMAP III Moulouya project at the State Secretariat for Water and Environment, Rabat

Mr Fouad Zyadi, national coordinator of the SMAP III Moulouya project at the State Secretariat for Water and Environment, Rabat

Mrs Demnati, head of department at the State Secretariat for Water and Environment, Oujda

Mr Abderrahim Boutaleb, local coordinator of the SMAP III Moulouya project

Prof. Abdelhafid Chafi, local facilitator of the SMAP III Moulouya project

Prof. Yassine Zeghloul, communications officer of the SMAP III Moulouya project
Prof. Abdelkader Sbai, SMAP III Moulouya project consultant
Prof. Mohammed Melhaoui, SMAP III Moulouya project consultant
Mr Najib Bachiri, Homme et Environnement Association
Mr Abderrahman Chemlali, APROCIB (white stork protection association)
Mr Mohamed Benata, ESCO Association, (*Espace Solidarité et Coopération de l'Orientale*)
Mr Mohamed Mokhtari, of, Province of Berkane Environment Department
Mr Mohamed El Yousfi, Province of Berkane Environment Department

Key people in the IUCN/ABHM project

Mr Mohamed Chtioui, Director of the ABHM
Prof. Mohammed Melhaoui, local scientific and technical coordinator of the project
Miss Bouchra Benzekri, IUCN/ABHM focal point at the ABHM Oujda
Mr Boubker El Houadi, section head at ABHM
Prof. Guy Chavanon, Mohamed I University Oujda
Prof. Ali Berrahou, Mohamed I University Oujda
Prof. Latifa El Hafid, Mohamed I University Oujda
Prof. Abdelkader Sbai, Mohamed I University Oujda
Dr Jean Pierre Boudot, IUCN SSC Dragonfly Specialist Group expert
Mr Hamid Kaouass, research student, Mohamed I University Oujda
Mr Abdeslam Fagrouch, research student, Mohamed I University Oujda
Mrs Annabelle Cutellod, IUCN–Med
Dr Dania Abdulmalak, IUCN–Med
Dr Brahim Haddan, regional counsellor of IUCN in North Africa
Mrs Demnati, head of department at the State Secretariat for Water and Environment in Oujda
Mr Najib Bachir, Homme et Environnement Association
Mr Mohamed Benata, ESCO Association
Mr Mohamed Khalloufi, Forestry authority (DREFO) research department.

II.2a Surveys and interviews with actors involved

The survey, which lasted almost a month, was carried out after the identification of the key people in each project, whom we thank for their collaboration. We conducted direct or telephone interviews with the managers, partners, stakeholders and beneficiaries of each project.

Once the various actors had been identified and contacted, field missions were organized in order to diagnose the present situation, subsequent to the various Moulouya projects. The main questions addressed to interviewees were as follows:

- *Do you know the ecological value of the Moulouya site in terms of biodiversity, as a Ramsar site or as a wetland protected area?*

- *What are the negative impacts on biodiversity?*
- *What are the main issues affecting the Moulouya site?*
- *How can we protect the Moulouya site together?*

Field missions were carried out during January and February 2010 as follows:

- Field missions in the upper Moulouya to assess the achievements of the PBREM project (ABHM, mining area, and waste co-treatment centre in Missouri);
- Field missions in the lower Moulouya to assess the achievements of the MWC project (state of physical actions);
- Field missions in the lower Moulouya to assess the achievements of the SMAP III Moulouya project (local coastal group (*cellule locale du littoral*) and future perspective of the coastal region charter);
- IUCN/Moulouya field mission on biodiversity prospection, discussion with partners and awareness-raising during the Moulouya Caravan ('Caravane de la Moulouya' in French)



Water pollution in the upper reaches of the Moulouya River. A lead smelter in the Himer Oued (Jerrada Province). Photo © M. Melhaoui

II.3 Project assessment: Project Cycle Management (PCM)

The Project Cycle Management (PCM) approach consists in a cycle of six stages (Programme, Identification, Formulation, Appraisal, Implementation and Evaluation), through which projects are processed from the policy framework to the final evaluation. The Logical Framework (Logframe) is the specific tool that is used to design, appraise, manage, monitor and evaluate the passage of a project through the PCM stages. In this case, we first applied PCM in order to better understand and assimilate the lessons learnt from the various projects in Moulouya and also to see whether the three selected projects were able to produce lasting benefits and act as lessons for managers and administrators. We also used PCM to check whether the three selected projects were:

- **Relevant** to the needs of partners and targeted beneficiaries;
- **Accomplishable** in technical, social and economic terms;

- **Efficient and well managed.**

We also sought to identify the right decisions (strengths) and difficulties (weaknesses) by highlighting the following elements:

- The definition of concrete objectives in a fixed timeframe for each project;
- Actors and beneficiaries;
- Problems to be solved;
- The implementation process of all activities;
- General assessment of all activities;
- The modalities of monitoring and assessment;
- Lasting benefits;
- Quality and success criteria: relevance, feasibility, viability, organization, efficiency, effectiveness and impact.

III. LESSONS LEARNT FROM THE IUCN/ABHM MOULOUYA PROJECT

One important factor for the success of the IUCN/Moulouya project was that it came after several other international (mainly European) projects on biodiversity in different parts of the Moulouya Basin. Involvement and work on a long-term basis (rather than two- to three-year projects) was important and was also a good investment in terms of effort/results. Local people were more used to working with international organizations, and some technical capacity had already been built up in the region.



The participatory approach in action during the IUCN/ABHM project. Photo © M. Melhaoui

III.1 Strengths

We put much emphasis on the modalities of the IUCN/ABHM project management, the involvement of partners and feedback from the local population. The scientific data and aquatic biodiversity results obtained were integrated into the Moulouya management strategy.

- ABHM and IUCN–Med agreed to entrust the project management to an experienced local consultant, who was well connected and recognised by the local and regional authorities.
- IUCN experts and skilled researchers from Mohamed I University in Oujda were involved in diagnosing the site's biodiversity. This partnership guaranteed the scientific quality of the results obtained.
- The project was launched at an opening workshop designed to inform and communicate with all the stakeholders in order to develop a participatory approach.
- Emphasis was placed on the production of documents that would constitute a data reference for the management of Moulouya biodiversity by the ABHM.
- Another important focus was the applicability of the project deliverables. For example, the building of an aquatic biodiversity database and the preparation of GIS maps by ABHM are already operational.
- ABHM's partners and local NGOs were mobilized and some training workshops were organized for them on sampling methods and analysis for aquatic biodiversity and an introduction to GIS. In terms of communication, the IUCN/ABHM project developed an original activity named the Moulouya Caravan to raise awareness about aquatic biodiversity and protection, which visited eight provinces in the basin. The project also involved the production of some communication and awareness tools.
- An Aquatic Biodiversity Management Committee was set up and ideas were

proposed for an aquatic biodiversity management plan.

III.2 Difficulties

We assessed the main difficulties of this project at different levels, for instance process, management, execution of programmed actions and their impact on the environment, participation by NGOs and local communities, and the transformation of scientific results into political actions. The main factors were:

- The late start of the project (delayed by 3 months), due mainly to communication delays between ABHM and the IUCN councillor;
- The change in IUCN–Med project coordinator;
- The large number of actions programmed in comparison with the duration of the project;
- The large area of the Moulouya river basin;
- Difficulties of Internet access sometimes;
- Logistical problems with the Moulouya aquatic biodiversity monitoring plan envisaged by the Aquatic Biodiversity Monitoring Network and the ABHM scientific committee, in that ABHM and the Faculty of Sciences of Oujda University have yet to sign a collaboration agreement and set up an aquatic biodiversity laboratory.



Training session on aquatic plants. Photo © M. Melhaoui

III.3 Lessons learnt from the IUCN/ABHM MOULOUYA Project

The main lessons derived from the IUCN/ABHM Moulouya project are as follows:

LESSON 1: This project conducted in a North African river basin was relevant and implemented to a high standard. The selection of target regions at basin level is an essential step in order to achieve regional conservation objectives more effectively. The quality of the deliverables was assured by the extensive knowledge of the biodiversity experts involved.

LESSON 2: Conservation projects should prioritize biodiversity hotspots (places with

high numbers of endemic species) in the Mediterranean. Biodiversity hotspots in the Mediterranean, which include river basins like the Moulouya, shelter a rich but threatened biota; hence the need for aquatic biodiversity conservation, especially of samples representative of the natural heritage of the Mediterranean side of Morocco. Biodiversity hotspots need to be better known and people living in them should be informed about both the value of their resources and the main threats to them.

LESSON 3: The IUCN/ABHM project was an innovative vehicle for developing environmental education and raising awareness about aquatic biodiversity and its protection. The IUCN/ABHM project promoted a set of good practices for raising awareness about environmental protection and the preservation of biodiversity throughout the Moulouya river basin through the activity of the Moulouya Caravan, which visited eight provinces in the upper and lower parts of the basin. The main recommended practices concerned the conservation of habitat for aquatic organisms, especially fishes. The main message of the Caravan was to highlight the complexity of aquatic systems, within which any change may have unpredictable effects on the biota. In this respect, the main recommendations included managing activities on river banks, performing environmental impact assessments prior to infrastructure development in the river and along its banks, and controlling water pollution.

LESSON 4: The involvement of stakeholders in biodiversity protection in the Moulouya basin was a key factor in the success of this project. A preliminary workshop was held in order to provide information and open communication channels between the stakeholders involved in the project, in a participatory approach. This resulted in better-informed local people and a consensual implementation plan. Stakeholders played a key role in the project through their participation in workshops and their cooperation in conservation activities as part of the Moulouya basin management. Similarly, important project decisions such as the selection of a project coordinator were made by mutual agreement between IUCN and the local authorities.

LESSON 5: Scientific research is a necessary tool for the knowledge and management of aquatic biodiversity in the Moulouya river basin. The research work carried out in the lower Moulouya by university researchers and the diagnoses resulting from European projects formed a necessary and useful database for the management of the site. The quality of the information is crucial to ensure its utility in long-term monitoring.

LESSON 6: The monitoring and rational management of the basin's aquatic biodiversity is a factor in promoting its viability and sustainability. It is crucial to define the structure for follow-up and long-term monitoring so as to ensure the continuity of the project objectives. The setting-up of a scientific committee and of an aquatic biodiversity management authority, for instance the Aquatic Biodiversity Monitoring Network (ABMN) within the ABHM, for monitoring, assessment and the development of scientific research into biodiversity is of key importance for the management of aquatic systems. The continuity of these structures requires interested people and a mechanism to ensure a long-term operational budget.

LESSON 7: Developing the expertise of the Aquatic Biodiversity Monitoring Network was vital for members to understand and improve their management of Moulouya's aquatic biodiversity. Local capacity building in the field and in the laboratory, involving cooperation with and between stakeholders, especially NGOs, was a major factor in the success of the IUCN/ABHM Moulouya project. Requests were received for other similar training sessions.

In general, the efficiency and effectiveness of the IUCN/ABHM project and its impact on the Moulouya river basin were substantial. The concrete targets of this project were attained because of the considerable involvement of the ABHM, local actors and beneficiaries. The

ABHM held regular meetings with local actors and beneficiaries at which they discussed and collaborated on water issues. In addition, the project ran to schedule, built on previous projects and local expertise, ensured a participatory approach, provided training and long-term tools for local experts and managers, raised awareness among the local communities by involving local NGOs active in this area, and helped establish a suitable monitoring structure.



Local capacity building is a key factor in the success of biodiversity conservation projects. Local people from ABHM, university students and NGOs in a training session on aquatic biodiversity techniques at Oued Zegzel. Photo © M. Melhaoui

III.4 Successes of the current IUCN/ABHM Moulouya project: The integration of aquatic biodiversity data in development planning in the Moulouya basin

FACT SHEET FOR THE IUCN/ABHM MOULOUYA PROJECT

1. *Identification of influential stakeholders and decision makers:* Around 50 people from local NGOs, universities, international organizations and both governmental and non-governmental offices of environmental affairs were identified, contacted, informed and consulted during the various stages of implementation of this project.
2. *Public awareness raising:* The Moulouya Caravan visited eight provinces, spreading the project results to more than 1,000 people. Its activities were reported in the national and local media (TV, radio, press and electronic media). The Caravan's activities comprised presentations and discussions, distribution of informative material, and scientific demonstrations of the collected material and the sampling equipment.
3. *Capacity building:* Infrastructure for biodiversity monitoring was developed in this project with an agreement to set up a laboratory to monitor aquatic biodiversity at the ABHM. Capacity building in the project prioritized local training, especially in field survey methods and GIS mapping of freshwater biodiversity. More than 20 people were trained to monitor aquatic biodiversity and around 20 others were trained in the use of GIS tools.
4. *Information quality:* Successful integration with development planning requires complete, high-quality data. A complete set of data about biodiversity and the main threats facing it facilitates the integration of biological information with management decisions. Biodiversity data generated in this project comprised the identification and the distribution mapping of 28 species of aquatic plants, 19 species of freshwater molluscs, 1 crab species, 42 species of dragonflies and 17 species of freshwater fish.



The involvement of stakeholders in biodiversity protection was a key factor in the success of this project Photo © M. Melhaoui

IV RECOMMENDATIONS

IV.1 Recommendations for future projects concerning the Moulouya river basin

The previous projects show that in most of the Moulouya basin aquatic ecosystems experience seasonal water level variations that are becoming more and more accentuated each year, with a torrential regime in winter and violent floods in spring. In summer, the water level is low throughout most of the basin, making it difficult to maintain aquatic biodiversity. The change in water regime is accompanied by a faster flow, turbidity and large temperature variations. As a result, several lakes in the basin that are continually swept by floods witness frequent fish mortality due to clogging spawning areas. The temperature in the Moulouya can vary between 11°C and 28°C and solid matter loads remain in suspension. Fertilizer use and the irregular release of water from dams also have negative impacts on the aquatic fauna and flora.

We underline, therefore, that several types of limiting pressures on the whole Moulouya basin are causing a decline in aquatic biodiversity. Some of these pressures are natural and there is no way of reducing their effects; we call on the ABHM and its partners not to amplify them. They are linked to the flood regime of the Moulouya river and its major tributaries, which periodically deposits too large a sediment load to allow habitats favouring the larval development of aquatic organisms to form and become structured.

Additional impacts are human-induced, and it is the role of the ABHM and all the relevant stakeholders to control them and so to reduce their impacts. Future projects will have to develop strategies and remedial or preventive practices to counter:

1. The desiccation of oueds, which is certainly due partly to the natural cycle of drought, but also to the extraction of groundwater for consumption and agricultural use;
2. The mechanical destruction of habitats, resulting for example from inappropriate regulation or channelization of watercourses, or gravel extraction directly from the main channel of oueds, which destroys larval habitats;
3. Discharge of untreated or insufficiently treated domestic or industrial wastewaters. Treatment stations need to be built, notably in all urban settlements along the Moulouya;
4. Habits such as the washing of vehicles with detergents in watercourses, which are harmful to biodiversity, and so must be banned everywhere by the government and neighbouring councils;
5. Dam building, which produces large quantities of fine sediment, making waters muddy and opaque over a long distance downstream; these waters then become unsuitable for the development of aquatic organisms. We would stress, however, that in the long term the creation of such artificial dams favours the formation of new types of habitats and therefore increases biodiversity;
6. The discharge of water from reservoirs, which can bring about anoxic sediments and generate sulphides toxic to aquatic organisms.

As a result of the project a database on five taxonomic groups has been updated, and is to be supplemented with other aquatic macro-invertebrate taxa. An aquatic biodiversity monitoring network for the Moulouya river basin is being set up as an initial measure at the level of the Hydrographic Basin of Moulouya. This network will address the recommendations proposed in the IUCN-ABHM project, as summarized in the following box.

Recommended actions for inclusion in projects concerning the Moulouya river basin:

- Controlling domestic (solid and liquid) pollution, particularly in the towns of Guercif, Outat El Haj, Missouri and Midelt;
- Enforcing legislation on pollution from mining (mining waste) and industrial activities as well as dangerous substances;
- Enforcing legislation on pesticide pollution;
- Enforcing legislation on the eutrophication of dams;
- Acting on the hydromorphology of the aquatic environment;
- Acting on wetlands;
- Managing flood risks;
- Preserving water quality for fish and setting up a programme of rational management of fishery resources in the Moulouya and its reservoirs (setting up fish stocking and artificial spawning facilities, creating and equipping a fishing task force, etc.);
- Taking social and economic factors into account by developing craft fisheries in the reservoirs (fishery cooperatives) and sport fishing: grouping and organizing fishermen in a cooperative structure in order to develop this sector and play an active and effective part in poaching control;
- Completing certain facilities, such as for artificial spawning;
- Enhancing river banks and dams and developing fishing regulation;
- Developing scientific research on the Moulouya river basin;
- Setting up a basin-wide monitoring network.

IV.2 Recommendations to improve the probability of success in the implementation of similar projects in other regions

The IUCN/ABHM project is a pilot project in Morocco and the North Africa region for the integration of aquatic biodiversity considerations in the planning of water resource management. With a view to transposing the results of this project to other regions, the main components that made this project comprehensive and efficient were:

- **Involving all stakeholders** (NGOs, government, the river basin agency (ABHM), decision makers, scientists, etc.) from the beginning of the project;
- Having a **local coordinator**;
- Defining the **outreach products** based on the needs and capacities of local stakeholders;
- Making a **diagnosis** of aquatic biodiversity;
- Setting up a **database and a GIS map base**.

An **Aquatic Biodiversity Monitoring Network** and a management plan specific to aquatic biodiversity must be set up for each river basin, with **programmes and actions** such as:

- Control and monitoring programme: selection of indicators to monitor species and habitats;
- Habitat and species conservation and rehabilitation programme: development of aquatic biodiversity rehabilitation techniques;

- Training programme: capacity building in hydrobiology, including biodiversity sampling techniques, biological quality of waters, systematics and fish-farming;
- Ecological monitoring, study and research programme: aquatic biodiversity hotspot research programme;
- Communication, education and awareness programme: a series of symposia on education, a cooperation programme, and communication with the press and the general public, e.g. the Moulouya Caravan.

V REVIEW OF AND LESSONS LEARNT FROM PREVIOUS PROJECTS IN THE MOULOUYA RIVER BASIN

Lessons to be learnt from previous projects in the region were identified in relation to project design, project results, adaptation needed during project development, and new orientations and opportunities emerging or needed to achieve the objectives. The information collected and analysed was used in the implementation of the IUCN/ABHM project and may be useful for a second phase or for new projects in order to minimize future failures. Each situation is different, of course, and the value of a succession of projects on the same site is that later ones can benefit from the results and progress of previous ones, as well as any identified weaknesses and failures.

Lessons are based on both facts and perceptions. Facts are quantifiable project results, and perceptions are individual and collective views of project performance.

V.1 The PBREM Moulouya project (2003–2005) (Préservation de la Biodiversité et des Ressources en Eau de la Moulouya)

The **Protection of biodiversity and water resources in the Moulouya river basin** (PBREM) project targeted the whole Moulouya basin from upstream to downstream (Figure 4). Some local government initiatives were carried out at this time, but there was relative isolation and a lack of coordination between the various actors.

Main objectives

- To achieve sustainable protection of the Moulouya river basin (MRB) against pollution from local communities and mining waste;
- To carry out a diagnosis in order to improve knowledge of the ecosystem and of the pressures on the water resources;
- To develop an innovative procedure for water resource use;
- To help improve the dynamics of participatory environmental governance.

Main activities and results

The project included several activities: a comprehensive study of MRB biodiversity, a workshop on establishing a regional strategy to protect the MRB and studies on the aptitude of farmland for irrigation with purified wastewaters and on the rehabilitation of polluting mining sites. The project also contributed to local capacity building and the development of a strategy to set up an MRB observatory.

The workshop, which involved stakeholders concerned with the integrated management of the MRB, was an opportunity to discuss the strategic decisions recommended for ecosystem conservation and sustainable development in the MRB. The town of Missouri also benefited from technical training in waste management.

The project was financed by AECID, the European Union through the LIFE Programme, the ENDA Maghreb programme, the University of Kénitra, Missouri town council and the ABHM. It was conducted over three years (2003–2005) by the ENDA Maghreb NGO.

V.1.1 Strengths of the PBREM project

The main strengths of the PRBM project were as follows:

- The management of the project was delegated to ENDA Maghreb, an international non-governmental organization based in Rabat, Morocco. This well-structured NGO recruited a local consultant as coordinator. ENDA Maghreb has considerable experience in the management of environmental projects in Morocco. ENDA Maghreb managed the PBREM project on the whole Moulouya basin in parallel with the second phase of the MedWetCoast project (emergency actions) in the lower Moulouya.
- At a scientific level, ENDA Maghreb signed an agreement with the Faculty of Sciences of Kénitra University for the conduct of the field studies contributing to the scientific database on the MHB.
- At a political level, ENDA Maghreb signed an agreement with Missouri town council for the installation of a solid waste co-treatment centre. This was financed by the European Union and the Spanish Agency for International Development Cooperation, with the collaboration of the Provincial Council, ENDA Maghreb and Ibn Tofaïl University in Kénitra.
- The Moulouya River Basin Agency (ABHM), the unifying water resource management body in Moulouya, acted as the institutional link with all the relevant government partners and was a member of the project coordination mechanism.
- The PBREM project organized a workshop on the management of household waste for municipal representatives and NGOs along the Moulouya and training sessions for local actors. In terms of communication, the PBREM project team prepared and distributed three news bulletins (*Infos du PBREM*) to disseminate the objectives and results of the project during its implementation.
- A regional seminar was organized by ENDA Maghreb in Oujda (24–25 June 2005) entitled 'Resources and biodiversity of conservation in the Moulouya Hydrographic Basin'. This seminar was attended by different actors concerned on one hand with biodiversity conservation and on the other with the development of the basin at national, regional and local scales. The outcome of the seminar was a common agreement to develop a coherent and integrated environmental strategy for the MHB.

V.1.2 Difficulties

The difficulties experienced in this project were assessed at all levels, including process, management, implementation of planned actions, and impact on the environment, NGOs and local communities. We also assessed the difficulties related to the drawing of concrete political decisions and actions from the scientific results (i.e. the difficulty of integrating these results in the MRB management plan).

The main difficulties were found in the final stages of both project implementation and evaluation. The results of the scientific studies of biodiversity and pollution activities in the basin were not disseminated as widely as expected. Some difficulties were also observed in the coordination of and information exchange between different teams working on building activities in the basin. In addition, the lack of further monitoring could affect the implementation and long-term operation of some important project targets. For example, the waste co-treatment centre set up in Missouri has not been operational since our last visit in January 2010 because of technical and managerial problems. As a result, the plan to reduce mining pollution in the upper Moulouya through engineering studies on the design of protection and rehabilitation facilities has been affected. These factors seem to be impeding a proposal to set up a regional observatory in the MRB as a pilot structure for enhancing environmental governance.

V.1.3 Lessons learnt and project assessment: the PBREM project

The main lessons derived from the PBREM project are as follows:

LESSON 1: Local communities play a key role in preserving the environment. The role of local communities in preserving the environment is very important, particularly as regards the management of solid and liquid waste. The town of Missouri is located on the banks of the Moulouya river, into which wastewaters are discharged daily in an unregulated way; this consequently constitutes a danger for biological diversity and water quality, and gases are given off from the waste. The waste co-treatment centre is an alternative solution for the rational management of solid waste, as it makes good use of the organic matter by turning it into compost for agriculture in this area and also reduces the environmental impact on the Moulouya ecosystem.

LESSON 2: The ABHM plays a leading role in the management of water resources. As a unifying water resource management body and main beneficiary actor of this project, the ABHM can play a leading role by promoting necessary synergies between the various stakeholders, in line with the importance attached by the Moroccan authorities to participatory river basin development.

LESSON 3: The MRB regional observatory is an appropriate management strategy for monitoring the Moulouya basin. The effects of the various measures on the MRB remain modest, in view of the lack of means and coordination between different actors, and the large area covered by the MRB. The setting up by PBREM of a body capable of extending the existing dynamics in time and in space, could, through a modelling structure such as a regional observatory, constitute a unifying institutional framework for the implementation and monitoring of the MRB integrated management strategy. This type of initiative could be expensive and would require long-term funding. It would therefore need to be designed and agreed on through a participatory approach in order to achieve successful results in the long term.

LESSON 4: Scientific research is a necessary tool for the integrated management of water resources in the MRB. The studies carried out by academic partners and experts—appointed as active partners in the PBREM programme—form an essential basis for a more rational management of the ecosystem resources of the river basin. Improving skills and developing tools for studying and monitoring biodiversity at local levels are crucial to guarantee the continuity of the results obtained.

LESSON 5: The concept of sustainable development should always be present in the preparation of management plans. The PBREM project has laid down the scientific bases for sustainable development of the MRB. Indeed, management should take into account not only ecological considerations but economic and social ones as well, with the institution of sound territorial governance.

LESSON 6: The involvement and cooperation of all stakeholders is a factor in the success of the project. The involvement of all parties concerned in the MRB project is the best way to improve participatory environmental governance dynamics.

LESSON 7: Regular assessments of projects and of their implementation are crucial to ensure the minimum impact in the region and to avoid repeating mistakes. The

assessment of projects by the ABHM and other partners is crucial for drawing some useful lessons for the future of the MRB. In spite of the relevance of the PBREM project, its efficiency, effectiveness and impact on the whole MRB remain rather modest. The specific targets of this project were only partly reached because there was limited involvement of actors and beneficiaries throughout the MRB. Pollution problems, for example, were not solved.

V.2. The MEDWETCOAST Moulouya project (2004–2006)

MedWetCoast (MWC) was a project of the United Nations Development Programme (UNDP), financed by **Global Environmental Facilities (GEF)** and the French Fund for the Global Environment (Fond Français pour l'Environnement Mondial or FFEM). It started in February 1999 and involved six Mediterranean countries and territories: Albania, Egypt, Tunisia, Morocco, Lebanon and the Occupied Palestinian Territory.

The regional project on wetlands and coastal regions of the Mediterranean region was financed by FFEM and UNDP. The Moroccan component of MWC concentrated on ecosystem conservation in five Sites of Biological and Ecological Interest (SIBEs):

- The Moulouya estuary;
- Mount Beni Snassen;
- Mount Gourougou;
- The Nador lagoon; and
- The Cap des Trois Fourches.

Objective

The main objective was to contribute to the conservation and rational use of wetland biodiversity in the Mediterranean.

Main activities and results

The specific report on **the Moulouya estuary SIBE** (Figure 4) was selected for examination in the context of the Moroccan part of the MWC project in order to find what lessons could be learnt. The site diagnosis was carried out by national experts: the Moulouya estuary site extends over 4,500ha and is characterized by coastal wetlands and associated fauna and flora.

The diagnosis showed that the Moulouya estuary SIBE has the following biodiversity characteristics:

- It is a unique site due to the width and permanence of its waters in comparison with other Mediterranean rivers in Morocco.
- It shelters a large diversity of flora and fauna, including a large number of rare, remarkable, endemic and threatened species.
- It displays a high rate of endemism.
- Particular animal and plant associations exist there, such as that of two extremely rare and vulnerable species: *Chalcides parallelus* and *C. mauritanicus*.
- More than 201 species of birds occur at the site, including the marble teal (*Marmaronetta angustirostris*) and the fishing eagle (*Pandion halieetus*); there are 92 breeding, 98 wintering and 115 migratory species.

- It shelters significant aquatic biodiversity, with more than 127 species of fauna.
- It is a crossroads for herpetofauna of various origins, with no less than 31 species: 4 amphibians and 27 reptiles.
- More than 224 beetles from the (super)families Caraboidea, Scarabaeoidea, Tenebrionidae, Cerambycidae, and Curculionidae have been recorded.
- The mammals from the site comprise 29 species, including 10 rodents, 7 carnivores, 4 insectivores, 4 bats, 2 lagomorphs, 1 macroscelidean and 1 artiodactyl. There is an important population of otters.
- The flora of the site is particularly rich and diversified, with 131 taxa identified.

With regard to the site's natural habitats:

- The Moulouya estuary site includes the estuary of the largest river of the Mediterranean watershed of the Maghreb and the longest *oued* in Morocco.
- It is an important transit and resting area for species migrating between the north and south of the Mediterranean.
- It is the best-preserved Mediterranean estuarine system in Morocco.
- It is the largest area of *sansouire* in northern Africa;
- Its beaches are considered among the longest in the Mediterranean
- Its flood plain is fluvial in type (broad and permanently flooded) unique in the Mediterranean watershed of Morocco;
- It includes the most extensive alluvial *Tamarix* forest in Morocco.



Figure 4 The Moulouya estuary Site of Biological and Ecological Interest (SIBE) (Melhaoui and Sbai 2008)

For all these reasons, the purpose of the project was to develop participatory and sustainable management of this site. A second stage of the project was delegated to the ENDA Maghreb NGO, owing to its experience in setting up emergency actions for the preservation of the Moulouya SIBE, in collaboration with experts from the Conservatoire du littoral (France).

The workshop for cooperation with the various stakeholders on the management of the Moulouya estuary SIBE was an opportunity to discuss some strategic guidelines for the

preservation of the ecosystem and the sustainable development of this site, which was designated a Ramsar site in 2005.

Final products

1. A qualitative study of tourism in the Moulouya estuary site sought to understand visitor motivation. Visitors' responses helped define what measures were needed to ensure sensible economic management of the area while at the same time preserving its rich ecological heritage.
2. The project signed a Memorandum of Understanding (MOU) with Oujda University for monitoring of the sites at Nador, Moulouya and Beni Snassen.
3. Visitors to Moulouya and the nearby Saïdia beach now find organized parking, signposting and dustbins, with eco-guards to enforce regulations and provide information to visitors. To support these measures, MWC Morocco has published posters and brochures with the central message 'My life is nature, I like it, I respect it' in French and Arabic.
4. A dune erosion study was conducted in January 2004 at the Moulouya, Nador and Le Cap des Trois Fourches sites. The study was designed to explore methods of rejuvenating the dunes and find ways of avoiding dune erosion in future constructions or developments.
5. To celebrate World Environment Day 2005 (5 June), MWC Morocco, with the support of local NGOs, organized a trip for 120 children to the Moulouya site. Several journalists covered the event, which followed a public awareness campaign in nine local schools. An information booklet on bird protection was distributed.

Other related activities that were carried out were:

- Development of trails;
- Restoration of coastal dunes;
- Restriction of access to a part of the site in order to limit disturbance;
- Total protection of some juniper areas;
- Development of parking facilities;
- Traffic monitoring using Geographical Information Systems (GIS);
- Caretaking of the site (with sentry boxes for eco-guards);
- Elimination of threats to the SIBE and management of waste in the summer period;
- Awareness-raising about environmental protection for the site through the production of communication tools and the *Regards sur la Moulouya* newsletter;
- Identification of socioeconomic actions providing added value;
- Zoning of the site.

V. 2.1 Strengths of the MWC Moulouya project

We have emphasised the modalities of MWC project management, the involvement of partners and the feedback of the local population. We have also tried to identify and emphasise the scientific data collected and the results that have been integrated in the management plan for the Moulouya estuary wetlands SIBE.

- The management of the project was entrusted to a consultant manager at a national level on behalf of both the Department of the Environment and the High Commission

for Water and Forests and the Fight against Desertification

- The involvement of the French Conservatoire du Littoral in this project was very positive due to its experience in the management of Mediterranean wetlands.
- Management was delegated to ENDA Maghreb for the urgent action phase. ENDA Maghreb is an international non-governmental organization based in Rabat. It is well structured and has considerable experience within Morocco.
- A coordinator and two local facilitators were recruited to take charge of local coordination of the project, in collaboration with an intersectoral and an advisory committee.
- For the diagnosis phase, a call for tender was put out to recruit 6 consultants in different specialties and fields. Their task was to carry out biodiversity, wetland and socioeconomic studies in order to come up with some relevant proposals. The documents produced constitute a data reference on the Moulouya estuary site. The site boundaries were also surveyed to produce an official map, in order to register the Moulouya estuary as a Ramsar site.
- Four eco-guards were recruited, equipped and trained during the project.
- An initial workshop was organized during the urgent action phase for the purposes of information, communication and development of a participatory approach.
- Local elected representatives and NGOs were mobilized and awareness-raising campaigns were organized; clean-up days were held at the Moulouya SIBE, Arab Environment Day and World Environment Day were celebrated, and publicity and awareness-raising materials were produced.
- Training workshops were organized for local actors and other stakeholders on issues such as biodiversity, the participatory approach, ecotourism, environmental education and project management. These workshops were supervised by highly skilled national and international experts.
- In terms of communications, one objective of the MWC project was the publishing of newsletters for coastal areas by the Department of the Environment; it also issued three other newsletters under the title *Regards sur la Moulouya*, which disseminated information on all the activities carried out during the project.
- Logistical measures carried out on the site included the installation of information signs, signposting, sentry boxes and beacons; restoration of coastal dunes by means of sand traps; development of trails and ecotourism circuits; organization of parking areas; fencing of areas for juniper protection; installation of enclosures for garbage and eradication of illegal dumps; and erection of bird-watching hides.
- The coastal zone of Moulouya benefited from an FFEM Mission on the problems of dune erosion (EID Montpellier) with the installation of sand traps, and also received a visit from the ship *Fleur de Lampaul* of the Nicolas Hulot Foundation.
- Visitor management: the Moulouya site is very popular in summer for water sports, especially jet skiing, particularly in the estuary. This activity also implies the use of motor vehicles, usually 4x4s, to reach the waterside, and this results in noise disturbance to the fauna of the SIBE and in general spoils the quietness of this natural site, which is a major attraction for nature tourism. The sport has practically disappeared since the MWC project became operational there. To achieve this, local NGOs keep cars and jet skis away from the Moulouya estuary during the summer period by closing the track which leads to mouth of the Moulouya. Signs have been erected banning vehicle access. This visitor management measure has helped to reduce the negative impacts of excessive visitor numbers and of tourism in general,

which disturbed the avifauna.

V.2.2 Difficulties

We assessed the difficulties found in this project at the levels of process, management, implementation of planned actions, and impact on the site, NGOs and local communities. We also focused on the difficulties faced in transforming scientific findings into political actions.

Coordination difficulties were found:

- The overlapping mandates when a project is coordinated by two different bodies, in this case the Department of the Environment and the High Commission for Water, Forestry and the Fight against Desertification, can lead to uncertainty and inefficiency in project implementation. As a result, stakeholders on the left bank of the Moulouya in Ras El Ma village (Nador province) were not involved in this project; all actions were programmed in the province of Berkane.
- Taking into account the late start of the project (delayed by two years), the diagnosis of wetland biodiversity phase was carried out hastily and therefore gave rise to some errors and deficiencies. In addition, coordination between the PBREM and MWC teams in the biodiversity diagnosis was limited.
- At a technical level, inventories often lacked precise GPS coordinates to help set up a biodiversity database.
- The dissemination of results was not consistent. Most of the documents on Moulouya were not published on the web (e.g. biodiversity distribution maps) and in other cases key analyses such as zoning maps of the Moulouya estuary SIBE were not carried out.
- A draft of the management plan was produced. However this version of the plan was not validated by local actors and so did not come into effect.
- The diagnosis reports emphasised the problem of a large population of wild boar on the site and the urgent need for measures to help local people. Unfortunately, no action has been undertaken in this respect. Wild boar population control is managed by the forestry authority, which does not have the means to organize a cull. This is even more difficult due to the proximity of the border with Algeria.
- A biodiversity monitoring plan for the Moulouya SIBE was drafted by a team of researchers at Mohamed I University in Oujda, but unfortunately, it was shelved.
- According to some local actors, the people who went on exchange visits abroad (to other MWC sites) were selected on no rational criteria and did not produce enough feedback.
- The facilities put in place through urgent actions in the field have been deteriorating since 2004. The monitoring and surveillance of the SIBE by eco-guards was finalized by 2006.
- Tourism in the SIBE continues to generate several tonnes of solid waste (e.g. packaging and plastic bottles) each summer. The rural district of Madagh is in charge of managing this waste. However, it lacks the means to do so, which explains why there are dozens of illegal dumps in the Moulouya estuary area. These dumps remain in the SIBE after the summer and are gradually eliminated by rural district employees and by environmental associations, but the waste is still to a great extent gathered by the wind in the wetlands and oxbow lakes of the Moulouya (an area that attracts large numbers of migrant birds), where it can prevent birds from settling.
- Although a local management group was set up for the Moulouya site continuity after the MWC project could not be ensured.

- 'La Maison de l'Environnement du SIBE de la Moulouya' (an environmental education centre) was planned, but was never actually set up. This centre was to have been a workplace for scientists and members of environmental associations. It would have served as a base for monitoring, scientific research, meetings, training and outreach activities in the Moulouya SIBE, while promoting organizational dynamics within a common management structure such as a foundation.

V. 2.3 Lessons learnt and project assessment: the MWC Moulouya project

The main lessons derived from the MWC Moulouya project are as follows:

LESSON 1: High quality and relevance of the MWC Moulouya project in a Mediterranean wetland. We underscore the quality of project development in Morocco with the support of the Conservatoire du Littoral. The management delegated locally in the Moulouya estuary SIBE and the diversity of experts involved in biodiversity diagnosis made this a leading project in spite of the above-mentioned negative points.

LESSON 2: The Moulouya estuary SIBE is a biodiversity hotspot in the Mediterranean. The Moulouya hosts a rich but threatened fauna and flora, hence it is crucial to preserve this biodiversity together with representative samples of the natural heritage of the Mediterranean watershed of the Maghreb.

LESSON 3: The MWC Moulouya project was an innovative project for the development of environmental education in the Moulouya estuary SIBE. The MWC project promoted good practices in terms of awareness raising, environmental protection and biodiversity conservation in the Moulouya estuary SIBE.

LESSON 4: The MWC project took the local communities into consideration and so reduced human pressure on the SIBE. The MWC project was an opportunity to provide socioeconomic support for the inhabitants of the SIBE and the surrounding area for the purpose of reducing human pressure on the site.

LESSON 5: The effective involvement of coastal communities was a factor in the success of the project. The role played by coastal communities was crucial for preservation of the environment, through the development of a municipal charter.

LESSON 6: Scientific research is a necessary tool for understanding and managing biodiversity. Research activities in the lower Moulouya and the diagnosis results have produced a necessary database for any strategy for the sustainable management of the site.

LESSON 7: Local capacity building is a practical means to improve the management of the Moulouya estuary SIBE. Local capacity building and greater involvement and cooperation with and between stakeholders and NGOs in particular were factors in the success of the MWC project.

LESSON 8: Monitoring and sound site management are factors promoting viability and sustainability. The creation of a site management committee and the assessment and monitoring of the project were extremely important for the site and helped to repair damage,

improve imperfections and ensure its sustainability.

Although the MWC project in the Moulouya estuary has ended, its efficiency, effectiveness and impact on this site remain considerable. The concrete targets of the project have been fully met, as the level of involvement of actors and beneficiaries was high. This project coincided with the registering of the site as a Ramsar site in July 2005. There remains the problem of the SIBE management, especially in view of the recent Moroccan law on protected areas.

The forestry authority could gradually delegate the management of the SIBE to a private institution or a foundation, for example, which would be more flexible and closer to the ground and to the inhabitants, while keeping the right to inspect the management process and to provide the monitoring and surveillance of the site (eco-guards). A foundation would also be dynamic and efficient at seeking external funds in order to carry out the main phases of the management plan that was not validated. We also underline the fact that this MWC project site was selected at the same time as four other sites in the same geographical area of Morocco: the Nador lagoon, the Cap des Trois Fourches and Mounts Gourougou and Beni Snassen. This meant that the project could not focus more on the Moulouya SIBE.

V.3 The SMAP III Moulouya project (2006–2009)

The SMAP III Moulouya project was financed by the European Community and coordinated by the **Tour du Valat** (France). The selected zones were the coastal zone of Moulouya in Morocco (Figure 5) and the El Kala National Park in Algeria.

The main objective was to support the efforts of the Moroccan and Algerian Governments and their agencies in implementing the principles of integrated coastal zone management (ICZM) in critical coastal zones where there was conflict between biodiversity protection and local development.

Activities and results

- Appraisal and diagnosis of the coastal zone and publication of a national expertise report on socioeconomic and local development applied to ICZM in the municipalities of Saïdia, Moulouya and Ras El Ma.
- Communication with local actors and raising their awareness of the ICZM procedure so as to achieve high participation levels; institutional capacity building (several training workshops) and preparation of a local ICZM plan.
- Mobilization of local actors (local coastal groups and an intersectional committee operational in the coastal zone) to participate and prepare a management plan and a Coastal Area Contract.
- Development of key actions generating welfare and opportunities for local inhabitants, notably in tourism.
- Setting up of performance indicators for monitoring and supervising the implementation of income-generating activities.

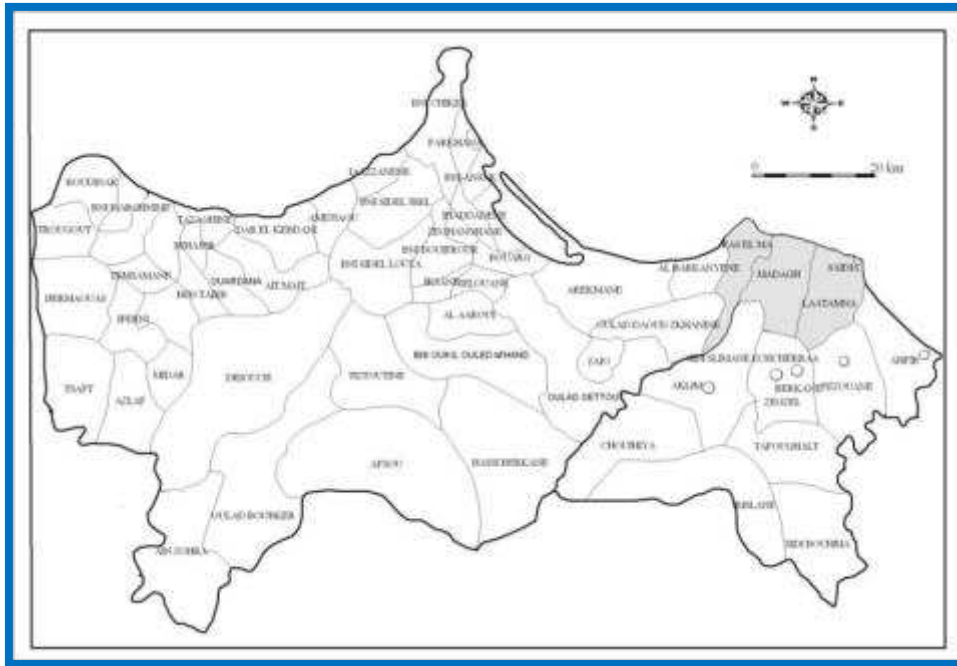


Figure 5 Municipalities targeted by the SMAP III Moulouya project (Melhaoui and Sbai, 2009)

V. 3.1 Strengths of the SMAP III Moulouya project

The contributions of the SMAP III Moulouya project on the scientific, political (as regards the decision makers and the legislative and institutional framework) and social levels were assessed. Much emphasis was put on the modalities of project management, involvement of partners and feedback from the local communities. The socioeconomic diagnosis of the coastal zone was appraised, and the results that were integrated in the coastal charter and the management plan for the area under study, which includes the Moulouya estuary SIBE, were assessed. The outcomes were:

- This project benefited from the procedures and experience of the MWC project.
- The project was managed by the Tour du Valat (France) in coordination with the Coastal region group of the Environment Department in Rabat, which recruited local staff: a coordinator, a facilitator and a communications officer.
- The project was launched with an initial workshop held on 24–25 October 2007 for the purposes of information, communication and mobilization of local actors and local NGOs.
- Two levels of cooperation were established: 1) thematic groups, and 2) an intersectional committee. Among the topics raised and discussed during the meetings were water management, tourism in the coastal zone, pollution, and coastal zone monitoring indicators.
- A major campaign for developing awareness of the need to protect the coastal zone was conducted during the following summer (11–13 July 2008) with the cooperation of the province of Berkane and the environmental NGOs' umbrella organization for Northern Morocco.
- Publicity and awareness-raising tools were produced to celebrate World Environment Day in Berkane on 6 June 2008.
- A workshop on the Moulouya coastal zone contract was organized in Saïdia during Coast Day on 24 October 2008.

- Training sessions for local actors were organized on Integrated Coastal Zone Management, GIS, formulation of income-generating activities, coastal region indicators, etc.
- The SMAP III Moulouya project website was created, hosted by the Moroccan Ministry of Environment site: www.minenv.gov.ma.
- Surveys, GIS mapping and a comprehensive socioeconomic study in relation to ICZM were carried out by two local university consultants.
- A consultant was recruited to draw up a Coastal Area Contract, and another to research tourist reception capacity and an ecotourism action plan.
- An integrated coastal zone management plan and a coastal charter for the Moulouya–Saïdia coastal area were produced.
- A proposal was put forward to set up a structure in Berkane for the implementation and monitoring of the Moulouya–Saïdia ICZM plan.

V.3.2 Difficulties

The SMAP III Moulouya project had some shortcomings in procedures, project management, implementation of planned actions and impact on the parties directly involved. We have also emphasised the difficulties faced in turning the project results into political actions.

- There was a lack of continuity in the personnel involved in project management. For example, the person responsible for managing the project at the Tour du Valat biological station was replaced during the execution phase. This change altered the communication between the actors and may have affected the final results of the project.
- Some of the project stages at local level were under-dimensioned in terms of personnel involved. The project was led locally by a team not commensurate with the size of the main ICZM objective (a forester, an ecotoxicologist and a hydrogeologist).
- Dissemination activities had limited reach. Most thematic group meetings took place in Oujda at the regional environmental inspection authority. This made it difficult for people to come from Berkane to attend the meetings.
- The content of the training given during workshops was sometimes deficient, with a lack of clear contributions made to the target groups.
- A study on ecotourism and reception capacity was undertaken with a view to producing an action plan, but the plan has not been published.
- One of the main objectives of the project was the production of a Coastal Area Contract. However, this was eventually converted into a guidance document, the Coastal Area Charter.
- There was insufficient involvement of local actors in some project stages. For example, the Integrated Coastal Zone Management plan for the Moulouya–Saïdia coastal area was not validated by local actors, who never justified their position.
- The local groups that have been set up suffer from a lack of continuity. The local coastal group for the province of Berkane has never met since its creation in 2009. There is no regular collaboration with the national coastal bodies.

V.3.3 Lessons learnt and project assessment: the SMAP III Moulouya project

The main lessons derived from the SMAP III Moulouya project are as follows:

LESSON 1: Coordination is needed between the various stakeholders in the coastal zone. The coastal zone and the SIBE are shared between two different provincial authorities (Nador and Berkane provinces). The governance of this area involves a multitude of ministerial departments and public, semi-public and private authorities. This sectionalization results in conflicting policies and wasted effort and so creates a pressing need for coordination between the various actors in the coastal zone.

LESSON 2: Cooperation with stakeholders and sound governance are key factors in setting up an ICZM scheme. The management of this coastal area is a complex task and requires the actions of the various authorities and actors to converge on an agreed management process, organized around clear objectives of balanced development of the coastal zone and wise use of its natural resources, with particular attention to the natural heritage of the Moulouya estuary SIBE.

LESSON 3: ICZM applies to an area as a whole. The integrated coastal zone management approach must take into account all the terrestrial, marine, natural, economic and social factors of the littoral zone, defined as an entire area for study and action. The coastal communities are the basic units in the SMAP III Moulouya project. This project took place around the time when Morocco signed the ICZM protocol, in January 2008.

LESSON 4: ICZM is a strategy that supports government policy for local development. The socioeconomic assessment of the littoral zone carried out under the SMAP III Moulouya project supports efforts by the Moroccan Government and its agencies to apply ICZM principles in critical coastal zones where biodiversity protection and local development are major issues and where the socioeconomic context is very fragile.

LESSON 5: Discussions and brainstorming at participatory workshops facilitated the drafting of the Moulouya–Saïdia coastal zone management plan and helped to identify a managing authority for the coastal zone. The participatory workshops held by thematic groups to identify issues, establish objectives and choose appropriate management scenarios for the Moulouya SIBE provided new ideas and proposals and laid down guidelines for the Moulouya–Saïdia coastal zone management plan. They also raised the question of a suitable management authority for the coastal zone and drew up plans for a permanent local coastal group.

LESSON 6: The proposed Coastal Area Charter formalized the commitment of stakeholders to implement the action plan and to decide how the coastal zone should be developed and managed in accordance with the objectives set. The Coastal Area Charter proposed in this project is primarily a document that blends together all the various approaches. It is based on a process of cooperation on the future of the coastal zone, and aims to link local problems to national and regional coastal conservation issues.

LESSON 7: Local capacity building through training, involvement and cooperation with stakeholders, especially NGOs, was a factor in the success of the SMAP III Moulouya project. The training sessions organized for local participants on ICZM, GIS, formulation of Income Generating Activities and coastal region indicators, etc. proved invaluable to managers and their partners.

LESSON 8: The creation of a coastal body is an efficient strategy for monitoring and establishing the ICZM concept. The local coastal group created in Berkane province in 2009 is meant to play a dynamic role in providing cooperation and guidance for various interventions in the coastal zone.

The SMAP III project was a practical framework implementing the exemplary Euro-Mediterranean partnership in the field of the environment. The concrete targets of the SMAP III Moulouya project were only partly reached in spite of the major involvement of actors and beneficiaries. This important project coincided with Morocco's signing of the ICZM protocol in January 2008. The ICZM concept, which was first introduced in the MWC project, was well assimilated by the majority of the parties involved. However, the adoption of the ICZM project and the commitment to the Charter that was formulated in the same context remain problematic. We underline the fact that no monitoring or assessment of project outcomes have been carried out since the project ended. The viability of this project was supported through training courses on ICZM and a coastal research programme developed at Mohamed I University in Oujda.

VI CONTRIBUTIONS MADE BY EUROPEAN PROJECTS IN THE MOULOUYA RIVER BASIN

VI.1 Contributions for managers and stakeholders

All three projects tried to integrate capacity building into their actions, particularly the MWC and SMAP III projects, which represented strong, essential links in the national strategies for biodiversity protection and for establishment of the ICZM concept.

The projects focused on administrators and local NGOs in terms of improving planning and programming in the field of participatory and protective management of natural resources. The areas of skills concerned socioeconomics, biodiversity conservation, geographical information systems, partnership and tools of the participatory approach. Many different actors benefited from this programme of local capacity building, including institutional actors, farmers, fishermen, local elected representatives, NGOs and rural women. The methods included training on various topics, the organization of workshops involving different actors and also thematic exchange trips. These experiences were reflected in particular in the management of the Moulouya estuary SIBE with the involvement of numerous skilled local actors.

For all the projects, capacity enhancement seems to have been a lever for the participation of beneficiaries. Awareness-raising activities, however, proved to be a determining factor in increasing public awareness as to the importance of preserving natural resources, in order to ensure the sustainability of actions in the post-project period. The dynamics of community awareness raising has yet to be developed in the whole Moulouya river basin, particularly in the Moulouya estuary site, which has been undergoing increasing visitor pressure especially in summer since the opening of the large Saïdia–Mediterranean tourist development and its marina.

The MWC project also had some environmental, political and social impacts in the Moulouya estuary SIBE. This is explained by the mobilization of the parties involved, cooperation, development of administrators' skills, promotion of the participatory approach and the conducting of important studies regarded as outstanding references for this site, which has been a Ramsar site since 2005.

After the end of MWC project in 2006, the management of the Moulouya SIBE was to be entrusted to a permanent authority charged with the management of parks and protected areas. Until now, it has been the Eastern Regional Directorate of Waters and Forests (DREFO, Oujda) which has not only the necessary know-how, but also the ability to

intervene in the Moulouya SIBE. This project coincided with the recent promulgation of the law on protected areas. DREFO will nevertheless have to establish agreements with Berkane province, the rural districts in the SIBE, the ABHM, NGOs and all other stakeholders in the SIBE to achieve participatory, efficient and rational management of the site, or to set up a management authority with a validated management plan and an environmental centre with nature guides to receive researchers and visitors. Moreover, it is necessary to maintain the achievements made and to find funds to improve the monitoring and sustainable management of the site. It will be also necessary to restart promoting the idea of a national park for the Moulouya estuary, with intensive awareness raising among local people on the positive values of the park, which will certainly attract large numbers of tourists. Some agricultural activities may then give rise to cooperatives for the production of organic products. Likewise, some sansouire plots can be very well exploited to promote sheep raising and possibly create a salt-meadow lamb food label.

The PBREM project held a brainstorming session on the necessary synergies between actions and guidelines recommended by regional authorities concerned with the preservation of the Moulouya river basin, and by national authorities responsible for land-use planning, agriculture and mining, to name only a few. The idea was raised to set up a regional observatory for the MRB, a body that serves and enhances environmental governance, but it has never been implemented since the PBREM project. Today, the creation of this observatory is more than necessary at a time when the environment is at the heart of a broad debate on the enacting of a National Charter for the Environment and Sustainable Development. This is a societal project and a current topic for debate throughout Morocco further to a Royal decision in July 2009. Indeed, the state secretariat in charge of water and the environment is creating a regional Observatory of the Environment of the Eastern region of Morocco.

Whereas the MedWetCoast project laid the foundations for wetland biodiversity conservation and for the integrated management of the Moulouya SIBE coastal wetlands, the SMAP III Moulouya project is considered to have been the first attempt to introduce the ICZM concept in all coastal villages from Saïdia to Cap de l'Eau. It substantially mobilized the parties involved, developed administrators' skills, promoted a participatory approach and developed the necessary synergies between the various actors concerned with ICZM.

The IUCN/ABHM project enabled the ABHM to integrate aquatic biodiversity considerations in the planning of water resource management. This project was regarded as a pilot plan for other river basins in Morocco and northern Africa. It took place at a time when the environment was at the centre of debates and discussions in Morocco to come up with a National Charter for the Environment and Sustainable Development.

The project coincided with the creation within the ABHM of a scientific committee for the Moulouya basin in January 2009, and echoed the general concern for developing an Integrated Water Resources Management (IWRM) plan in the Moulouya basin. It generated recommendations for an aquatic biodiversity management plan with performance indicators—biodiversity management tools for administrators—and specific actions relating to aquatic biodiversity for the ABHM and its partners. In order to meet five-year targets, a schedule of work is being drawn up listing the general operations to be carried out and the specific activities to accomplish them. After their implementation, the management plan will be readjusted according to the results obtained. A scheme like a 'River Contract' would be of considerable advantage for research in this Mediterranean river basin, based on European experience.

VI.2 Contributions for scientific research and environmental education

Studies and investigations carried out in the Moulouya basin have resulted in the production of many unpublished papers and other documents. These documents currently serve as background information for several researchers.

These projects have also developed their information and communication components, which improved significantly from the PBREM project in 2003 up to the IUCN/ABHM project in 2009. Likewise, the awareness-raising and environmental education components have grown in importance through the sequence of projects, and the MRB has become today a fertile field for the development of scientific research and an ideal site for the environmental education of schoolchildren and university students.

Besides these essential objectives, the MRB offers research and innovation opportunities to:

- **Develop scientific research and carry out thematic ecological monitoring** ('observatory') of rare species (endemic or endangered, etc.) in an area of remarkable faunal and floral interest: several research papers on the biodiversity of the Moulouya SIBE need to be transformed into a database and a GIS map base, and the ABHM wants to develop a 'river contract' type of project with the University to carry out research in the Moulouya basin on the basis of European experience;
- **Carry out fieldwork experiments** for the installation of innovative activities of biodiversity conservation and eco-development (environmental jobs, ecotourism);
- **Implement applied training schemes** to improve the skills of local actors and active participants on the site;
- **Promote information, education and awareness** among different groups (schoolchildren, students, local inhabitants, national and foreign visitors): several teaching tools were produced during the projects, but could not be traced afterwards; the production of professional communication tools such as nature guides, booklets and CD-ROMs in several languages would be of considerable help as an effective means for raising visitors' awareness of the site;
- **Develop control and management of a mixed terrestrial, freshwater and marine area**, dependent on several different administrative authorities.

VII. GENERAL CONCLUSIONS

Favoured by its geographical position, its climatic and geological history and its highly diverse ecosystems, Morocco is an important part of the universal heritage. The Moulouya river basin, especially its wetlands, constitutes a biodiversity hotspot in the Mediterranean. This precious natural heritage is of vital socioeconomic interest for the country. Exploited biological resources constitute a substantial part of national wealth, notably for agriculture, animal husbandry, forestry and fishing.

The wise control and enhancement of water resources are very ancient practices in Morocco and have always been decisive factors in the organization of space and land use, as the geographical context and climatic conditions are variable and irregular. Morocco has implemented a strategy of wise water use and control since the 1960s, in line with the policy of promoting its natural resources through the planned and integrated management of water.

The emergence of competition for water by different sectors, namely for domestic, industrial and irrigation use; the difficulties of managing the resulting water shortage during periods of drought, which are becoming more and more frequent; and the problem of pollution generated by social and economic activities, have all led to a radical reconsideration of the legal and institutional context of water management.

To address the challenges of water management, the Water Act was passed in 1995. Several bodies were set up, such as the High Council of Water and Climate, water basin agencies, prefectural water committees and provincial water boards.

After the challenge of mobilizing the water necessary for its economic and social development, Morocco is now confronted with a new challenge, namely how to make efficient use of its increasingly scarce water resources within a perspective of sustainable

development. The droughts of recent years have reinforced the country's sense of hydrographic fragility and made public authorities aware that water is not an inexhaustible resource. The current imbalance between water supply and demand is indeed worrying due to its consequences on people and the environment.

Besides its socioeconomic interest, national biological diversity is of particular ecological importance. The national biodiversity survey carried out by the Ministry of Territorial Planning, Water and the Environment counted more than 24,000 animal species and 7,000 plant species, with a rate of endemism of 11% for fauna and 25% for vascular plants, a rate unequalled in the entire Mediterranean basin.

The unique biodiversity of the Moulouya river basin requires that this precious heritage be protected and preserved, and plans must be put in place for its sound management, use and sustainable development. To that end, a strategy and a national action plan for the conservation of Moroccan biodiversity have been drawn up by the Department of the Environment, based on the following priorities:

- The conservation and sustainable use of biological resources;
- The improvement of scientific knowledge through research and training;
- The development of control and monitoring indicators of ecosystem condition and of biological diversity;
- Awareness raising and education;
- The strengthening of the legislative and regulatory frameworks;
- The development of international and European cooperation, especially to generate the ability to meet the challenges of natural resources management and sustainable development in Morocco.

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ANNEXES

ANNEX 1. Main results of the diagnosis of aquatic biodiversity in the Moulouya basin. Prof. Mohamed Melhaoui.

ANNEX 2. *Information material on aquatic biodiversity used for workshops and awareness-raising activities.*

ANNEX 1. MAIN RESULTS OF THE DIAGNOSIS OF AQUATIC BIODIVERSITY IN THE MOULOUYA BASIN

1- Diagnosis results

In spite of conservation efforts, the aquatic ecosystems of the Moulouya have suffered serious degradation, which is still progressing rapidly. The severe, natural and very frequent droughts during the last two decades have aggravated this situation considerably. The rate of water use is constantly increasing, while water reserves are declining significantly. Besides the frequent drying-out of habitats throughout the river basin, we underline the increased salinity of the lower Moulouya coastal wetlands.

Following the example of other sectoral studies that have pointed out the seriousness of the losses to aquatic and sub-aquatic biodiversity, the IUCN/ABHM project shows that the deterioration of vegetation in aquatic areas has unfortunately exceeded the threshold of reversibility at a large number of sites. This deterioration is all the more serious as vegetation shelters a very diverse fauna, which obviously also undergoes heavy losses.

The lower Moulouya wetlands have witnessed massive and rapid destruction in recent years, which has led to the loss of some habitats and plant groupings. The impacts on the vegetation of these ecosystems are of various origins, but are predominantly due to agriculture, hydraulic infrastructure developments and urbanization, as well as hydrological disturbances linked to natural drought and climate change. Data on aquatic biodiversity and all the underlying changes that affect it should be taken into consideration in the next version of the general plan for integrated water resources management (PDAIRE) for the Moulouya river basin. They include, in particular:

- Dam building, which is considered to be a major factor of in the destruction of natural watercourse habitats and their plant cover: it acts by reducing water flow or even drying up the river bed downstream of the dam and by sending sediment downstream, which results in losses in biodiversity (the current construction of the Tamalout dam is a case in point); it is also a limiting factor for shad, eels and other migratory fishes;
- Erosion and deforestation (which are closely linked), since they eventually lead to a process of desertification, which has a negative impact on the watercourse, especially through the silting-up of dams and reduction of their storage capacity;
- Agriculture, a major activity around most wetlands: it spreads into wetland habitats and is a source of plant populations that colonize them. Agriculture also damages aquatic vegetation by pumping out ground and surface waters, thereby lowering water levels and reducing the length of submersion (as in the Chrarba marshes, towards the mouth of the Moulouya), and by diverting surface waters, which affects aquatic biodiversity.
- Overgrazing and cutting of riparian vegetation, which are among the main anthropogenic reasons for the loss of plant groups and habitats. Overgrazing threatens marshland vegetation, especially wet grassland and reedbeds, which are transformed into bare ground or agricultural fields. Trampling of lake margins, due to tourist activities, speeds up the deterioration of vegetation and the destruction of natural habitats.
- The impact of mining sites, with the potential for water pollution in the upper Moulouya, notably in Zaida, Mibladen and Aouli, and in the region of Touissit in the lower Moulouya;
- The effects of various forms of pollution: urban, industrial (small-scale oil mills) and agricultural (fertilizers, pesticides and plant protection products) as well as the polluting load discharged into the Moulouya river by the sewers and drains of adjacent settlements, all a real threat to aquatic biodiversity;
- The problem of conflicts over customary water rights, notably between the upper

reaches and the downstream part of the Moulouya basin, infringements of the Water Act (No 10-95), illegal sand extraction and dam water release: these are further threats to aquatic biodiversity;

-The lack of awareness about aquatic biodiversity and preservation of water resources among the communities along the Moulouya.

In addition to the threats linked to human activities, the impact of climate change and associated risks, notably hydrological risks such as flooding and the deposition of waters' sediment load during floods, which is very harmful to biodiversity;

The effects of natural drought in this arid region is currently believed to have contributed to a sharp deterioration in the Moulouya's aquatic biodiversity, especially as Morocco has experienced severe droughts in the last two decades, while water needs have increased; these droughts also cause additional problems of high variation in the water levels in reservoirs (marling);

For all these reasons, aquatic biodiversity data need to be integrated in development programmes for the Moulouya river basin in order to improve management practices and protect threatened species.



Water pollution in the Moulouya basin. Photo © ABHM



Solid waste in the Moulouya river basin. The treatment centre for solid waste is in Missouri. Photo © M. Melhaoui

2- Awareness raising

To integrate data on aquatic biodiversity into the planning of Moulouya water resources management and to emphasise the importance of aquatic biodiversity, the IUCN/ABHM project carried out an original and effective awareness-raising campaign known as the Moulouya Caravan for the Preservation of Biodiversity, which was conducted in eight provinces of the Moulouya basin. This awareness campaign, which was widely reported in the media, enabled communities in the area to discover more about the biodiversity of the Moulouya from its source to its mouth. The main objective was to achieve widespread awareness and to disseminate the results of the aquatic biodiversity diagnosis among the various local actors in the Moulouya basin. It sought to make young people and residents of the Moulouya area understand their personal and civic responsibility to protect and preserve the Moulouya's water resources and aquatic biodiversity. The Moulouya Caravan was a joint project involving IUCN–Med in Málaga, the ABHM and its partners, the University of Oujda, local NGOs, the services of the Environment Department for Eastern Morocco, the Academies of the Ministry of Education and environmental associations in Moulouya river basin.

The Moulouya Caravan also took place in the context of two major events:

- The proposal to set up a National Charter for the Environment and Sustainable Development in Morocco;
- The celebration of the United Nations International Year of Biodiversity in 2010.

The Caravan is a mobile exhibition of the Moulouya river basin from the mouth of the river to its source in the Middle Atlas, covering 8 provinces:

Lower Moulouya: Oujda, Berkane, Nador, Taourirt, Guercif and Jerada

Middle Moulouya: Missouri

Upper Moulouya: Midelt



The Moulouya Caravan travelled across eight provinces to achieve widespread awareness and disseminate the results of the aquatic biodiversity diagnosis among the various local actors in the Moulouya river basin. Photo © M. Melhaoui

The Moulouya Caravan was equipped with posters, fliers, stickers, brochures, CD-ROMs, educational booklets about fish, molluscs, aquatic plants and dragonflies, sample displays, and talks on the importance of aquatic biodiversity and the vital resource that is water, which lies at the root of the individual and collective needs of the Moulouya population and is now limited in quantity, degraded in quality and increasingly expensive.



The Moulouya Caravan in the Alaymoun High School (Berkane province). Photo © M. Melhaoui

3- Stakeholder involvement in the IUCN/ABHM Moulouya Project

- Dissemination of biodiversity data and public consultation

The active participation of stakeholders in the preservation of aquatic biodiversity was a decisive factor for the success of the project. This participation was increased by the involvement in the project of different parties and their support for the sustainable benefits brought by the project. The efficiency and effectiveness of the project will therefore be all the more ensured in the future. The local organization of partners and their cooperation in seminars or information workshops was undoubtedly decisive in the success of the project, which has to be guided by the needs and priorities identified by the ABHM's main partners.

- Local NGOs play a fundamental role in the protection of the environment in general and biodiversity in particular. During the IUCN/ABHM Moulouya project, they expressed great interest in raising awareness among the area's residents of the need to protect the Moulouya, which remains a symbol of biodiversity in the Mediterranean. Their grouping under the banners of the North Eco-Platform in the lower Moulouya area and of RALM (Network of Associations of Missouri) in the upper Moulouya is a good sign that they are pooling their efforts.
- ORMVAM (the Moulouya regional office for agricultural enhancement) manages irrigation channels. In the lower Moulouya, macrophytes are often considered by ORMVAM agents to clog irrigation channels, slowing water flow and changing local flow patterns, or even temporarily raising water levels. To limit their development, macrophytes are cut mechanically or ripped out manually. These practices are not very efficient. The problem requires some objective thought. While Chinese carp have been used successfully to combat eutrophication in reservoirs, it has not been so in the Moulouya irrigation channels, where the results of trials in the lower Moulouya irrigation area in 1999 were not spectacular.
- The Environment Department service for the Eastern Region has been involved in this project since its start, as it is part of the Environment Strategy of the National Action Plan. The Moroccan Government has signed several protocols and international conventions, including the International Convention on Biological Diversity (CBD) in 1995 and the Ramsar Convention (protection of wetlands) in 1980 by the Water and Forestry Authority. There are 24 Ramsar sites in Morocco, 4 of them in the MRB. There is also a national legal framework, an institutional framework and agencies devoted to biodiversity.
- The biodiversity field survey led by local university researchers and their collaborators resulted in an updated database which can be regarded as a reference for the MRB and added value for secondary and university education and research. The majority of

Mohamed I university researchers sit on ABHM scientific committees.

4- Evaluations of the current project by policy makers

The results of this project can be regarded not only as added value for the management of the fauna and flora in the Moulouya river basin, but also as additional knowledge of the country's ecological heritage and biodiversity to be fed into the Clearing House Mechanism on Biodiversity of Morocco (website: <http://ma.chm-cbd.net/>).

The success of this project and its efficient management encouraged policy makers—the ABHM board of directors and the Eastern Morocco Development Agency (ADO), which is a member of IUCN–Med—to think about continuing this project and, in the future, formulating other priority projects for the preservation of biodiversity in the Moulouya's aquatic ecosystems.

- Capacity building and training

Now, for the first time, a river basin in Morocco has a database and takes aquatic biodiversity into consideration in its management programme. For this purpose, the ABHM has set up a scientific council and has programmed biodiversity among its areas of interest

Aquatic biodiversity management currently takes the form of an open debate with all stakeholders. Recommendations for the Aquatic Biodiversity Management Plan result from a process of cooperation between different actors to define a common plan containing directions, operational objectives and actions to which actors and users of the site would be committed. It is supposed to be a real working tool for administrators and must ensure that the efforts undertaken in the Moulouya basin are sustainable, especially through the involvement of local actors.

Moreover, the Moroccan Ministry of the Environment has made the knowledge and preservation of environmental resources in the Mediterranean region of Morocco a top priority. It is working towards the creation of a regional environmental observatory. The results of this project in the Moulouya basin will be incorporated in this future agency.

5- Main aquatic biodiversity results obtained and management recommendations

The following are the main results obtained from the biodiversity assessment carried out in this project. Based on these results, a set of information material has been developed and a series of recommendations has been drawn up for dissemination among both local people and stakeholders:

5.1 Aquatic plants

The present situation of aquatic vegetation is so alarming that it requires emergency protection measures; in particular, the discharge of industrial and mining effluent must be stopped, overgrazing reduced and the cutting of wetland vegetation controlled along the Moulouya and its tributaries. Greater efforts are needed to raise awareness in local communities about the ecological value of aquatic plants, to encourage studies and monitoring of the status of rare or threatened flora (Figure 6), and to limit discharges of domestic waste into the Moulouya.



Unio durieui (Deshayes, 1847), an endangered species according to the IUCN Mediterranean Red List, is present in the Moulouya basin. Photo © M. Melhaoui

Numerous mollusc species play a key role in ecosystems and provide various services. Species such as the Melanidae and *Physa acuta*, which are Mediterranean species of stagnant waters and very slow-flowing watercourses, have important ecological functions (as decomposers of organic matter, for instance) and may be considered indicator species for organic matter proliferation.

The species of *Unio* and *Margaritifera*, which show slow development and long life expectancy, are filterers and accumulate many toxins such as heavy metals and pesticides. At high levels these toxins can kill them or impair their development and reproduction. Endocrinal disorders may also be a factor in the decline of the two species, as demonstrated with other molluscs. However, their conservation consists in controlling pollution and keeping them in shellfish farming experiments.

After the construction of the Mechraa Hammadi dam, the Office of Agricultural Enhancement (ORMVAM) carried out a number of hydro-agricultural developments in the lower Moulouya, greatly increasing the number of sites favourable to the settlement of molluscs and to the spread of parasitic diseases among people and livestock. This should naturally mobilize the Ministry of Health in collaboration with malacology researchers to set up a mollusc shelter survey programme in line with a national strategy to control shellfish that transmit parasitic diseases, especially *Bulinus truncatus*.

The creation of dammed reservoirs (absence of watercourse), hydroelectric power stations (change of flow) and agricultural practices (eutrophication of watercourses, pollution by pesticides, increase in turbidity due to soil erosion), have almost led to the disappearance of several shellfish sites at various locations in the lower Moulouya.

At the ecological level, freshwater molluscs are the basic diet of many aquatic vertebrates; (fish, amphibians, reptiles, birds and mammals). However, they are subject to the impacts of climate, especially irregular rainfall, flooding and the decrease in the piezometric level of underground waters linked to climatic and anthropogenic factors: For example, *Margaritana margaritifera marocana*, an endemic freshwater species in Morocco, is actually endangered in the lower Moulouya (Figure 8). Warmer summers, which make the upper reaches of the river dry up more quickly, is an additional risk factor for the malacofauna. The non-permanent movement of water in irrigation channels can also be fatal for molluscs.

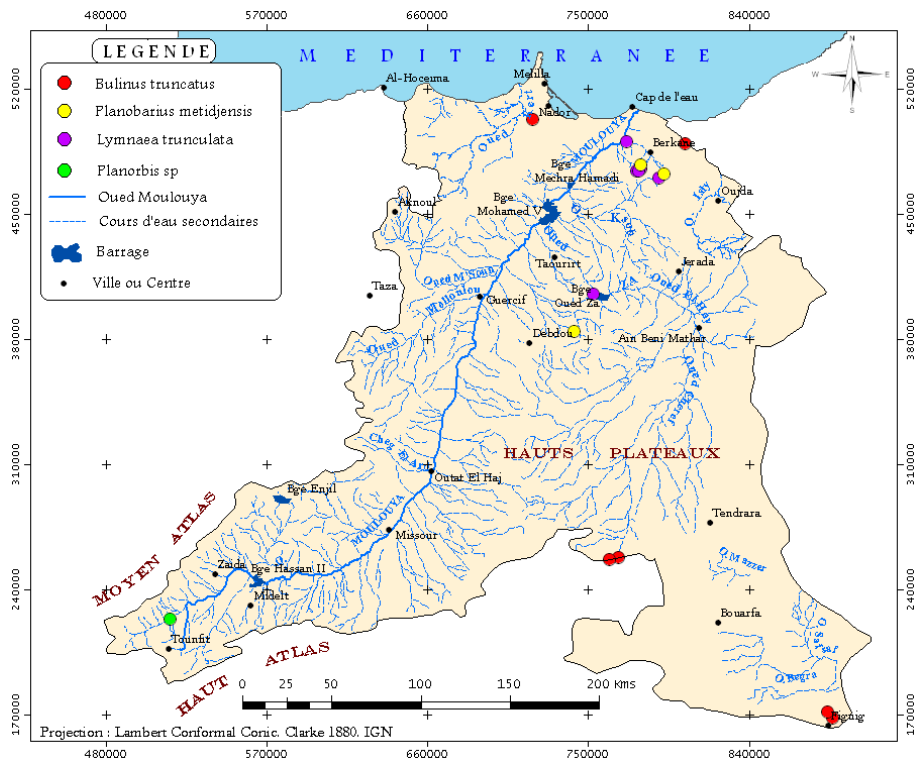


Figure 7 Distribution map of molluscs that act as intermediate hosts of parasitic diseases in the Moulouya river basin (Melhaoui and Sbai, 2009)

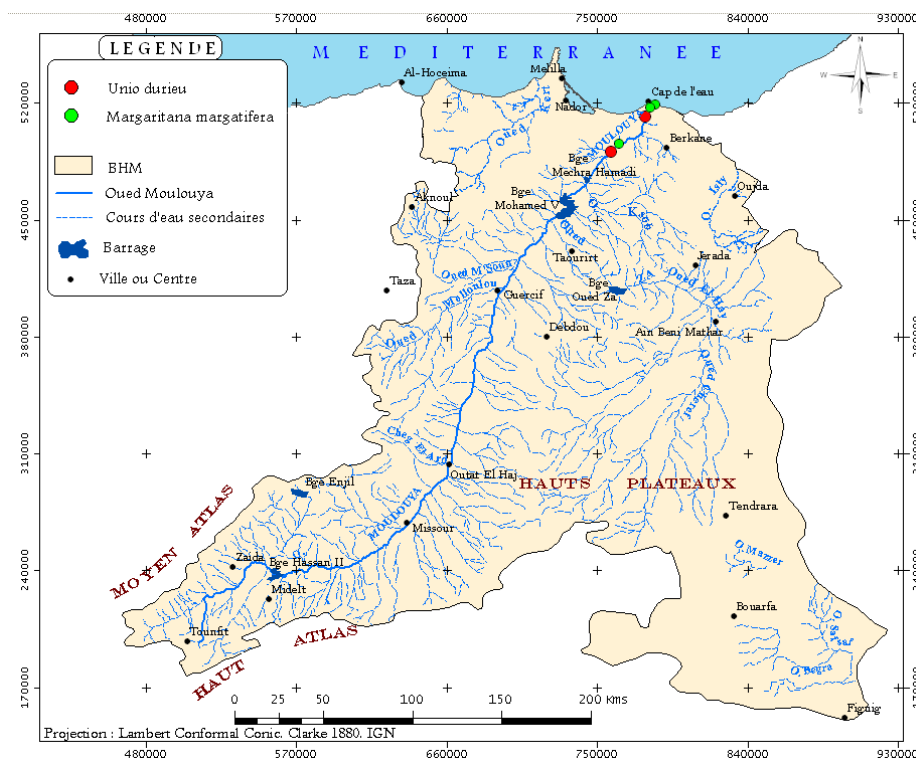


Figure 8 Distribution map of threatened bivalve molluscs in the Moulouya river basin (Melhaoui and Sbai, 2009)

5.3 Freshwater crabs

The diagnosis showed that the native freshwater crab species is endangered in the Moulouya basin due to problems of stream diversion, as in the case of Oued Zegzel, pollution, as in the case of Oued Zebra (effluent from Sucrafor in Zaio), or severe floods carting mud, as in the case of Oued Za. During the 2009 inventory in the Moulouya river basin, we updated the distribution map of this species and set up a database of locations where it is found so that its occurrence can be taken into account during development work

(Figure 9). To improve the management of the Moulouya freshwater crab, we recommend:

- An ecological study of this species in locations targeted by the inventory conducted during this project.
- A genetic study of these populations would be of interest to check whether they all belong to the same species, and it would be an opportunity to find out if there are any endemic subspecies in the Moulouya.



The freshwater crab Potamon fluviatilis = Potamon edule is an endangered species in the Moulouya basin. Photo © M. Melhaoui

This research confirms the scientific importance of the Moroccan population of freshwater crabs, as well as the high risk of extinction it is facing. It is an opportunity to renew the call to policy makers to take immediate concrete measures, with the support of local nature conservation associations and researchers from Mohamed I University in Oujda, for the protection of this animal, which depends completely on fresh water and has an extraordinary adaptive ability to survive in extremely arid locations. We therefore recommend protection for locations, with permanent, flowing, freshwater streams that harbour freshwater crabs, to be declared as natural reserves.

Moreover, we have to be alert to the risk of invasion by the alien freshwater crab *Ericeira sinensis*, known as the Chinese crab, in northern Morocco. This crab exists in southern Spain and has a body 10–15 cm in diameter; it is recognizable by its hairy legs, the dark, blotchy, olive brown colouring of its carapace and the pale tips of its legs. This species, originating from China and Korea, was first spotted in Europe in 1912 in northern Germany. It probably arrived in Europe in a larval stage in ships' ballast water. Today, it is present in most large European rivers. However, its nocturnal behaviour and cavernicolous character mean that it is poorly known. Because of the damage it can cause to river banks by digging its tunnels, this species is considered to be undesirable in Europe.

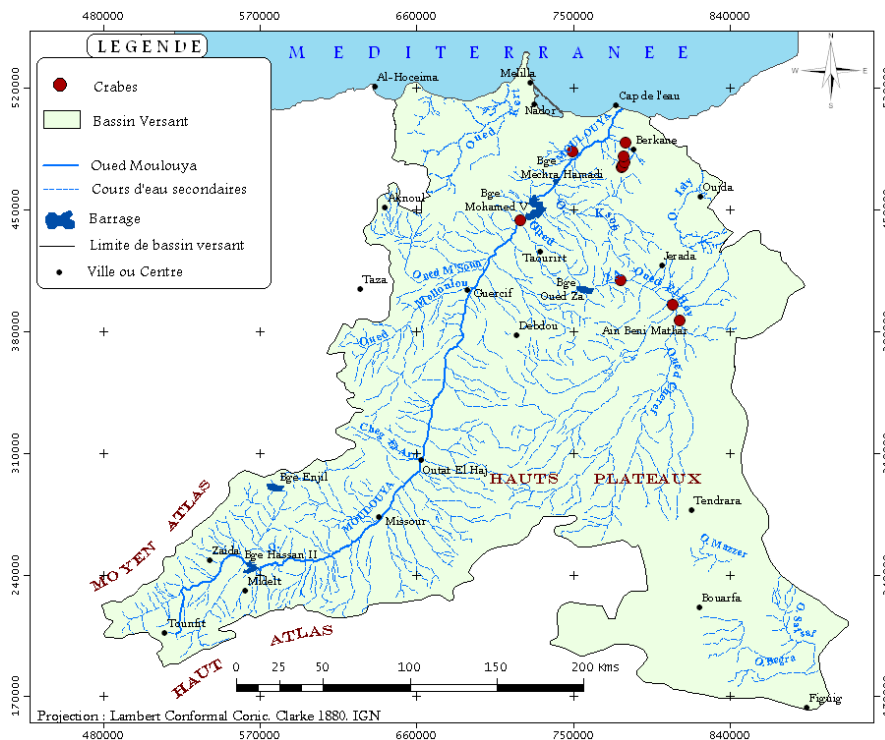


Figure 9 Distribution map of the native freshwater crab in the Moulouya river basin (Melhaoui and Sbai, 2009)

5.4 Dragonflies and damselflies

New survey work shows that the Moulouya river basin shelters a rich fauna of dragonflies and damselfies (42 species, about 70% of the total Moroccan fauna of Odonata). Thirteen Moroccan endemic species, 1 endangered species and 9 species classified as near threatened have been recorded there (Figures 10 and 11). Six species are new for the Eastern province, but others were not found and could be locally extinct due to the destruction, draining or pollution of watercourses and marshes.

The upper and middle course of the Moulouya river is characterized by a very poor Odonata fauna. That is due to the torrential floods and the constant shifting of sediments in that part of the river, which prevent the lasting establishment of suitable habitats for their larval development.



Calopteryx exul, an Endangered species on the IUCN Mediterranean Red List, occurs in the Moulouya basin.

Good water quality must be ensured throughout this river network in order to guarantee the permanence of these species there. This requires an improvement to urban sewerage systems. The considerable deterioration in the chemical and biological quality of the waters in the upper reaches of the Oued Za basin, due to development and waste from the town of Ain Beni Mathar, is obvious when the state of this watercourse in 1983–1985 is compared with its state in 2009. This must be addressed and corrected, as must the effluent from the water purification works in Guercif, on the Moulouya. The same applies upstream in the larger towns such as Outat -el-Haj and Missour.

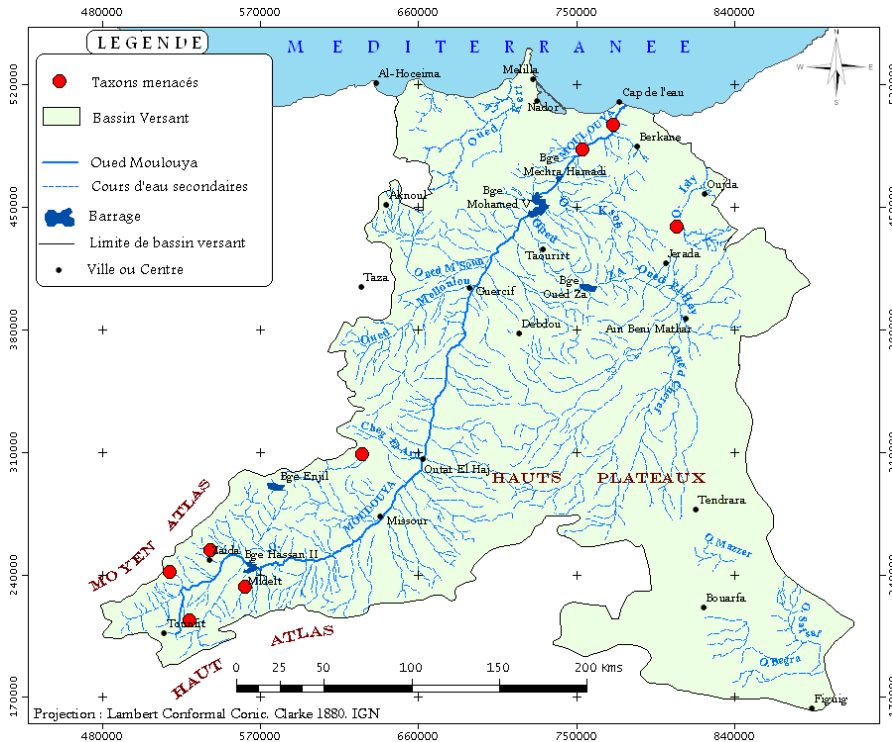


Figure 10 Distribution map of threatened dragonfly species

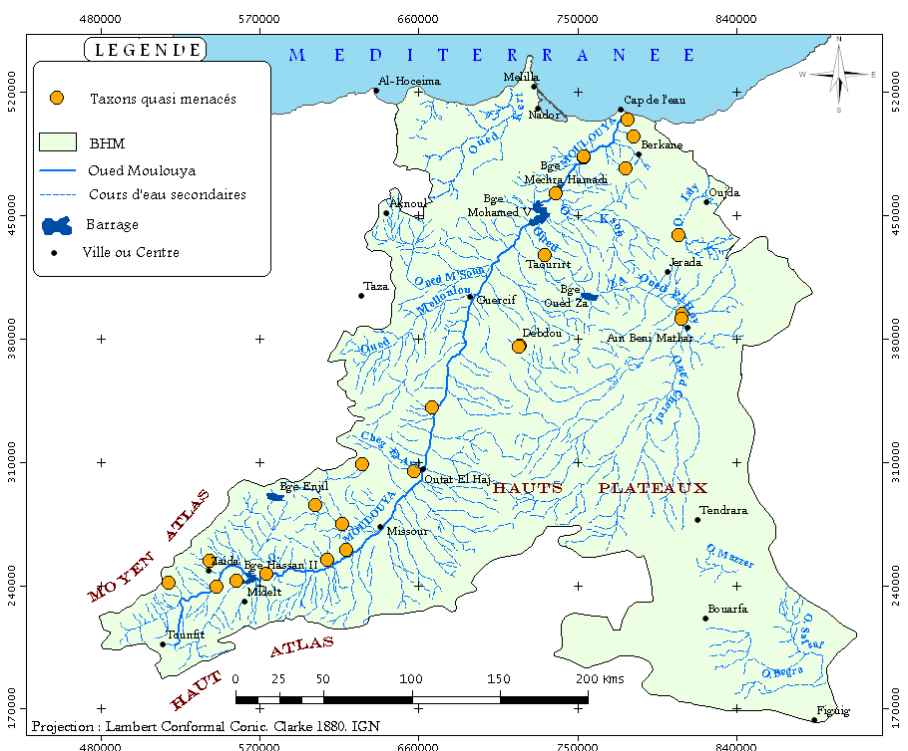


Figure 11 Distribution map of Near Threatened dragonfly species

5 Freshwater fish

The waters of the upper Moulouya are classified as cold waters (suitable for cold-water fish species such as salmonids, e.g. trout) and lukewarm waters (suitable for fish other than salmonids, such as carp, pike, perch, pike-perch, black-bass, eel and shad). The size of the Moulouya river basin, its northward flow to the Mediterranean, the diversity of its relief and the complexity of the stream network, account for the diversity and endemism of its ichthyofauna, some species of which are endangered (Figure 13), and the diversity of introduced species.

The indigenous ichthyofauna in the Moulouya river basin is characterized by the predominance of Cyprinidae, which represent more than half of the native species in the Moulouya and its tributaries. The upper reaches of the basin are characterized by the occurrence of wild trout *Salmo trutta var. macrostigma*. The range of this species is limited by its water quality requirements (oxygen and temperature levels). The Moulouya estuary has a relatively important semi-marine fish fauna. The oxbow lakes of the estuary are also colonized by strictly marine species such as gilt-head bream, sole and sea bass, or semi-marine such as *Mugil* and *Cyprinodon*, and migratory species such as eels and shads, which are endangered.

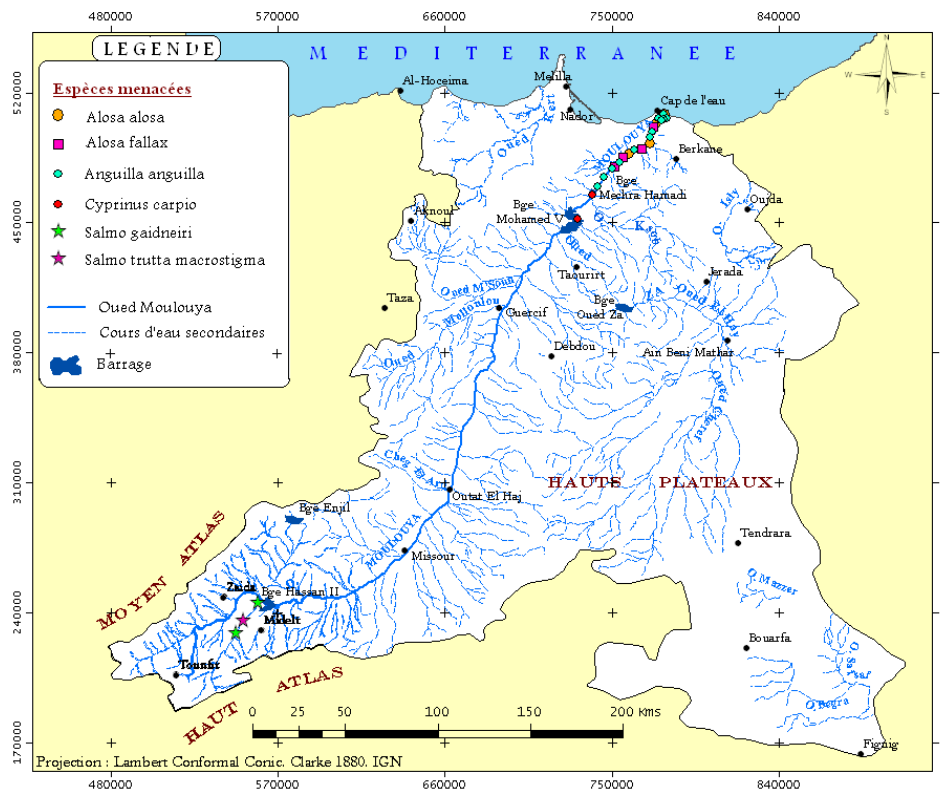
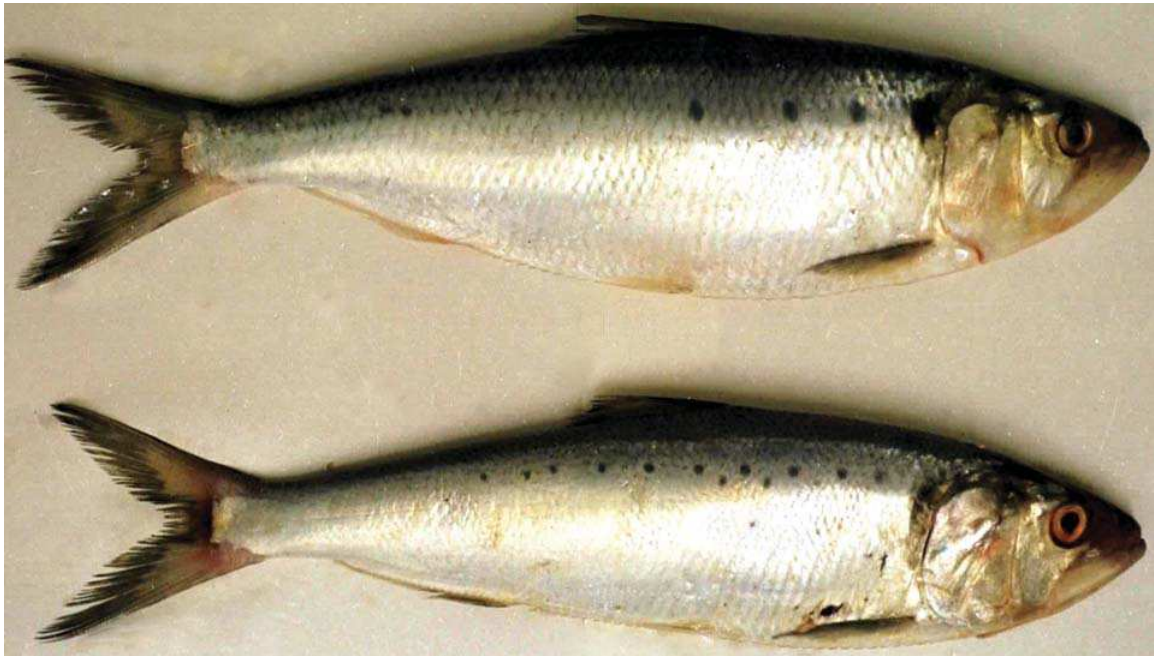


Figure 12
Distribution map of endangered freshwater fish in the Moulouya river basin (Melhaoui and Sbai, 2009)

Eels and elvers (glass eels) supported a significant fishery in the mouth of Moulouya until 2004. Shad (*Alosa*), formerly abundant in the lower Moulouya, is currently undergoing a worrying decline because of different forms of habitat deterioration and is now rarely caught, because dam building prevents it from migrating to the upper reaches in order to reproduce. A few spawning areas that are still accessible in the lower course of the Moulouya are therefore crucially important. Twenty years ago, this species was generating substantial incomes for fishermen in the lower Moulouya. Unfortunately, its decline is now such that its future survival is in serious doubt. This is due to mining pollution, industrial effluents and urban waste, which are discharged into the Moulouya without any treatment. We should also highlight the absence of fishways to bypass the dams on the Moulouya.



Shad, *Alosa alosa* (Linné, 1758) (*above*) and *Alosa fallax* (Lacépède, 1803) (*below*), two fish species listed as Regionally Extinct northern Africa Red List occurred in the Moulouya basin in the past but this will not spawn. Photo © M. Melhaoui

In the lower Moulouya, the shad is of considerable ecological interest in terms of fish biodiversity, since this species has survived for a long time despite the effects of various forms of pollution and the building of the Mechraa Hammadi dam, which was designed without a fishway. The shad is endangered in the Moulouya estuary and is included on the IUCN Red List. The reappearance of shad in the Moulouya estuary appears to be linked to the reduction of fishing pressure in this safe, protected area, the diversity of breeding areas along a 30km stretch of river, and a reduction in pollution from certain water engineering developments. Another important fact is that the extraction of sand and gravel (spawning habitat) for building work is carried out a long way upstream of the estuary, just downstream of the Mechraa Hammadi dam.

Currently, eel and shad fishing are banned in this area, which is now protected by the Waters and Forestry authority. Neither of these migratory species is subject to any management practice. However, elver fishing is an important source of income for local fishermen, who are adept at catching them and are just waiting for the authority to grant them permission to do so.

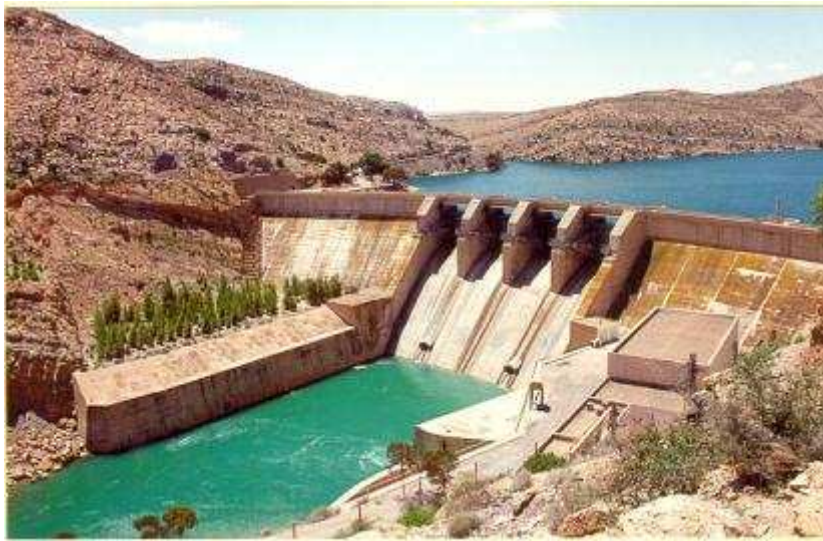
In the Beni Snassen mountains at 1210m above sea level, the Zegzel gorges drain a karstic system producing clear waters for much of the year. Here, a population of barbels (catfish) is threatened with extinction because of water diversion by farmers and water pollution linked to the habit of washing vehicles with detergents in the lower course of the Zegzel.

The expansion of the dam building policy gave rise to a third type of milieu in the intermediate zone, with barbels as the predominant species and some other introduced species such as carp, pike, black-bass and pike-perch. A census recorded 12 introduced species in the Moulouya, resulting from two phases of introduction:

- The first phase (from 1967), described as ‘the period of sports fishing’, was characterized by a proliferation of fishermen's associations in Morocco, which lay at the origin of most of the introductions, for instance pike-perch, rudd, black-bass and pike. These ‘blind’ introductions were carried out by the authorities and fishermen's associations without any prior scientific study.

- The second phase (1981–1999) saw the introduction of three Chinese carp species: the herbivorous carp, *Ctenopharyngodon idellus* (Valenciennes, 1844), the silver-plated carp, *Hypophthalmichthys molitrix* (Valenciennes, 1844) and the big-headed carp, *Aristichthys nobilis* (Richardson, 1845), with the intention of reducing eutrophication in the Mohamed V and Mechraa Hammadi dams and the Moulouya irrigation channels.

Fish stocking operations have intensified since the 1980s above the Mohamed V and Mechraa Hammadi dams and in the new reservoirs. Since 2000 river diversions have been made regularly every year but without any prior study. No efforts are currently being made to improve fishing operations by encouraging the private sector or setting up fishermen's associations.



The Mohammed V Dam.
Photo © ABHM

Throughout the Moulouya river basin, administrators have to address several types of pressure limiting or causing a decline of fish and aquatic organisms in general. These pressures must be taken into consideration during development work.

Some constraints are natural and linked to the flood regime of the Moulouya and its major tributaries, which periodically cause a considerable modification of sediments, preventing the development and structuring of habitats favourable to fish larval development. Climate change can also account for the reduction in rainfall, resulting in reduced flows and the drying-up of some parts of the river, which can be considered intermittent or ephemeral following long periods of drought. Other factors are human-related and result from carelessness and the use of this environment without taking precautions. This category includes:

- Drying-up of rivers, which is partly due to the natural cycle of drought, but also results from the abstraction of groundwaters for consumption and agricultural purposes;
- Mechanical habitat destruction, resulting, for example, from operations to straighten or inappropriately channelize watercourses (e.g. the diversions of the Zegzel), or the extraction of sand and gravel directly from the main channel of *oueds* (e.g. the Oued Za in Taourirt); all this destroys the habitats of larvae;
- Poaching of fish, especially from unguarded reservoirs;
- Discharges of untreated or poorly treated domestic or industrial wastewaters, such that the building of effective purification and treatment stations is crucial, notably in all large towns, especially in the upper and middle Moulouya;

- Pollution from agricultural activities (excessive use of pesticides and chemical fertilizers);
- Bad habits such as washing vehicles in watercourses using detergents (which are toxic to fish), which must be banned everywhere;
- Dam construction (e.g. the Tamalout dam in the headwaters of the Oued Ansegmir, a salmonid watercourse in the upper Moulouya), which generates large amounts of fine sediments, making the waters muddy and opaque, and therefore unsuitable for the development of aquatic organisms, over long distances downstream;
- Reservoir water releases (a frequent occurrence at Mechraa Hammadi dam), which can bring about anoxic sediments and generate toxic sulphides harmful to aquatic organisms.

In view of the importance of fishery resources to both biodiversity and the economy, the Water and Forestry authority should set up a code of conduct for fish conservation and management in order to raise awareness regarding fish habitats around dams or along the Moulouya and its tributaries. Fish habitat is such a complex ecosystem that the slightest change in any part may have unforeseen negative effects. This concerns construction works in and beside watercourses, where both the authorities and residents have to protect these special places: if fish habitat is destroyed, fish then disappear as well as other forms of aquatic life. Activities and practices which may harm fish and their habitats include:

- Dredging;
- Diversion or channelization of watercourses;
- Destruction of aquatic and marginal vegetation;
- Water abstraction;
- Wastewater discharges;
- Dumping of solid waste;
- Bridge building;
- Shoreline stabilization and bank reinforcement, etc.

Many measures have to be taken to avoid harming the habitat during activities in or near water, especially environmental impact assessments (Law 12-03) before project implementation begins. Biologists and fishery engineers of the Waters and Forestry authority are the only ones authorized to determine the status of fish habitat and to decide if the body of water requires legal protection.

Moreover, the strong variation in the tidal waters of dams can result in low water levels and raises concerns for fish. The development of artificial spawning grounds in different sections of the river could be a favourable solution. The artificial spawnings are easy to move when low water levels occur and can be simply withdrawn when water returns to normal levels, avoiding egg mortality. However, the whole fish management system needs to be reviewed at each dam, with a specific programme and the means to monitor stocking operations and the young fish nursery and especially to carry out studies on fish stocks. It will also be necessary to promote commercial sports fishing, and to fight poaching.

Although the role of aquatic plants in fish habitat is obvious, rocks and logs are also important elements. In lakes fed by very small streams, marginal rocks are often the only places where some species can spawn successfully. Rocks can also protect the shore. These are therefore elements that deserve to be protected. Woody debris provides important shelter for fish, especially in watercourses. Logs can also improve the habitat by gouging deep pits in watercourses, and can even change their course. If for any reason rocks or

woody debris have to be removed from the water temporarily, they should be kept and then put back in the same area or a nearby area at the same depth.

Where the reproductive habits of local species are known, it is important to make sure that activities nearby or upstream do not disturb critical stages in the life cycles of the fish. In the Moulouya, for instance, Cyprinidae spawn during spring and early summer, while Salmonidae generally spawn from autumn until spring.

Aquatic organisms and especially fish depend for their growth and reproduction on the quality of the waters in which they live. In general, water quality is determined on the basis of quantitative and qualitative criteria, such as, presence, of certain nutrients in sufficient quantities, oxygen content, pH (potential hydrogen), temperature, and the presence of substances known for their toxicity (metals, pesticides, phenols, etc.). Quality standards for fish waters aim at protecting the fish ecosystems, and therefore at enabling many different species to live and reproduce in watercourses. Water Law 10-95 and the Fishing in Continental Waters Law (Dahir of 21 July 1923) form the legal framework defining quality standards for fish waters. It should be borne in mind that river fishing is managed by the Waters and Forestry authority. Fishing activities are currently banned in the Moulouya SIBE, which has been a protected reserve since 2000. This allows for good protection of migratory fish such as eels and shad.

Sand and gravel (spawning habitat for several species of fish) is extracted for building work on a large scale upstream of the Moulouya estuary. In the future, it will be desirable to restore and rehabilitate stretches with degraded gravel fish habitat and to maintain the stability and quality of running water systems. Moreover, it is imperative to guarantee the free movement of reproducing migratory fish in the Moulouya. Improvements to fishways and similar devices may allow shad to quickly re-colonize areas from which they have disappeared. The downstream migration of shad also needs to be facilitated with specific devices, and elvers, eels and shad must be enabled to migrate to good quality areas in order to increase the recruitment rate of these species.

All these considerations must be taken into account in a fish management plan in order to better serve the authorities, fishermen and the local population of the Moulouya river basin.


ANNEX 2. *Information material on aquatic biodiversity used for workshops and awareness-raising activities.*


ANNEX 2. Information material on aquatic biodiversity used for workshops and awareness-raising activities

Calendars







Posters (1/2)


PROJET UICN/ABHM Moulouya – MAROC
 Programme de préservation et de réhabilitation de l'écosystème aquatique et des écosystèmes terrestres et marins à l'échelle du Bassin Hydrologique de la Moulouya








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Les Mollusques Aquatiques de la Moulouya

CLASSE DES CLAS TERROPODES

-  *Clas terropode 1*
-  *Clas terropode 2*
-  *Clas terropode 3*
-  *Clas terropode 4*

CLASSE DES LAMELLIBRANCHIENS (BIVALVIENS)


-  *Lamellibranchien 1*
-  *Lamellibranchien 2*
-  *Lamellibranchien 3*
-  *Lamellibranchien 4*
-  *Lamellibranchien 5*
-  *Lamellibranchien 6*


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Les Plantes Aquatiques de la Moulouya


Les hydrophytes émergents

-  *Hydrophyte émergent 1*
-  *Hydrophyte émergent 2*
-  *Hydrophyte émergent 3*
-  *Hydrophyte émergent 4*

Les hydrophytes à organes submergés et flottants

-  *Hydrophyte submergé 1*
-  *Hydrophyte submergé 2*
-  *Hydrophyte submergé 3*
-  *Hydrophyte submergé 4*

Les algues d'eau douce



-  *Algue d'eau douce 1*
-  *Algue d'eau douce 2*
-  *Algue d'eau douce 3*
-  *Algue d'eau douce 4*


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La Faune Piscicole de la Moulouya



Espèces autochtones

-  *Esope commun (Linnaeus, 1758)*
Pêche étour
-  *Alburnus alburnus (Linnaeus, 1758)*
Grande étour
-  *Barbus haasi (Félix, 1922)*
Barbus haasi
-  *Labeo niloticus (Linnaeus, 1758)*
Truite de la Moulouya
-  *Anguilla anguilla (Linnaeus, 1758)*
Anguille européenne
-  *Alburnus alburnus (Linnaeus, 1758)*
Alburne
-  *Silurus glanis (Linnaeus, 1758)*
Silure commun
-  *Carassius auratus (Linnaeus, 1758)*
Carpe commune
-  *Mugil cephalus (Linnaeus, 1758)*
Mulet
-  *Neosalanx daniconius (Linnaeus, 1758)*
Loup de mer
-  *Squalius laietanus (Linnaeus, 1758)*
Squalin
-  *Chelone fimbriata (Linnaeus, 1758)*
Chelone fimbriata

Espèces introduites

-  *Latesilurus niloticus (Linnaeus, 1758)*
Truite de la Moulouya
-  *Salmo trutta (Linnaeus, 1758)*
Truite commune
-  *Carassius auratus (Linnaeus, 1758)*
Carpe commune
-  *Carassius auratus (Linnaeus, 1758)*
Carpe commune
-  *Carassius auratus (Linnaeus, 1758)*
Carpe commune
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Carpe commune
-  *Carassius auratus (Linnaeus, 1758)*
Carpe commune

Posters (2/2)







Caravane de la Moulouya
 pour la protection de la biodiversité aquatique

قافلة ملوية
 لتحفظ على التنوع البيولوجي

جميعا من أجل الحفاظ على التنوع البيولوجي
 من دالية إلى مالتة ملوية



De l'amont à l'aval de la Moulouya
 Ensemble pour la protection de la biodiversité aquatique



Le Bassin Hydraulique de la Moulouya

L'Agence du Bassin Hydraulique de la Moulouya,
 un organisme au service d'une gestion intégrée des ressources en eau de la Moulouya




التنوع البيولوجي

يشكل التنوع البيولوجي (الحياتي) جميع الأنواع النباتية و الحيوانات ومواردها الوراثية والنظم البيئية التي تنتمي إليها هذه الأنواع، إنه باختصار تنوع كافة أشكال الحياة على وجه الأرض سواء كانت على اليابسة أو في المياه ويوفر التنوع البيولوجي للعالم ضمانا للحصول على الخدمات متصلة من الأغذية ومن الأخشاب ومن المواد الخام التي يستخدمها الإنسان في حياته اليومية ولبناء حضارة ومستقبله ولاشمل التنوع البيولوجي الأنواع الحيوانية الموجودة في محيط بيئي عالمي أو على اليابسة في وحدة زمنية محددة لحسب بل يشمل النظم البيئية والوراثية التي جاءت منها هذه الأنواع

اقسام التنوع البيولوجي

يمكن تقسيم التنوع البيولوجي إلى ثلاث فئات موزعة حسب التسلسل الهرمي وبخلاف النوع الواجب باعتباره يمثل ثقافة البشرية وجزءاً من حضارتها وأهم هذه الفئات **التنوع الوراثي** ويقصد به تنوع الموروثات داخل الأنواع ويشمل ذلك مجاميع متميزة من نفس النوع **تنوع الأنواع** ويقصد به اختلاف الأنواع في وسط بيئي معين **تنوع الأنظمة البيئية** ويصعب قياس هذا التنوع لأسباب عديدة منها أن هناك تداخلاً واضحاً بين الأنظمة البيئية الأساسية والثانوية

Si la biodiversité est protégée c'est grâce à MOI,
Si la biodiversité est menacée c'est à cause de MOI



L'Année internationale de la biodiversité est l'occasion de réfléchir à la manière dont nous avons pu préserver la biodiversité (passé), aux défis qui nous attendent et aux domaines dans lesquels nous devons agir.

Booklets



