



**CCMS WORKSHOP
ON
ECOSYSTEM AND WATER QUALITY MODELING
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**WORKSHOP REPORT
ON**

SUSTAINABLE MANAGEMENT

OF

OUALIDIA LAGOON

Editors

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Introduction

This report provides an assessment of the issues and problems that are confronting the people of Morocco and recommendation to address future management of the Oualidia Lagoon. The assessment was accomplished by an international group of resources management experts, who are sponsored by NATO - Challenges of Modern Society (CCMS) program, in conjunction with host country Moroccan government (national, regional, local), nongovernmental organizations (NGOs) and private sector individuals (list of participants below). The participants were assembled by the Moroccan Ministry of Fisheries. The purpose of this report is to suggest a basic framework for making informed decisions and recommendations for taking positive actions for sustained use and development of the Oualidia Lagoon. We submit this report with respect for the fact that the government of Morocco and the people of Morocco are doing the best job that can be done given current resources and the social-political system to manage the resources of the Oualidia Lagoon. The NATO –CCMS study group has been meeting / collaborating since 1995. They recently published Coastal Lagoons: Ecosystem Processes and Modeling for Sustainable Use and Development (CRC Press, 2005). The book presents models and guidance on decision making for sustainable management of coastal lagoons.

This report and its recommendations are submitted as a constructive assessment of needs and opportunities to better address the management of the Oualidia Lagoon for sustained use and development. It is not our intention to criticize the current management practices or the current system of management. The NATO-CCMS resource scientist/management experts were largely unfamiliar with the resources and management organization existing in Morocco prior to the workshop. Recommendations are provided for modification of existing operational procedures, measures, and means based on what has been assessed is working in other countries and geographic areas.

Oualidia Lagoon is located on the Atlantic coast of Morocco between El Jadida and Safi. The lagoon is approximately 7 km long and 0.5 km wide (surface 3 km²). It exchanges water with the ocean with a major inlet as seen in Figure 1. The major inlet is 150 m wide and a secondary inlet is active during the high tide of spring tides. There is significant groundwater seepage.

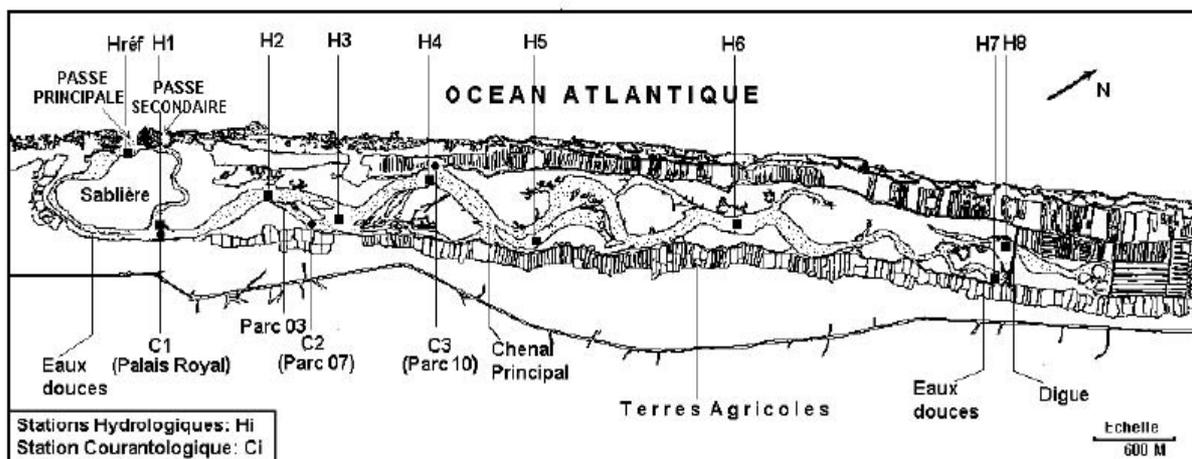


Figure 1. Oualidia Lagoon

The lagoon watershed / catchment area is not well recognized (there is no map of the watershed area, pollution sources are not identified, there is no detailed information on land use). There are shellfish, agriculture, and tourism industries as well as a growing population (although growth is occurring at a slow to moderate rate). It is clear that there are discharges from agriculture and of domestic sewage (permanent population about 5,925 and up to 30,000 during summer season). There are no other industrial activities.

Until 1996 Oualidia Lagoon was recognized as a water body in good environmental status (class A – Moroccan classification for shellfish area). There was no recorded sanitary or eutrophication problems. Before 1996 the biological diversity was much higher and the lagoon was important as a nursery area for coastal fishes. Since that time, non-native oyster (*Crassostrea gigas*), aquaculture has grown and the native clam population, (*Ruditapes decussates*) has, decreased. Also, agriculture production was more important than it is currently.

After 1996 the lagoon was classified as class B, which implies that bivalves must be depurated before human consumption. This grossly corresponds to a moderate level of pollution. The pressure comes mainly from diffuse pollution sources.

In general, the major problems with management for sustained use and development of the Oualidia Lagoon. Can be summarized as:

1. Degradation of the health of the lagoon ecosystem including decline in water quality and loss of natural habitat.
2. Recognition of the interdependence of the social economic system and ecological system
3. Lack of a planning and coordinating implementation organization that focuses only on the Oualidia Lagoon and its watershed / catchment area.

Details on these issues are provided within this report.

Report of the Management / Decision Making Working Group

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BACKGROUND

Morocco has a decentralized decision making process that focuses on Regional Coordinating Councils. The Councils are chaired by the Governor(s) that over-see activities in particular geographic area(s). Local representatives of Ministries sit on the Councils as do the mayors of local jurisdictions. In addition, the Councils have formal Advisory Committees that address management issues. It is a national objective to involve citizens in governess of Morocco; therefore, it is a basic principle to seek public involvement in the work of the Councils. As a rule, Councils seek to make decisions based on consensus, however, ultimately, the Governor, as Chairperson, is the final decision maker. This framework is constitutionally established. Management actions that are taken are based on the laws and policies established for each of the Moroccan Ministries.

The current management framework addresses a broad geographic area, much larger than that of the Oualidia Lagoon and its catchment area / watershed. To our understanding that there is no formal agreement that establishes a mandate for coordination specifically on and for conservation of the Oualidia Lagoon and its catchment's area / watershed. Although collaboration does occur, it has been identified as less than adequate to meet the needs of conservation of this International recognized lagoon (RAMZAR designated site).

This report respectfully provides an assessment of current issues and problems as well as recommendations for management for sustained use and development of the Oualidia Lagoon. Of particular note is a key missing element for informed decision making, coordinated planning, and implementation of positive management actions for sustained use and development - a site specific Oualidia Lagoon Catchment's Area / Watershed Organization or COMMISSION. Specifically, a Commission established to develop and implement an integrated strategy for sustained use and development of the Lagoon. Among the recommendations for improvement to management and decision-making is establishment of such a Commission. Such a Commission should: (1) provide oversight of the top leaders, executive level (i.e. the existing Regional Coordinating Council), in the establishment of goals for sustained use and monitoring program implementation; (2) include a formal working group at the Policy Level that meets regularly; (3) establish technical work groups that have consistent; (4) hold regularly scheduled meeting for technical work; and (5) ensure stakeholder involvement.

OUALIDIA LAGOON COMMISSION

Terms and Principles for Management

Terms and Principles to be applied in implementing sustainable use and development practices:

1 Sustainable management is managing to meet present needs and addressing the needs of future generations. Conceptually it requires the awareness and consideration of the ecological system and its relationship to the social economic system. It also requires

measurement of, and accountability for what the ecological unit provides to society, specifically the Outlaid Lagoon and its catchment area / watershed production value (e.g. aquaculture, agriculture, and tourism).

2 Sustainable management is a conscious social decision that provides for the long term health of both the ecological and economic systems of the ecological unit. The finite capacity of the ecological unit's natural capital can not meet the growing demands of society without a plan for sustainable management.

3 The use of the best available information, knowledge, and tools need to be infused throughout the decision making process. An ecologically based monitoring program of key indicators is a critical factor in management for sustainable management.

4 The use of models as tools in the decision making process will enhance awareness of the interrelationships within the ecological unit, especially its input and output variables. This will further enhance accuracy of predictions for, and awareness of the consequences of management decisions.

5 Decision making should involve all interested parties including government (federal/national, regional, and local), NGOs, scientific institutions, business users groups (e.g. aquaculture, agriculture, and tourism) and general public.

6 Management of decision making requires a formal cooperative institutional structure for the Commission that is empowered through appropriate policy and legal authority.

7 The Commission should have a written Charter or Agreement that commits the parties to work cooperatively to address the goal of sustainable use and development of the natural capital.

8 A conflict resolution process should be identified that provides ample and open consideration of differing view and interests. (It is believed that such a process is in place for the management of the Oualidia Lagoon where the Regional Council is involved in management and the Governor is the ultimate decision maker. Administrative adjustments to the process should be developed in recognition of the establishment of the Commission which will focus specifically on implementation of positive management actions for sustained use and development of the Lagoon and catchment area / watershed.)

9 Environmental education is essential in order to insure long-term sustainability and a participatory process. Education should be at two levels: (1) public awareness of the problems of the environment, especially the linkages between catchment area / watershed activities and consequences on the downstream water body and (2) formal education of young people in order for them to understand the central role of the natural environment in their future welfare.

SPECIFIC PROBLEMS

The specific problems and causes were identified during workshop as a result of discussions with local scientists and managers. They are:

1 Natural water capacity and volume of lagoon has been reduced by artificial structures and have compromised and reduced the natural processes and pollutant / contaminant assimilation dike have partitioned off the upper sections of the lagoon.

2 Water quality problems related to sewage discharge to the lagoon through underground seepage waters due to the absence of waste water transport, delivering and treatment facilities. These sewage waters charged with bacterial coliforms can have impacts on oyster culture and swimming activities. Thus “bacterial pollution” is important issue.

3 Agriculture run-off (use of fertilizers, and pesticides lack of protection (buffer) zones, uncontrolled grazing if cows and horses in or proximate to the aquatic environment.)

4 Eutrophic conditions in the lagoon, particularly at the upper end part.

5 Loss of biological diversity

6 Occasional toxic algae blooms which affect oyster culture activities. These are amplified by excess nutrients provided by remineralisation of organic detritus and agriculture inputs.

7 Lack of an organization that develops and coordinates implementation of management plans specifically for the Oualidia Lagoon and its watershed / catchment area.

8 Lack of a development or integrated land use plan

9 Human disturbance (jet ski motorized vehicles).

10 Lack of data on system (inventory/studies of ecosystem/lagoon)

Population growth (slowly increasing) and tourism are two factors that are acerbating these problems.

RECOMMENDATIONS

The following recommendations are respectfully provided as guidelines. They are based on successful work directed at sustained use and development of natural capital / resources as observed and practiced by the NATO-CCMS scientific experts in other areas of the world. It should be recognized that in different countries with different cultures the recommendations may need to modify to address unique interests of those involved.

1-Problem: Loss of Natural Lagoon Hydrodynamics

Recommendations:

Most important priority: Restoration of natural lagoon dynamics - Study the impacts of restoring natural lagoon dynamics:

- * Determine the impacts of removal of the (dikes at the upper end of the lagoon.) - Hydrodynamic study begun - need additional data and analysis.
- * Determine the impacts of potential saline pollution into the system- need data and analysis.
- * Restore natural dynamics of lagoon by removing dikes (per results of impact study).
- * Monitor and evaluate restoration and impacts.

Concerns:

- * Access to agricultural management and need to evaluate impacts to agricultural interests.

2- Problem: Need for Effective Wastewater

Recommendations:

Complete the Design and Development of an effective wastewater delivery system (sewers) & wastewater treatment plan

Concerns:

- * There may be alternative designs/plans that may provide an improved cost/benefit ratio
- * Use of wastewater for spray irrigation may have impacts as a result of ground water infiltration
- * Existing zoning/land use plan should be more strictly implemented /enforced

3- Problems: Need for an Integrated Sustainable Lagoon Management Plan (ISLMP) for the lagoon and surrounding area

Recommendations:

- * Develop an Integrated Sustainable Management plan for the lagoon and catchment area / watershed that integrates sector, social interests-economic system with sustaining natural capital.
- * Involve all relevant socioeconomic and ecological interests and sectors
- * Develop, implement, and revise regularly (5-10 years)
- * Implement and enforce the existing development / zoning plan for maximum protection / conservation of lagoon health and quality
- * Review and improve the existing plans (i.e. Development / zoning, etc.) in accordance with this more comprehensive ISLMP
- * Support the development of RAMSAR Biological Reserve Management Plan and integrate into the overall ISLMP

Concerns:

- * Existing development/land use plan does not provide adequate buffer for lagoon health, land use / habitat protection
- * Existing plans are sectorial and do not address the interdependence of the socioeconomic and ecological systems.

4-Problem: Contamination and pollution (inorganic and organic) from agriculture and animals

Recommendations:

- * Improve agriculture techniques – including bio- agriculture, new and improved techniques for erosion and pollution prevention and water use regulation, etc.
- * Educate and inform farmers and regional public to restrict animals (e.g. cows, horses) from lagoon area;
- * Study impact of agriculture on lagoon (social, economic, ecologic) short and long term;
- * Develop and implement Best Management Practices and buffer zones along lagoon

5- Problem: Human disturbance from motorized vehicles (jet skis) are reducing water space/habitat so avian use and aesthetic quality is being diminished in the lagoon as a result of the noise pollution.

Recommendations:

* Restrict the use of motorized vehicles (jet skis, ATV's etc.) by zones and/or number of units allowed.

6- Problem: Lack of Data to properly assess, monitor, and evaluate the status of the lagoon and the impacts resulting from the uses of the lagoon.

Recommendations:

* Conduct an Environmental Impact Study of existing and future proposed uses of the lagoon and its water shed catchment area. This will require the collected adequate data for assessment, evaluation, modeling, monitoring, and informed decision making.

* Conduct inventories (resources specifically bird use, habitat needs, and plants)

7- Problem: Challenge of administrative coordination between the local, regional, and national agencies and there is a need for a local integrated implementing entity,

Recommendations:

1 Establish a Commission within the scope of the existing cooperative institutional structure – the Regional Coordinating Committee. An organizational chart example is provided in Appendix 1.

2 The Commission should be empowered through appropriate policy, legal, and financial instruments to establish monitoring programs and implement management actions within the watershed, catchment area.

3 Establish a Charter for the Commission, a formal Letter of Agreement that commits cooperation between the Regional, and local governments. The signatories should be the members of the existing Regional Coordinating Committee at highest levels of the respective government organizations. This group should serve as an Executive Committee (see Appendix 1).

4 Establish the Commission and identify specific staff to service and manage technical workgroups (noted below). The Commission will identify policy / legal needs and seek consistency in management of issues that need to be considered on a multiple agency basis. The Commission also should serve a functional role in directing representatives from the technical working groups on priority work issues.

5 Establish Technical Working Groups. The following working groups are recommended: Water Quality, Nutrients, Toxics, Hydrologic, Hydrobiological, Shell Fisheries & Aquaculture, Exotic / Invasive Species, Migratory Birds. Working Groups should be established to address local needs and regional / national interests. These groups will establish plans to address agreed upon (at Commission and Executive levels) goals and objectives. These groups also will recommend goals and objectives to Commission and subsequently to the Executive Committee for adoption.

6 Establish Advisory Committees for the general public (citizens), scientific and technical interests, local governments, and non government organizations (NGOs). Other Advisory committees also may be appropriate to meet local interests and needs.

7 Invite stakeholder involvement from all businesses that have an interest in Oualidia Lagoon and its catchment area / watershed. This should include representatives from agriculture, shell fish and aquaculture industries, tourist industry (developers and managers), and others.

8 Encourage/promote integrated socioeconomic and ecological programs (i.e. the Women's Cooperative)

9. Hold Round Table meetings at each level of the organization on a regular basis. For example:

- Executive Committee – Annual

- Commission Committee – Bi-monthly

- Working Groups – monthly

10 Facilitate decision making process by developing joint tools for inter- ministry / local government jurisdictional management, like unified automated data bases and modeling tools for impact assessment. Establish procedures for data base replenishment and assessment data base resources as well as exchange of information for environmental impact assessment and operational needs.

11 Establish a formal dispute resolution process for the Commission. Differences of opinion need to be elevated to higher authority within the organization to ensure that competing interests for natural capital are fully considered.

12 Establish an environmental education program directed at: (1) public awareness of the problems of the environment, especially the linkages between watershed/catchment area activities and consequences on the downstream water body(s) and; (2) formal education of young people (education curriculum for primary and secondary levels) in order for them to understand the central role of the natural environment in their life and lives of future generations.

13 Establish a planning process. The planning process can be simple. The following seven step processes is offered as an example:

Step 1-Set the goals for sustainable use and development of the Oualidia Lagoon and its catchment area / watershed.

Step 2-Define problem(s) – describe the problems/conditions that affect the Oualidia Lagoon ecological and social-economic structures.

Step 3-Define the system – Oualidia Lagoon's ecological and socio-economic structural components.

Step 4-Develop and use an effective decision support system.

Step 5-Develop and integrate this plan into the infrastructure by function (committees and workgroups of the Commission).

Step 6-Formulate Action Plans to address identified needs for information, policy, and legal framework.

Step 7-Evaluate progress on a regular basis (at least annually by the Executive Committee and bi-monthly by the Commission).

Conclusion

Morocco should take great pride in the level of collaboration that is occurring. The recommendations provided here are suggested as guidelines to improve the working relationships between the Ministries, local governments, and interest groups as well as the citizens of the area. Specifically, to improve the effectiveness and efficiency of decision making on inter-Ministry / local government jurisdictional issues for the purpose of sustained use and development for the Oualidia Lagoon. Again, this report and recommendations are respectfully provided as guidelines. They are based on successful work directed at sustained use and development of natural capital / resources as observed and practiced by the NATO-CCMS scientific experts in other areas of the world. It should be recognized that in different countries with different cultures the recommendations may need to modify to address unique interests of those involved. We are thankful that we had the opportunity to work with the scientist, engineers and other interested parties. We look forward to continued collaboration and the enjoyment of our future friendships.

**Report Of The
Monitoring And Assessment Of Water Quality
Working Group**

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Existing Monitoring Activities

There are four types of monitoring activities starting from 1994:

On shellfish (oysters):

- Microbiological (E.coli 2 times per month, Salmonella occasionally)
- Chemistry (heavy metals, PCB, PAH) (4 times per year)
- Phycotoxins (ASP, DSP, PSP) (2 times per month)

On water:

- Phytoplankton (Moroccan Official list of toxic species also the total list of species and abundance - 2 times per month)

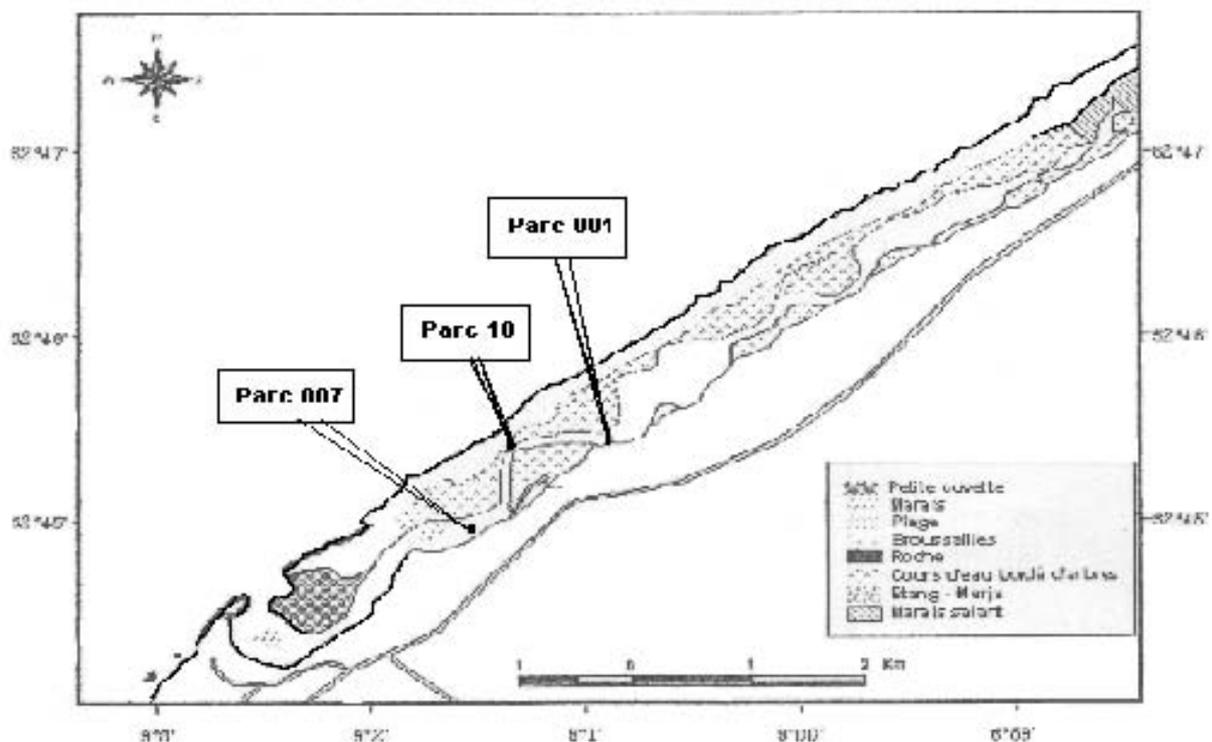


Figure 1. Oualidia Lagoon with marked monitoring stations

Recent results from the microbiological programme confirm that the safety degree of shellfish area of Oualidia is B. The quality of coastal lagoon was monitored in heavy metals, pesticides and hydrocarbons, from 1993 until now, by using the oyster *Crassostrea gigas* as a quantitative bioindicator of chemical pollution. The mean concentrations of these contaminants shows that they are lower and they do not affect oyster quality.

Concerning harmful algae blooms (HABs) samples are taken fortnightly in the same four stations. Individuals are taxonomically classified at the level of species and counted to determine density. Not only potentially toxic species but the full range of species present.

The level of training and enthusiasm of the responsible personnel for this task is excellent. Moroccan experts have shown an impressive knowledge and concern of problems associated with HABs.

HABs (red tides) are a critical question in all aquaculture activities and are becoming an increasing problem all over the world. According to hearings, Moroccan scientist are very well aware about that problem and are very well trained to face any potential problem in the future. This concern should be also shared by stakeholders. Scientist at the INRH have explained that only two HABs events (in 1996 and 2005) produced by *Lingulodinium polyedrum* and *Dinophysis* has been recorded. According to experience in many other lagoons, blooms are recurrent as most dinoflagellate species can form cysts that settle into the sediment to become active in following years.

On the other hand in terms of monitoring for bathing/coastal water quality bacteriological analyses are conducted (3 stations, 2 per month, May-September, one in January).

Temperature is regularly measured during monitoring cruises and occasionally dissolved oxygen is measured.

From 1993 to 2001 there was regular sampling of nutrients (phosphates, nitrites, nitrates) and also dissolved oxygen, pH, salinity, suspended solids, and chlorophyll a. After 2001 this monitoring stopped.

Monitoring techniques are well established and calibrated, based on standard methods.

The results are stored in a data bank in Department Qualité Salubrité du Milieu Marin (IRNH, Casablanca) and sent to the Ministries. All the results are elaborated in reports and some are published in peer- reviewed journals. However, in spite of more than 10 years monitoring no time trend analysis was performed.

Management of shellfish is carried out according to the European norms; however, results are not used for ecosystem quality assessment and management.

Recommendations

After discussion with local experts, NATO LEMSM presents the following general recommendation for Morocco institutions:

□ Monitoring of following nutrients in the water column is recommended: phosphates, nitrates, nitrites, ammonia, total P and total N. Special methodology is often necessary in case of lagoons, due to their specific nature. For example the analytical techniques utilized in measuring eutrophication parameters in marine areas or freshwaters are sometimes not applicable to lagoons, due to factors such as intermediate salinity, possibility of presence of humic substances, differing water color, and presence of large amount of suspended material. (For further details see Chapter 7 in the book *Coastal Lagoons; Ecosystem Processes and Modeling for Sustainable Use and Development*, Edited by Ethem Gonenç and John P. Wolflin, CRC Press, 2005).

- For monitoring organic matter in the water, the parameter BOD₅ (5 days Biochemical Oxygen Demand) can be used.
- In sediments we recommend monitoring organic matter. For this analysis a simple combustion method, at a settled temperature, can be used.
- Salinity and chlorophyll a in the water should be incorporated in monitoring activities. In general lagoons have a large amount of periphyton which hampers chlorophyll a analysis. In general sampling in lagoons require more time than required in the open sea.
- Monitoring of groundwater is recommended. Estimation of groundwater sources is needed as well as enrichment of groundwater with nutrients especially with nitrates.
- Evaluation of pollution loads (mainly nutrient load evaluation) is necessary. This evaluation can be performed based on standards for each habitant (N, P and BOD) multiplied by the number of permanent habitants, and also the number of tourists during the summer. Agriculture and cow production must also be considered. This pressure determination can be also based on standards for area / type of agriculture and animal species produced.
- Preparation of environmental assessment based on indicators (for better use by decision makers)
- Preparation of popular assessment for public / local community use
- Consider the use of the available data for ecosystem health assessment and biological diversity assessment.
- Changes in agriculture practices might be necessary in order to decrease pollution and reduce erosion. (Buffer zones along the land used for agricultural purposes should be set. Cows should be kept away from the neighbor of the lagoon etc.)
- Develop meteorological monitoring from existing one (precipitation) by adding other parameters (wind speed, wind direction, evaporation, air temperature, cloudiness etc.). This information is needed especially for modeling.
- In lagoons the major driving forces are usually the wind stress, water level changes related to tides, and direct atmospheric pressure. The list of monitoring parameters can be expanded of modeling needs.
- Develop medium-term monitoring for HABs. by acquiring the capability of isolating and growing cultures in laboratory in order to start a culture collection of potentially toxic species.
- Maintain existing phytoplankton monitoring (species composition and abundance) and extended by adding biomass.
- In case sufficient funding is available, other ecosystem components can also be monitored, such as macrophytobenthos, macrozoobenthos, and fish (species composition and abundance). This monitoring will allow a direct comparison to European countries that are asked to monitor these components according to Water Directive Framework. It will also allow a more precise ecosystem health assessment.

Note:

After working with local experts and learning of their experience, NATO LEMSM experts are convinced that Morocco has good scientists carrying high quality scientific and monitoring activities. NATO LEMSM experts were pleased with the exchanging of experience and mutual learning process. NATO LEMSM experts are open to further collaboration and cooperation on expert by expert basis.

There were some communication problems stemming from that NATO experts are mainly communicating in English and Morocco experts in French.

Appendix

Sample Cooperation Organization Structure

