Centre for Development Innovation

Lake Burullus

Local Food Security and Biodiversity under Pressure

Henk Zingstra

Final Report

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Project BO-10-011-124, Lake Burullus: Towards an integrated approach of the wise use of wetlands, sustainable water resources management and agricultural development in Egypt

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Project Report

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Lake Burullus
Local Food Security and Biodiversity under Pressure

Zingstra, H.L.

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The overall objective of the project is to support the State Ministry of Environmental Affairs of Egypt in its task to protect and manage the Lake Burullus and to halt the ongoing deterioration of the condition of this important Lake which is designated as a Wetland of International Importance under the Ramsar Convention. The project has gathered and analyzed water quality and water quantity data, data about land use changes, socio-economic data of the fishermen living around the Lake and information about the responsibilities and governance structure for management of the Lake to identify the drivers behind the deteriorating quality of the Lake and to design solutions to stop the loss of biodiversity and the decreasing value of the Lake for catching fish and providing animal protein and income to the livelihoods living around the Lake. An important component of the project was to gather and analyze information about the attitudes and expectations of the local population and in particular of the local fishermen with respect to the management of the Lake.

Orders
+ 31 (0) 317 486800
info.cdi@wur.nl

Preface

In 2010 the Centre for Development Innovation (CDI), Wageningen UR was contracted by the Embassy of the Kingdom of the Netherlands in Cairo to carry out a scoping exercise on identifying opportunities to broaden bilateral relations between Egypt and the Netherlands in the areas of water management and agriculture. During that project the problems related to the management and protection of Lake Burullus became clear and after consultation with the Ministry of State for Environmental Affairs of Egypt it was decided to embark on a project that would support the Ministry in its efforts to halt the ongoing deterioration of the Lake. The start of the project implementation coincided with the "Arab Spring" in January 2011 which resulted in the disposal of President Mubarak. During the first mission in June 2011 it became evident that the fragile political situation impacted also the cooperation with the State Ministry for Environmental Affairs. In addition, weakening law enforcement affected the situation in and around Lake Burullus where poaching and the pace of constructing new aqua culture ponds increased. Although (illegal) hunting has always been carried out, this significantly increased since January 2011. According to the Egypt Independent (January 14, 2013)[1] "bird hunters returned with a vengeance - due to harsh economic times, lack of security and political turbulence - and are now blatantly entering protectorates to hunt, breaking many local laws and international treaties in the process".

Despite two requests submitted to Ministry of International Cooperation (one in 2012 and one early 2013) no formal approval for obtaining water monitoring data of the Egyptian Environmental Affairs Agency (EEAA) was received and a formal approval for the project was not granted. During the project period four different Ministers were leading the State Ministry of Environmental Affairs. Also the position of the Governor of Kafr el Sheik, who is chairman of the cross-sectoral management committee, changed during the implementation and it was therefore not possible to organise a meeting with him.

Professor Dr Moustafa Fouda, advisor to the Minister of Environment, was one of the few who did not change position and who stayed committed to the project and helped to find solutions whenever they occurred. His support as well as the interest of various other experts in Egypt in the wellbeing of Lake Burullus and in finding a solution for the deteriorating environmental situation of the Lake and the decreasing situation of the livelihoods around the Lake were a strong incentive to finalise the project.

Despite the problems depicted, the project managed to gather relevant data including data about the water quality, the socio-economic situation of the fishermen, the responsibilities with respect to the management of the Lake and the land use changes in and around the Lake. Using the DPSIR tool the drivers behind the deteriorating situation of the Lake have been identified and recommendations for halting this process are given. The conclusion of the report is that the deteriorating quality of the Lake as refuge for migratory birds and as a source for fish for the local market is for the biggest part caused by unclear and even conflicting arrangements about the management and the lack of law enforcement. It for that reason makes no sense to elaborate a new management plan as long as the sharing of responsibilities is not clarified and a clear governance structure is agreed upon.

Dr Co Verdaas
Director
Centre for Development Innovation, Wageningen UR

[1] Egypt Independent, 14-01-2013; Amidst political turmoil, bird hunters trespass wetland protectorates' boundaries.

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Project summary

Project title

Towards an integrated and climate proof management of Lake Burullus (mainstreaming sustainable water resources management, local food security and biodiversity protection).

Project organization

Initiators: Embassy of the Kingdom of the Netherlands, EL&I-department (Cairo) and the Ministry of State for Environmental Affairs of Egypt.

Beneficiary: Cross Sectoral Management Committee of Lake Burullus.

Partners: CARE Egypt, Terrasphere (NL), Drainage Research Institute (Egypt) National Institute of Oceanography and Fisheries (El Kanater, Egypt), Coastal Research Institute (Alexandria, Egypt), Alterra, Wageningen UR (NL).

Lead Implementation: Centre for Development Innovation, Wageningen UR.

Project goal

The goal of the project is to present information about the current status of the Lake Burullus and to indicate trends by gathering and analyzing existing data with respect to water quality, salinity, land use, the amount and quality of fish caught and biodiversity. An important component of the project is to gather and analyze information about the attitudes and expectations of the local population and in particular of the local fishermen with respect to the condition and management of the Lake.

Output

Status description of the current situation of the Lake and a strategy for mainstreaming the wise use of the Lake with sustainable water resources management, local food security and biodiversity protection.

Implementation process

The initial idea was make a status report of Lake Burullus based on up to date information about the water quality, biodiversity and the ecosystem services provided by the Lake, to describe trends and to design intervention options to curb the deteriorating condition of the Lake. The status report was planned to be discussed in the cross sectoral management committee to reach common agreement about the current condition and the trends as a bases for the design of management interventions. However; due to the political situation the meeting with the cross sectoral management committee has not taken place. Information in this report is retrieved from the management plan for Lake Burullus (2002) and many other reports (see literature) plus additional information gathered and analyzed in the frame of this project by the Drainage Research Institute (water Quality Data), TerraSphere (analyses of land use changes based on satellite images), Care Egypt (interviews of fishermen), the National Institute of Oceanographic & Fisheries Research (Alexandria Branch and Fish research station in Kanater; fish data and water quality data) and the General Authority for Fish Resources Development (GAFRD; fish data).

Introduction

In 2011 the Centre for Development Innovation (CDI), Wageningen UR was assigned by the Netherlands Embassy in Cairo to analyse the opportunities for broadening the bilateral relations between Egypt and the Netherlands in the areas of water management and agriculture. In the course of this assignment it became clear that water management in Egypt is justifiably focussed on securing enough drinking water and water for the production of food. Environmental concerns are however not taken into consideration in the National Water Resources Plan of Egypt while the ongoing deterioration of the water quality and the lack of appropriate measures to tackle these problems are causing an increasing threat to the health of the population and jeopardize the possibilities to produce clean drinking water. Also the water quality is becoming a problem as a source for irrigation purposes and the more downstream the more the water is becoming contaminated with an increasing amount of pollutants.

The lack of appropriate measures to address the problems of the deteriorating water quality are especially noticeable in Lake Burullus, a coastal lake which is receiving its water from one of the branches of the Nile. Lake Burullus is providing a wide variety of important services including providing fish for the local population through capture fisheries, employment for the local fishermen, provision of medical plants, fodder for cattle, reed for thatching houses and last but not least, biodiversity. Recent data show that there are about 65.000 fishermen are working on Lake and that for about 600.000 people the Lake is the most important source for animal protein.

Because of its importance for migratory water birds the Lake Burullus has been designated as a Wetland of International Importance under the so called Ramsar Convention and as a Protectorate under Egyptian legislation. The State Ministry of Environmental Affairs in Egypt bears the responsibility for the management of the Lake but lacks the power to reverse the down going environmental condition of the Lake. The Netherlands Embassy though the office of the Agricultural Councillor offered support through the Policy Support Programme of the Ministry of Economic Affairs. Wetlands and the implementation of the Ramsar Convention belong to the responsibilities of the Ministry of Economic Affairs in the Netherlands (at the start of the project called the Ministry for Economic Affairs, Agriculture and Innovation). And moreover the Netherlands has a lot of valuable knowledge to offer about the important role wetlands play in sound integrated water resources management and in managing and restoring wetlands.

Based on communications with different stakeholders it appeared that there were various views on the environmental condition of the Lake and on the possibilities and ways to improve the situation. There were especially diverting opinions about the question whether the Lake was still exchanging water with the Mediterranean and if so, to what extent the Lake was salt, brackish or fresh water. Also different views were expressed about the level of pollution of the Lake and the impact the influx of nutrients has on the fish population and biodiversity. It was concluded that a thorough analyses of the impact of the environmental condition plus an analyses of the social and economic relevance of the Lake for the local population would be a prerequisite for designing management and restoration interventions. The first step towards the design of management and restoration activities is that all stakeholders agree that the current situation and trends are unacceptable. Next all stakeholders need to agree on the root causes for the deteriorating situation since only plans that address these root causes for the deteriorating situation are sustainable on the long term.

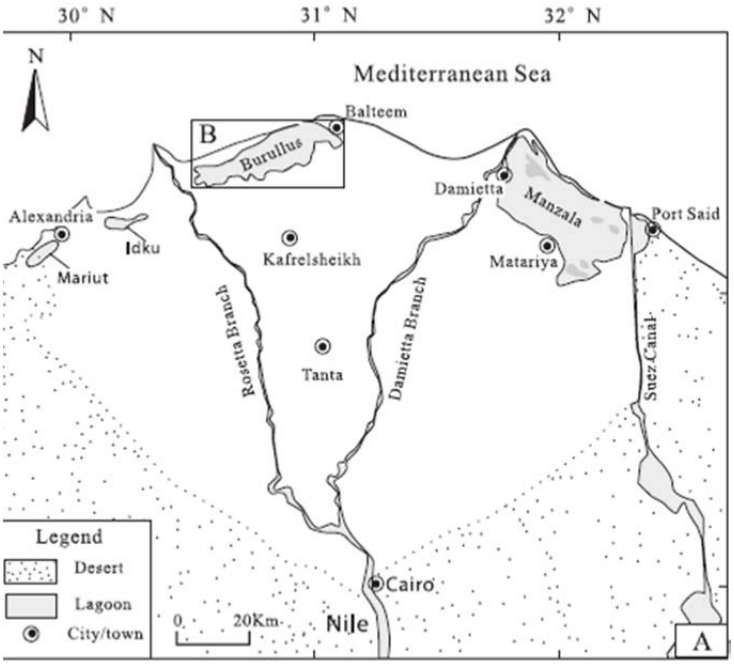
The following report has been written based on monitoring data available at various organisations in Egypt, an analyses of satellite images to assess the land use changes and information gathered about the attitude and needs of the local population through interviews.

Additional water quality data were gathered and analysed by the Drainage Research Institute (of the National Water Research Institute). Dr Suzan E.A Kholief of the National Institute of Oceanographic and Fisheries (Alexandria Office) provided information about water dynamics in the Lake and water quality, Dr Gamal El-Shabrawy of the Fish Research station in El Kanater provided data on fish and water quality and the General Authority for Fish Resources Development provided also data on the amount and species of fish caught, the Coastal Research Institute (Alexandria) provided data on water quantity. Care Egypt was contracted to carry out interviews in the fisher communities to gather information about the attitudes, needs, expectations and living circumstances of the fisher communities. The satellite images to identify the changes in land use in and around the Lake were analysed by TerraSphere (Amsterdam).Valuable support was provided by my colleagues Ir. Peter van der Heijden (aqua culture expert) and Ir. Koen Roest (water quality expert).

An overview of the experts and organisations contacted and spoken with in the frame of this project is to be found in Appendix 1 of this report.

At this place I would like to extent my gratitude to Professor Dr Moustafa Fouda, advisor to the Minister of Environment in Egypt and to Dr Hans van der Beek, the former agricultural councillor at the Netherlands Embassy in Cairo who provided ongoing support to this project.

1 Introduction to Lake Burullus[2]



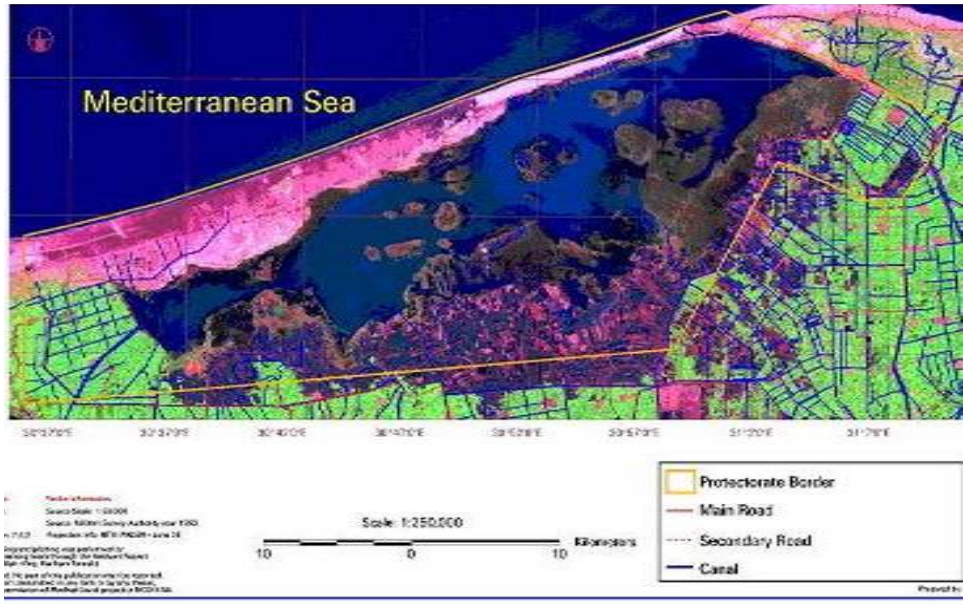
Map 1: Location of lake Burullus.

Lake Burullus is one of Egypt's most important wetlands offering a wide range of ecosystem services. These services include capture fisheries to provide fish for the local market and jobs for the local fishermen but also the purification of polluted water from upstream agricultural lands and of untreated waste water from towns scattered around the Lake before the water is being discharged into the Mediterranean. Further, local people use the Lake for gathering medicinal plants, for reed harvesting and for cattle grazing. Last but not least the Lake is important for protecting biodiversity and especially for offering shelter and food for migratory water birds. This last aspect was the reason for designating the Lake in 1988 as a Ramsar site; a wetland of international importance under the Convention for the Protection and Wise use of Wetlands of International Importance. (Date of Designation; 9-9-1988). Ten years later, in 1998 (decree 1444) the Lake was declared a protected area by the Prime minister.

Currently the Lake features on the so called Montreux List of the Ramsar Convention because key elements of the reasons why the wetland was designated as a wetland of international importance are under threat. In the terminology of the Ramsar Convention there is concern that "changes in ecological character occurred, are occurring or are likely to occur". This implies that the site is likely to be deleted from the list of wetlands of international importance. The pollution of the Lake by pesticides and nutrients used in agriculture upstream of Lake Burullus and the lack of sufficient water purification facilities for sewage water from the towns and settlements scattered around the Lake are mentioned as the main reasons for the deteriorating water quality. A Ramsar Monitoring mission was carried out in 1991 and the report of this mission recommended the government of Egypt to take appropriate measures and to submit an application to the Ramsar Wetland Conservation Fund to facilitate the initiation of a number of urgently

[2] Much information in this chapter is derived from the report: "Lake Burullus" (Burullus Protected Area) by Kamal H. Shaltout and Magdy T. Khalil (Publication no. 13 of the National Biodiversity Unit, 2005.

required measures. Now, 22 years later, the conclusion can only be that the situation has further deteriorated dramatically.



Map 2: Lake Burullus with the border of the Protectorate (Management Plan 2002).

Lake Burullus holds a wide diversity of wetlands habitats, ranging from fresh water swamps and reed beds in the south, to salt marshes and mudflats in the north. Sand dunes dominate the sand bar separating the lake from the Mediterranean sea. It is important to note that these sand dunes and the coastline are included in the protected area.

In 2002 a management plan was elaborated and approved, funded by the UNDP through a GEF Programme. This management plan is still astonishingly accurate in the description of processes that are threatening the ecological integrity of the Lake. It provides a systematic analyses and overview of the ecological values of the Lake and the processes that are putting both the ecological status as well as the livelihoods of the local population at risk. Based on the evaluation of the trends and status of the Lake the plan proposes a number of tangible and concrete proposals to stop the down going spiral and to restore and maintain the ecological services the lake provides. Now more than 10 years later it can be concluded that the management plan and the activities it proposes have not led to the desired results. The trends are still the same and the ecological condition of the Lake has further deteriorated. This is not because the management plan is unclear but mainly because the sharing of responsibilities for the implementation of the management plan is the unclear and because of the lack of law enforcement. The overall impression is that incompetence and a lack of willingness of the responsible authorities to cooperate is the main reason for the deterioration of the Lake's state at such a rapid pace. It therefore makes little sense to draft a new management plan as long as the willingness, capacities and sharing of responsibilities between the responsible authorities on the protection of the Lake has not been guaranteed. A Memorandum of Understanding between all parties involved in the management of the lake clarifying the will to cooperate and agreeing on the sharing of responsibilities is a precondition before starting the discussion about the drafting and implementation of management and restoration activities. In 2012 a Cooperation Protocol between the Ministries of State for Environmental Affairs, the Ministry for Scientific Research and Technology, the Ministry of Agriculture and Land Reclamation and the Ministry of Irrigation and Water Resources was prepared "for the rehabilitation of the Lake" but the current status is unknown (see also chapter 10).

A clear example of the lack of cooperation and lack of an effective governance structure is the fact the General Authority for Fisheries Research (GAFRD) under the Ministry of Agriculture and Land Reclamation is issuing permits for the construction of fish ponds within the borders of the Protectorate which are in violation with the legislation that applies to the Protectorate and for which the Ministry of State for Environmental Affairs is responsible.

The land uses along the shore lines of the Lake have undergone significant changes over the past decades. While the surface of irrigated agriculture has decreased substantially the surface of aqua ponds have increased significantly; starting from close to zero hectares around 1980 up to 33.660 hectares in 2011. This massive increase has had considerable impacts on the other ecosystem services especially on the biodiversity, on the capture fisheries and consequently on the local food security and livelihoods.

According to the management plan the Protectorate covers an area of 46.000 hectares but calculating the area following the border on the maps of the Protectorate this should be 126.000 hectares. Possibly the management plan refers to the size of the Lake. The Protectorate also includes the coast line, the dunes and sandbar north of the Lake. Next to the lack of wardens one of the major problems related to inspection and law enforcement is that the border is not following any recognizable topographical line in the landscape and therefore cannot be traced in the field. Nobody actually knows where the legal provisions of the Protectorate start to be applicable.

The size of the Lake has significantly decreased over the years also since it was designated as a Protectorate. Before 1980 the Lake was gradually reduced in size due to the reclamation of shallow parts especially along the southern shores first for agriculture but increasingly since 1980 the establishment of aqua culture ponds. It is estimated that the Lake's surface in 1810 was 1092 km^2. Based on an analyses of satellite images carried out in the frame of this project the surface is 52.898 hectares including 16.828 hectares of reed beds and 3506 hectares of marsh vegetation. See further chapter 7.

If the current trend of deteriorating water quality, decreasing open water surface, dwindling fish stocks, deteriorating fish quality and the loss of biodiversity is not stopped, the Lake will lose its capacity to provide one or more of its important services and not only the wildlife will suffer but also the local population will be devoid from her most important source of animal protein while the fishermen will lose their jobs.

1.1 Summary of current trends

- The capacity of the Lake to purify waters is decreasing. According to the publication "Lake Burullus" (Burullus Protected Area) by Kamal H. Shaltout and Magdy T. Khalil (Publication no. 13 of the National Biodiversity Unit, 2005) the water quality[3] of the Lake is under stress because of the discharge of waters from upstream agricultural areas and from non-purified sewage water from the villages and towns around the Lake. However no further data are provided. The capacity of the Lake to purify the water through natural processes is decreasing because the shrinking surface results in insufficient water volume to cope with the pollution. Ultimately the deteriorating water quality of the Lake will have a negative impact on the quality and quantity of the fish caught and on the quality of the water discharged into the Mediterranean. Further the deteriorating water quality will have a negative impact on the health situation of the people living around the Lake and on the health situation of the cattle grazing along the shore lines of the Lake and on the islands (see chapter 6).

[3] Water Quality refers here to the biochemical condition of the water including nutrient levels, heavy metals and residues of pesticides but excluding salinity levels. The salinity level will also need to be determined conclude whether the water is brackish, salt or fresh.

- One of the most important trends is the increase of aquaculture ponds. The expansion of the aquaculture goes at the expense shoreline habitats. The shorelines and of the numerous islands in the Lake are used for grazing cattle. No information is available about the impact of the expansion of aquaculture on this activity but it seems apparent that the grazing possibilities and the possibilities to harvest reed along the shores has decreased and has had a negative on the local livelihood (chapter 7).
- Expansion of the aquaculture decreases the possibility to harvest medical plants which can provide an important source of income for the local population. To what extent medical plants are actually contributing to the local economy could not be estimated nor confirmed; the majority of the people living around the lake depend on fishing and/or crop cultivation.
- The expansion of the aqua culture, the expansion of reed in the Lake and the silting up of the bottom of the Lake by detritus decreases the retention capacity of the Lake. The retention capacity is particularly important in view of the expected sea level rise which will increase the chances of flooding of the vulnerable coast of Egypt. Because of its surface the Lake offers the possibility to retain significant volumes of water which would decrease the immediate threats of flooding of the adjacent low laying areas including the towns and villages around the Lake.
- The decreasing Lake surface and especially the disappearance of shoreline vegetation has significant negative impacts on the biodiversity of the Lake. The reed beds and shore lines are particularly important for migratory and breeding birds for which the Lake is one of the most important areas along the Mediterranean coast (Important Bird Area (IBA) according to Bird Life International). But also rare species of herpeto-fauna (amphibians) and rare plant species disappear because of the creation of aquaculture ponds.
- The Lake has a potential to create some additional income from tourism especially along the coastline at Baltim village. The Lake offers opportunities to organize bird watching tours and some simple nautical activities but the potential to develop this kind of activities and to develop additional income for the local population are negatively impacted by the expansion of the aquaculture and the deterioration of the water quality of the Lake.
- The amount of fish caught in the Lake and the quality of the fish is under stress because of the deteriorating water quality, the increasing number of fishermen, the decreasing surface of the Lake and the catch of fry to populate the aqua culture ponds. All these trends will ultimately lead to decreased yields of capture fisheries and consequently lower incomes of the local fishermen and declining quantities of fish on the local markets. Because fish is the main source for animal protein in the diet of the local population the declining fish yields will have a negative impact on the local food security. Data about the amount of fish produced by the aqua culture ponds are not available (see chapter 3).
- According to various sources the aqua culture ponds are predominantly owned by families living outside of the area and the revenues as well as the yields from the fish ponds are transported out of the area. The massive increase of the aquaculture is not only leading to an imbalance in the ecosystem services of the Lake but is in addition a source for growing social in-equality and social unrest.
- Because of the trends presented above the livelihoods of the fishermen are at risk. The fishermen are inadequately organized and lack the power to defend their stakes despite some attempts to get the attention of the responsible authorities see also Egyptian Gazette date 27-07-2011 in which reference is made of a delegation of fishermen to the Governor of Kafr el Sheikh. The article also refers to the fact that the open water of the Lake is more and more divided into blocks which are not accessible for the fishermen. On 11-05-2012 the Land Center for human rights organized a meeting in Cairo titled: “The rights of fishermen and the management of natural resources in light of the Egyptian revolution". “The workshop will be an open discussion between many of the participants of the fishermen and representatives of trade unions, fishing, and human rights activists and journalists on the management of natural resources and the rights of fishermen in their programs of presidential candidates and visions of potential members of the Constituent

Assembly to prepare the Egyptian constitution and we hope to answer the workshop for a number of questions of consciousness and the vision of presidential candidates."

1.2 Exploitation of the ecosystems services

The current process is an example of a process that is described in the millennium ecosystem assessment. Over-dependency and over-exploitation of one service, for instance reclamation of the Lake for aquaculture, may easily and suddenly lead to an undermining of the ecosystem's capacity to provide other functions/services (e.g. biodiversity, water storage, flood regulation, fish catch and water purification), and jeopardizes the sustainability of the Lake itself, ultimately leading to the collapse of its capacity to provide one or more services. Hence it is argued that an imbalance in Ecosystem Services leads to reduced resilience of wetland ecosystems and their ability to operate and cope with shocks, such as extreme weather events due to climate change. In elaborating responses it is necessary to seek to accommodate as much as possible the plural demands by society on the lake's ecosystems, which in turn requires maintaining for stakeholders, not just for sustainability reasons, the diverse ecosystem services the Lake provides. What the outcome will be and how to strike the balance will differ from case to case as this will depend on (i) the biological and a-biotical features and capacities of the Lake's ecosystem, (ii) the drivers and pressures on the Lake's ecosystem (including impact responses), and (iii) the governance system, the priorities and the choices at national and local level. For this purpose a DPSIR analyses will be carried out at the end of this report to support the identification of response strategies to the current trends.

The current process is an abuse of the several international conventions Egypt has signed up to including the Convention of Biological Diversity, the Ramsar Convention and achieving the UN Millennium Development Goals to which Egypt also committed itself.

1.3 Management challenges

Local traditions, the relatively high rate of population growth, illiteracy especially among women, unemployment and a low proportion of women in the work force all have implications for the quality of the Lake and its management.

- Activities such as bird catching, though no longer an economic necessity, may persist through tradition and poverty,
- Population growth puts further stress on already over-exploited resources,
- Illiteracy puts greater challenges on public awareness campaigns, and participation by local people in management events and activities,
- Unemployment extends the challenge of finding alternative opportunities,
- Women have a vital role to play in many aspects of the acceptance and implementation of management for El Burullus.

2 Management plan and management responsibilities

Following the designation as a protected area in 1998, a management plan was elaborated and approved in 2002. The plan was elaborated in the frame of the GEF project "Conservation of Wetland and Coastal Ecosystems in the Mediterranean region", funded by the UNDP. Although it should have been updated in 2010 this plan is still actual and strikingly accurate in its analyses and proposals for management activities. It was edited by Professor M. Kassas, who died in 2012 and who is one of the most outspoken and well known and respected conservationist in Egypt and who devoted a big part of his life to the protection of Lake Burullus.

A significant part of the information in this chapter is derived from the management plan. The objectives of the management plan are:

- to restore pristine ecological and landscape values,
- to maintain and enhance ecological and landscape values,
- to conserve the Burullus resources through sustainable management,
- to improve socio-economic opportunities for local people, and
- to develop public awareness for nature conservation.

These objectives are supposed to be achieved by 2010 through the establishment of "effective institutional arrangements" and an investment of $ 5.650.000.

The Protected Area is under a mixture of State- and private-ownership. Most agricultural and dwelling areas are owned by individuals (private sector). The rest is owned and managed by the local administrative authorities represented by Kafr El-Sheikh Governorate and its subordinate municipal Councils of Districts and Local Units.

2.1 Organizational aspects

The Ministry of State for Environmental Affairs of Egypt is bearing the overall responsibility for the protection and management of the Lake as a Protectorate. The Ministry has established a local management body that is responsible for management and inspection of the protected area. The management organisation employs about 20 wardens who carry out basic monitoring activities but also have the mandate to address violations against the law. The manager's office is at the office of the governor of the Governorate Kafr El Sheik, under which Lake Burullus resorts administratively. In practice the governor is overseeing the management of the Lake and intervenes on behalf of the Ministry in infringements and disputes with respect to the Lake. The governor is also the chair of the "cross sectoral management committee" while the manager serves as the secretary of the management committee. All stakeholders are represented in the cross sectoral management committee but during the last years no meetings of the committee have been convened.

Members of the **cross sectoral management committee** include the following organizations:

- The Governor of Kafr El Sheikh (Chairman),
- The Secretary-General of Kafr El Sheikh Governorate (Vice-Chairman),
- The MedWet Coast Project Manager,
- The Director of Lake Burullus (representing the Ministry of Agriculture),
- The Manager of the Protectorate (Secretary), (contracted and paid by the Ministry of State for the Environment.

and the local representative of each of the following institutions:

- The Ministry of Health,
- The Ministry of Housing and New Communities,
- The Ministry of State for the Environment,
- The Coast Guards (representing the Ministry of Defense),
- The Police Force (representing the Ministry of Interior),
- The Chief of Fishermen Co-operatives.

An **executive committee** headed by the Manager of the Protectorate will assist the management committee and bears the following responsibilities:

- implement the directives of the Management Committee,
- carry out the day-to-day tasks of patrolling,
- report to the Management Committee on all new developments in and around the site.

An **Advisory Committee** comprising all relevant stakeholders, including representatives of relevant ministries, representatives of NGOs, representatives of local communities and fishermen associations, was designated. The Governor of Kafr El Sheikh chairs the Committee that has been given a legal status through Governorate decree - issued with their structures and functions. The Committee ensures the participation and the involvement of concerned stakeholder groups in the decision making process.

2.2 Responsibilities

The Governor is the single most influential stakeholder at the local level. It has its own Environment Office, Local Administration Councils and Investment Council. The latter institution plays an important role in the approval and allocation of land for development projects.

The Coast Guard, which falls under the jurisdiction of the Ministry of Defense, is responsible for security and controls all illegal smuggling activities along the coast (which forms the northern border of the Lake).

The Water and Environment Police (falling under the Ministry of Interior) enforces fisheries and environmental regulations, such as restrictions concerning hunting, fishing and quail netting within the protectorate. There are two police stations on the Lake shores and a third is under construction.

Ministry of Housing and New Communities

This Ministry has constructed an international coastal highway between Sallum (on the border with Libya) and Rafah (on the border with Palestine), which traverses the protectorate from east to west. Part of the highway is a bridge over the Bughaz and the highway cuts through the entire sand bar that divides the lake from the Sea lengthways. This highway is rapidly attracting new inhabitants and settlements to the area. The Ministry holds also responsibility for issuing and control of permits for the building of houses. The environmental impacts of the increase in human activities on either side of this highway are yet to be properly assessed.

Ministry of Health

The 'Directorate of Public Health' in Kafr El-Sheikh Governorate is responsible for health issues affecting inhabitants of the Burullus Protected Area.

Ministry of State for the Environment

The Nature Conservation Sector (NCS) of the Egyptian Environmental Affairs Agency (EEAA) has the ultimate legal responsibility for the proper management of the Protected Area and its resources.

Ministry of Agriculture

The local branch of the General Authority for the Development of Fisheries Resources (GADFR), Ministry of Agriculture is responsible for the management of the Lake's fisheries. It issues permits for the establishment of fish farms (aqua culture ponds) in among others the Protectorate and it issues permits to the local fishermen and the boats used for fishing on the Lake. The Ministry of Agriculture determines the distribution and area of rice cultivation in the Nile Delta and fines farmers violating the instructions by exceeding the limits of areas allowed for this crop. Consequently, this Ministry controls to a large extent the amount of drainage water flowing into Lake Burullus.

Ministry of Irrigation and Water Resources

This Ministry is responsible for water resource management and the maintenance of all watercourses in the country. It is also concerned with the volume of water in the Lake as it might limit the likely sea water intrusion into the Delta. It is also responsible for amount of water that flows into the Lake.

A number of non-governmental organizations in the Kafr El-Sheikh Governorate also play a key role affecting land and resource use in the area. Four of these are mainly concerned with local community development and a further six are fishermen's cooperatives. A recent addition to the list of local stakeholder groups is the 'Charity Association for Environmental Protection'. These organizations are not involved in management decisions.

2.3 Conflict of interests

The lack of co-ordination between the responsible authorities, the unclear division of responsibilities and the conflicts between different institutions are serious impediments to effective management of the Protectorate. Insufficient penalties for violation of existing laws (especially illegal fishing and bird hunting) are not only a constraint for effective management but might even encourage such violations. But most violations happen unnoticed and remain without punishment because of a sheer lack of inspection and law enforcement. There is also a considerable lack of legal awareness among some of the stakeholders and major players in the Protectorate. According to the management plan effective management of the Protectorate is also impacted by conflicting and insufficient legislation, which makes law enforcement even more complicated.

The issue of the lack of coordination and unclear responsibilities is also acknowledged by the authors of the management plan. The management plan devotes specific attention to the improve the sharing of responsibilities and to improve coordination between the responsible authorities and organisations and the tuning of planned activities and permitting issuing impacting the quality of the Lake. For this reason the Cross Sectoral management Committee and Advisory Committee have been established however without any improvement in the management.

A clear example of the lack of coordination is the fact that the General Authority for Fish Resources Development (under the Ministry of Agriculture and Land Reclamation) is issuing permits for the construction of aqua ponds within the boundaries of the Protectorate in violation with the legislation that applies to the Protectorate and for which the Minister of State of Environmental Affairs bears the responsibility.

Also the issue of Law Enforcement is touched upon in the management plan. The following steps to improve law enforcement are proposed:

- organize series of lectures and panel discussions on legislative instruments operative in the Protected Area, audience may include members of the Management Committee, Councils of the

Kafr-el-Sheikh Governorate and the five concerned districts (marakez), senior members of the departments of local government,
- revise and resolve conflicting elements of the legislation, close loop-holes through which violations may escape punishment, and provide the managers of the Protected Area and their partner stakeholders with support of law,
- develop guidelines for defining roles and responsibilities of institutions participating in management of the Protected Area, and for integrating the roles of institutions that issue licenses for fishing, hunting, boats, etc,
- develop facilities available for law-enforcement bodies: the manager of the Protected Area, the Water Surface Police Force, police stations to be increased from the present number of 2 to 3 - 4, increase the number of boats available for monitoring and policing, etc,
- set and enforce quotas, including timing of fishing, the purpose is to minimize stock depletion and to sustain ecological equilibrium, this should be based on sound scientific inventories.

At national level a Supreme Committee for integrated wetlands and biodiversity conservation was established through a ministerial Decree (# 2649) of the prime Minister issued on 29th November 2007. This Committee is chaired the Minister of Environment, with membership of representatives of many governmental institutions, private sector, scientists and NGOs (e.g. Egyptian Environmental Affairs Agency, Nature Conservation Sector, National Center for Water Research, Ministry of Housing, National Institute for Oceanography and Fisheries, National Authority for Remote Sensing, Ministry of Agriculture and Land Reclamation, Ministry of Health, General Authority for Tourist Development, Ministry of Economic Development, Ministry of Local Development, Ministry of Interior). The Supreme Committee will oversee the implementation of the national plan and its programmes, review policies and plans for sustainable development of wetlands, provide financial mechanisms for supporting the implementation of the national plan of action, and coordinate national actions related to Ramsar convention.

The first meeting of the Supreme Committee was held in March 2008 but no further information is available on whether more meetings have been held and what the results were.

2.4 Cooperation Protocol 2012

In 2012 a Cooperation Protocol between the Ministries of State for Environmental Affairs, the Ministry for Scientific Research and Technology, the Ministry of Agriculture and Land Reclamation and the Ministry of Irrigation and Water Resources was prepared “for the rehabilitation of the Lake” but the current status is unknown. The text of the Cooperation Protocol does not present clarity about which Ministry will have the leading role in the implementation of the Protocol; the text refers only to the importance of cooperation and the Egyptian Environmental Affairs Agency, the Institute for Oceanography and Fisheries, the Remote Sensing Authority, the General Authority for Fish Resources Development and the Water Research Center (Coastal Research Institute) are mentioned as the implementing agencies again without indication of who is coordinating. The lack of involvement of regional organisations including the Governate is also striking.

The protocol was prepared by the Egyptian Environmental Affairs Agency to bolster cooperation between 4 Ministries with the aim to build “a bridge of cooperation between scientific communities and decision-making for rehabilitation of the northern lakes and manage it in sustainable development way and to maximize economic returns”. An annex to the Protocol presents more detail about the aims and activities of the cooperation (see chapter 10).

3 Ecosystem services and livelihoods

3.1 Livelihoods

Lake Burullus is located within 5 districts of the Governorate (from east to west: Baltim, El-Hamoul, El-Riad, Sidi Salem and Metobes), with a total population of 965,220 individuals. (2002 data) Baltim district has the largest population mostly concentrated in the town of Baltim (37,300 individuals). In addition to Baltim town, there are 15 villages belonging to 6 Local Administrative Units from the 5 districts with parts of their areas lying inside the Protected Area.

The total population living within the Protected Area was 171,700 in 1996 and 188,900 in 2001, an average annual growth rate of 2%. The number of males is consistently slightly higher than the number of females. Illiteracy is relatively high for the inhabitants of the Protected Area, but it is always much higher among females (57.5% - 89.9%) than that of the overall population of any village or town (30% - 79.8%). The average total unemployment in the 15 villages and Baltim town in the Protectorate is relatively low (8.5%) compared with other parts of the Governorate, but it is much higher for women (23.4%). The sharing of women in the labour force of the area is remarkably small (6.7%).

Most of the labour force within the Protectorate is working in agriculture, fishing and hunting, with only a small minority working in industries such as boat building and repair, mechanics or in various services.

The infrastructure for providing basic social and medical care and education is weak and limited to the towns. The average family size is between 6 and 8 persons.

Baltim city and Bourg el Burullus are the two biggest towns surrounding the Lake holding approximately 50 % of the population. Most people still live from fishing on the lake. The cultivated area per capita in the governate is twice as high as elsewhere in the delta. (0,24 feddan per person and Egypt 0,11 feddan).

The Northern parts, near the outlet to the sea, seemed to be more well-off than the other areas in the South and West. In general the fishermen villages visited seemed over crowded, with houses built without urban planning and with stifling proximity to one another. The buildings vary between huts made of reeds dwelled by the very poor to houses made of cement in various sizes relative to the wealth of the owner. But the majority of houses seemed simple two story houses, small but made of cement.

The roads leading to the fishermen villages are paved for the most part and seem to satisfy the immediate needs of the fishermen. However, the streets within the villages are mostly narrow, poorly paved and turn muddy and slippery during the winter showers.

The villages visited during the research carried out by CARE for this report enjoyed tap water in the houses, although there were complaints that they may suffer water cuts for hours. For sewage they use pit latrines. They enjoy electricity as well.

There are local schools although like the rest of rural Egypt there are complaints from both parents and teachers. Both parents and students complaint against the quality of education and are mostly skeptical about the value of education when there are limited job opportunities[4]. Teachers complaint that students lack manners and do not seem interested in education while realizing they can earn money from the Lake.

[4] Mostly meaning desk job and jobs with government entities.

The nature of the work and living around the Lake is asking its toll of the health of fishermen who usually suffer early bone pains. They mostly have to stop working around the age of 50. In addition the health services are said to be poor. There may be hospitals, but these receive little trust from the fishermen and lack many basic hygiene, qualified medical care personnel, tools and equipment. The hospital in Menyet el-Morshed is not functioning, according to fishermen. The hospital in Burg El-Burullus was renovated through local community mobilization. But the physicians working there are said to be reluctant to offer good service. Most fishermen are resorting to private medical care service providers (physicians) for those who can afford it, and those who are unable to afford it either endure their ailments in silence or seek treatment at hospitals in major towns.

There are also many community development associations; more than 25; who are affiliated to the Ministry of Social Justice and Solidarity, working according to Law 84 of year 2002. However, these tend to act as charity organizations rather than community development organizations. They collect money from the rich and buy items for the poor; e.g. blankets in winter, or give amounts of cash to cover household expenses to orphans and female-headed households. At least one such organization has expressed interest in acquiring new skills and concepts to adopt a more developmental approach towards the community in cooperation with CARE Egypt.

3.2 Fisheries

Fishing is the leading economic activity in the Protectorate. Fish production from the Lake increased strongly from 1980 to 2000 from just 7,273 tons in 1982 to 59,400 tons in 1996. It remains high with 55,300 tons and 51,768 tons taken in 1999 and 2000 respectively. The latest data on fish production for 2011 shows a dramatic decrease to about 41,000 tons. The increase in the catch is the result of an increase of the number of fishermen and boats and a more intensive catching effort rather than the result of improved productivity.

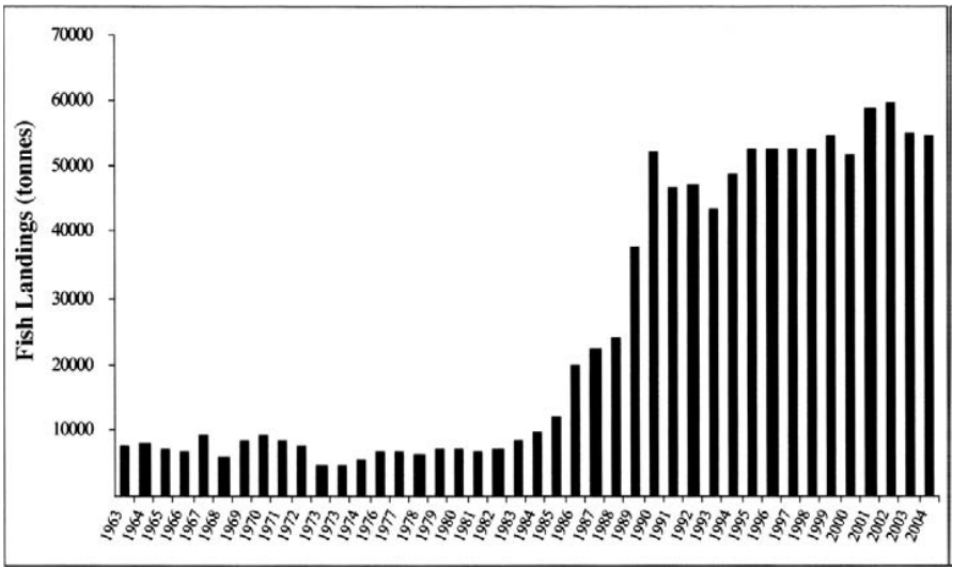
The number of fishermen increased from about 9,000 in 1963 to about 21,600 in 1993. In 2000 there were approximately 28,000 fishermen working on the Lake, of whom only 10,266 were licensed. The number of licensed boats also increased from 2438 in 1963 to 7277 in 1993 and 9665 in 2000. Of these, only 153 are motor boats and the rest are classified as third class boats of three types: the samboak (the smallest), the feluca (medium-sized) and the sailboat (the largest).

According to data from the GAFRD at the moment (2012) there are 65.000 fishermen fishing on the Lake while about 8000 boats have been licensed. The Egyptian Gazette (27-07-2011) mentions 100.000 fishermen and their families being dependent on the Lake for their livelihoods.

The most common boat types used are sambouk and felouka types carrying between 1 to 5 fishermen. The sailing boats can carry up to 8 fishermen. It is said that there could be at least 25000 boats operating in Burullus (CARE Report).

According to data gathered in the research carried out by CARE only about 12% of the fishermen are estimated to be licensed and observing the renewal of their license[5]. Fishermen pay social insurance and taxes as prerequisites for obtaining their fishing license. The annual subscription / fee for social insurance is low and so is the pension itself (below 2 dollars a day). The fishermen seem to not really appreciate the importance of social insurance until they reach pension age. Fishermen complain against the income taxes which depend on subjective estimations. There are complaints of severe variations between similar cases in the estimation of their dues.

The annual catch per fisherman increased from about 0.8 tons in 1963 to about 2.0 tons in 1993 and then decreased to about 0.9 tons in 2000. Likewise, the annual catch per boat doubled from about 3 tons in 1963 to about 6 tons in 1993 and then declined to about 4.3 tons in 2000. Dividing the fish caught in 2012 by the estimated number of boats would mean an average catch of 1.64 tons per boat per year in 2012. The variation in the yield per boat per year can be explained as follows: when the fishing intensity increases, the fish stocks decline as does the amount of fish caught. The next year the fishermen respond by decreasing their fishing intensity the following year allowing the fish stocks to recover and the process tarts all over again. This is a major issue for the livelihoods along the Lake and is a major source for instability not only of the lake ecosystem but also for the socio-economic situation of the livelihoods around the Lake.



Graph 1: Increase of fish yields in Lake Burullus (Source: Lake Borullus of the Nile Delta: A Short History and an Uncertain Future; Author(s) :Henri J. Dumont and Gamal M. El-Shabrawy; AMBIO: A Journal of the Human Environment, 36(8):677-682. 2007. Published By: Royal Swedish Academy of Sciences).

The income from fishing is decreasing, because of the reduction in fish quantity and quality. The CARE study team observed that fishermen in East and South Burullus may be better off than those in the West and they seem to earn enough daily income from fishing to meet basis needs. Whereas in Mineyt al-Morshid, fishermen seemed to suffer worse conditions. The study team has witnessed 8 fishermen coming back from illegal fishing practice (a tahaweet) and carrying with them around 50 kg of illegally small size tilapia fish; at an estimated price of 2 to 2.5 EGP/Kg. Another fisherman in Mineyet al-Morshid

[5] One of the Fishermen Chiefs showed the study team of CARE around a hundred and fifty renewed licenses which had not been claimed by their owners for a month; while indicating that hundreds more do not bother renew nor issue a license.

indicated he stops fishing from mid-December through end of February, gets into debt, and fishes the remainder of the year to earn a living and pay off debts.

The average size of the fish caught in the Lake has declined. In 1992 about 65% of the total catch of tilapia was categorized as small, 25% as medium and only 10% as large. Thus, although the total tonnage of fish caught in the Lake has grown over the past three decades, the value of the catch in terms of quality, size and revenue has declined. The decrease in seize is a sure sign of overfishing; yields of 1000 kg ha-1 are indeed extremely high and not sustainable in the long run. However, the high amount of fish caught may have contributed to keeping the Lake from turning hypertrophic because of the removal of nutrients along with fish biomass. (El Shabrawy, Gamal and Mohammed E. Goher, New York, 2011). Over-exploitation of fish stocks is exacerbated by illegal fishing practices, and by taking fry illegally at the al Boughaz inlet to supply the fish farms.

Generally, fishermen like to compare the current situation to the situation in 2005 and 2006 when there evidently were more high value fish; e.g. mullet and sea bass. The current production of the Lake is mostly tilapia, with catfish and grass carp (especially in the South and Western areas) and reduced production of mullet in the North East. GAFRD figures confirm this as it shows high yield of high value fish such as shrimp, mullet and Nile perch in 2006. This is possibly attributed to the management activities carried out under the "Project for the Conservation of Wetlands and Coastal Ecosystems in the Mediterranean Region MedWetCoast" which helped to clear the Primbal canal introducing fresh Nile water to the Lake and helped dredge the Boughaz inlet allowing more exchange with the Mediterranean. It also supported the police force with the purchase of 2 motor boats.

The nutrient enrichment has played a major role in the changes of the trophic status of lake Borullus and appear to have a much greater effect on the primary producers than changes in the salinity. The comparison of the basic dissolved nutrient salts in the water of Lake Burullus from 1987 to 2004 showed that a notable increasing in most nutrients more than earlier recorded.[6]

(See chapter on water quality for more information).

The present fish population in Lake Burullus consists of 25 species, 15 of which live in fresh or brackish water. Of the remaining 10 species, four (*Sparus aurata*, *Johnius hololepidotus*, *Solea solea* and *Liza saliens*) are of purely marine origin which invade the Lake for some time. The remaining six species (*Aphanus fasciatus*, *Atherina mochon*, *Anguilla anguilla*, *Mugil cephalus*, *Liza ramada* and *Gambusia affinis*) belong to a separate group of obligatory migrants which spend their adult life in the brackish water of the Lake and migrate to the sea for spawning (Goher, Mohammed El-Sherif (2009).

The composition of fish caught clearly shifted from mainly euryhaline and marine species to fresh water species, particularly tilapia. In 1964 approximately 45% of the catch was tilapia, 25% shrimp and crab, 20% mullet and 10% catfish. This pattern changed from 1991 onward into nearly 75% tilapia, <10% shrimp and crab, 10% mullet and <10% catfish.

For the estimated 65.000 families of fishermen, or about 250.000- 300.000 people, fishing is the main source of income. The fish caught in the lake is all sold on local markets; local in this respect meaning mainly the Governate Kafr El Sheikh. Estimates indicate that around 600,000 people depend for their animal protein on the fish caught in the lake.

[6] Mohamed El-Sherif Mohamed Goher; National Institute of Oceanography and Fish., Fish Reasearch Station, El-Kanater El-Kharia Cairo; Chemical assessment of water quality and some heavy metals in Lake Borullus (Egypt); Acad. Soc. Environ Develop 10-4 (2009).

3.2.1 Fishing methods

Three main fishing methods are employed in Lake Burullus. They are Trammel nets, Gawabi and Hosha.

Trammel nets
These are 3-layered entangling nets commonly used to catch different fish species including cichlids. Two types of trammel net are used in Lake Burullus. The Nasha type is about 60 cm high with a mesh number of 14-17 per 50 cm for the inner layer and 5-6 per 50 cm for the outer layer. The Khanayen type, on the other hand, is 40 to 50 cm high with a mesh number of 20-22 per 50 cm for the inner layer and 7-8 per 50 cm for the outer layer. Trammel nets are used with and without sound stimulus.

Traps
Known locally as Gawabi. These are cylindrical basket traps made of galvanized wire net with an open cone at one end for the passage of fish and a set of claps at the other end from which the catch is removed.

Hosha
This is an enclosure built in the lake by erecting low dykes made of mud and straw, with one or more narrow openings. Fish swim into the Hosha and the openings are periodically closed. The Hosha is then pumped dry and the fish harvested.

3.2.2 Opinions of the fishermen in 2000

In October 2000 a survey was carried out to gather information about the position of the fishermen. (Source: Untitled publication (PDF); authors and date of publication unknown). The majority of the respondents were fishermen, farmers, fish merchants and fish brokers (middle men). Theses Interviews were undertaken in fourteen villages. These villages are El bourg, Souk Eltalat, El Kom Lahmar, El Shorafa, Matrowa, Elmaksabah, Hanafi Elkobra, Shihab Eldin, Elbanaien Elsharkia, Elaaqula, Abousalah and Imad.

The respondents had a rather negative impression of the impact of the fish ponds on their fishing activities as is shown in the following answers:

- Fish farms cause pollution to the lake water through draining their polluted water into the lake (100%),
- Fish farms need a great amount of employees especially for guarding (76.5%),
- The expensive feeding in case of applying dry fodder (52.9%),
- These farms motivate the fishermen to practice illegal fishing of fish spawn from the inlets, where fishing net of these spawn is sold at a price of about L.E. 75-100. Consequently, this activity is profitable but it causes harmful effects on the lake fish population (47.1%),
- The absence of effective implementation of currently existing legislation to stop the illegal practices of fish farms owners (33.3%). Moreover the fishermen claim that most of the fish farms owners are policemen and judges who are, from their point of view, above the law.

In asking the respondents about their membership in fishermen cooperatives, it showed that 79% of them are a member and 21% are not-members. The cooperative members stated that fishermen cooperative renders some services to them, these services are:

- Rendering fishing requirements on credit,
- Issuing licenses for fishermen and boats,
- Solving problems of fishermen with the local authorities,
- Collecting fees from their fishermen.

The members state that these services are insufficient. In asking them about their problems in dealing with their cooperative, they stated the following:

- Limited capital of cooperative, the matter that adversely affects its performance of socioeconomic services (82%),
- No loans have been rendered to members in disablement and illness conditions (77%) Neglecting health services (64%),
- Inability of the cooperative to protect them (56%),
- Random estimations of taxes without any cooperative role in that concern (32%),
- Complicated managerial producers (27%),
- The cooperative services are in favor of board of directors at the expense of member affairs (25%),
- Collection of fees from fishermen to renew fishing licenses each year without any added benefit,
- Fishing requirements are sold to members in a relatively higher prices (18%),
- The fishermen " heads" lost their leading role in organizing fishing and protecting fishermen (16%),
- Absence of permanent sites of cooperatives in which members can discuss their problems with board of directories (13%),
- Negative attitudes of board of director towards members (11%).

In asking the members about their proposed solutions to the proceeding problems that stated the following:

- Increasing the capital of cooperatives trough raising value of membership shares and specifying a share of the governmental investments to cooperatives in order to develop their performance (78% of the respondents),
- Emphasizing the health insurance for fishermen families (75%),
- Expanding the base of cooperatives services to include medical (health), social, cultural and marketing services to increase their benefits on the one hand and on the other hand to be sure of loyalty (63%),
- Cooperatives should compensate their members in emergencies to reduce the harmful effects of usual and unusual risks (56%),
- Implementation of cooperatives role in solving problems of members and protecting them (55%)
- Rendering the fishing Cooperatives should be in charge of banning fishing young fish spawn close to inlets (43%),
- Simplifying the procedure of licenses and reducing the fees required (32%),
- Reorganizing fishermen cooperatives on the basis cooperative principles, for instance democratic control and services at cost to improve their role in the socioeconomic development.

3.2.3 Results from the interviews in 2012

As part of the project CARE Egypt interviewed fishermen and representatives of the fishermen cooperatives in January 2012.

The major complaints identified by the fishermen around Lake Burullus centered around the following and are very much in line with the results of the interviews carried out in 2000 and presented above:

– Damages caused by aquaculture ponds surrounding the lake. These damages are diverse and very serious to fishermen:
  - The fish farms encroach on the area of the Lake. Those who rent a fish farm often do not observe the buffer zones between the Lake body and the farm and tend to extend their farms further into the Lake,
  - The fish farms discharge their waste water, rich in ammonia and other soil nutrients, into the Lake. This increases the plantation area near the fish farms and raises the Lake soil bed,
  - The discharges from the fish farms further pollute the Lake waters (e.g. with high ammonia),
  - It has developed into a tradition that a fish farmer renting a farm around the Lake prevents fishermen from fishing in the area adjacent to his fish farm.

– The reduction in the size of fishing area due to:
  - Activities to dry parts of the Lake for different purposes, including transforming the dried areas into aquaculture ponds or houses,
  - Increased vegetation in the Lake.

– Water pollution which from the perspective of the fishermen is due to:
  - The 8 drainage canals dumping agricultural, sanitary and some carrying industrial waste water into the Lake,
  - The drainage of the fish ponds.

– The increased levels of Lake waters pollution; has serious effects, including:
  - Health hazards to fishermen (EEAA bacteriology tests confirm that bacteria in the Lake water near the drainage canals are high than acceptable limits, while the number of drainage canals is 8. The most dangerous of these seem Koshtner drainage which carries industrial pollutants from the neighboring Gharbia governorate,
  - Reduction in quantity and quality of fish.

– Abusive practices of fishermen, with poor law enforcement. Such abusive or ill-practices are many with diverse ferocity, including:
  - Catching high value fish-fries at the inlet between the lake and the sea, thus mostly depriving the Lake from such wealth of fish. It should be noted here that fishermen indicated this is due not only to fry catching but also to the pollution of the Lake waters by the drainage canals pouring into it,
  - Forming *"tahaweet"* hoop nets in which fishermen enclose an area with reeds serving as hoops. This is regarded a form of extending control over a certain area.
  - Using motor boats, and trailing nets while both are illegal. When asked what about the efforts of the environment and water police in combating these; fishermen indicated that:
    - The horse power of the illegal motor boats is often higher than that of patrol boats,
    - When a patrol boat identifies a docking motor boat and tries to confiscate it, the general attorney's office would overrule the confiscation and order the boat back to owner,
    - When patrol boats approach the motor boats, they come under attack from the motor boat sailors who use rocks and shattered glass to force the patrol boat or others away from their boat.
  - Using illegal sizes *(mega)* of fishing nets,
  - Fishing without licenses,
  - Sailing boats without licenses or without projecting license details as required by the license.

Fishermen gave accounts of times some 8 years ago when the head of the internal security force responsible for ensuring security in the Lake enjoyed a strong and just personality. He was able to ban the illegal fishing practices: e.g. smaller size nets, the "tahaweet".

- The excessive spread of reeds and other plants that hinder fishing is another cause for concern. Reeds and other plants grow so extensively that they may close the *saradeeb* (i.e. narrow water ways between reed leading from shore to inside the Lake). Fish farmers indicated there are efforts to remove such but such efforts are insufficient.
- Some respondents indicated that large parts of the Lake are controlled or regarded to be the private fishing areas of influential families (although this couldn't be verified by any official).

3.2.4 Social organization of the fishermen

Fishermen Chief in El-Burg holding an award for community service

Fishermen Chief or (Sheikh Sa'yadin) is a Senior level community leader who is officially recognized and is being elected once by fishermen for a life time job. This Sheikh Sa'yadin is responsible for renewal of fishing licenses, and he's also expected to look after the interests of the fishermen. This Chief is officially recognized through GAFRD.

There are around 6 fishermen cooperatives in areas around Lake Burullus intended to serve the needs of the fishermen. Each cooperative has a board of around 11 members including a chairperson (who may be the fishermen Chief), a treasurer, a secretary and a deputy chairperson. All fishermen are expected to be members in one of these cooperatives. However in Al-Burg only 250 out of around 4000 registered fishermen; i.e. around 6% of the members; attend the general assembly meetings. This may confirm what has been said by interviewed fishermen that fishermen do not seem to realize any added value in membership of these cooperatives. On the contrary, they seemed to think that these cooperatives serve the board members more than serving common fishermen. It should be noted however that both the fishermen Chiefs and the chairpersons of the cooperatives met showed interest in serving the interests of the fishermen, and showed evidence of their efforts / activities to advocate the rights of law-abiding fishermen against law-violators.

3.3 Aqua culture

The creation of fish farms along the southern shores of Lake Burullus started around 1980 on abandoned agricultural lands. The pace of building of these aqua culture ponds increased significantly over the following years due to the higher economic output/feddan. The success achieved by the model El-Zawia Fish Farm project launched by the Government early in 1980 encouraged the private sector to follow suite.

Both through their effluent and their encroachment into the Lake the fish farms have a considerable impact on the water quality of the Lake and on the availability of fish caught by the fishermen.

In 2002 it was estimated that fish farms occupied 1346 ha within the borders of the Protectorate, with an annual production of 115,335 tons (source: Management Plan).

Fish farming was always predominantly applied along the southern shores but more recent increasingly along the northern shore. The profitability of the fish farming can partly be attributed to the fact that the ponds are stocked with fry caught illegally caught at the Boughaz (inlet). Taking fry from the Lake has a

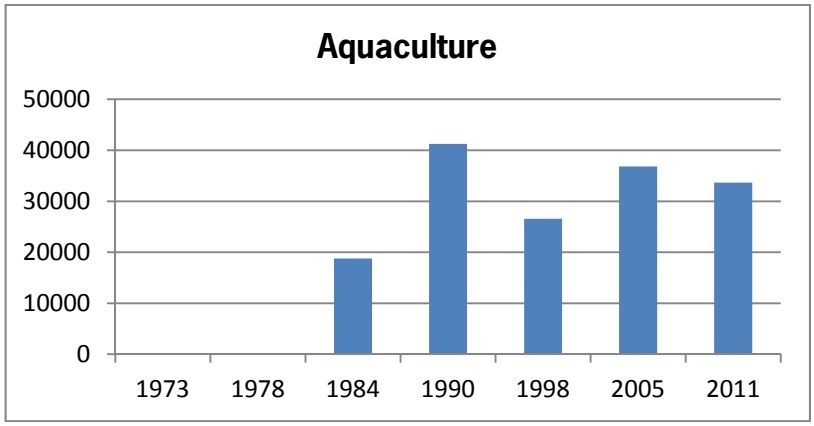
substantial negative impact on the fish stocks in the Lake and reduces the fish stocks available for the fishermen and the availability of fish on the local markets.

An undated report provides interesting background information about the establishment of the aqua culture ponds and their owners. (Unknown author, PDF) The process of creating aqua culture ponds started when the Ministry of Interior gave 4600 Feddans (about 2200 hectares) of the southern part of the lake to leading persons of the Ministry. This part of the lake was promptly transformed into fish farms. Afterwards fish farms proliferated on the southern shore of the lake. Most of these farms obtain their fry from illegally operating gangs who capture the fry from the only existing inlet. One of the major problems the fishermen are confronted with are organized gang raids looting fish fry in the inlet to the Lake. These gangs sell the fry to the fish farm owners. Most of these owners are VIPs Fishermen have filed complaints against these practices leading to arrests but they were released without being sentenced due to strong manipulation and pressure of the fish farm owners. According the fishermen the deterioration of the fish stocks in the Lake are caused by these illegal practices[7].

According to a report by Shaltout Kamal A and Magdy T. Khalil (2005) Hoshas (embanked fish ponds) occupy 12.689 ha along the southern shores of the lake and of this area about 45 % is between 1-42 ha and about 15% between 126 and 420 ha. In addition to 171 licensed Hoshas there are about 1079 Hosha without a license. Together they cover an area of 17.522 ha. A Hosha produces more or less twice as much per in tons/ha as the open water.

Based on an analyses of satellite images in the frame of the current project the following conclusions can be drawn:

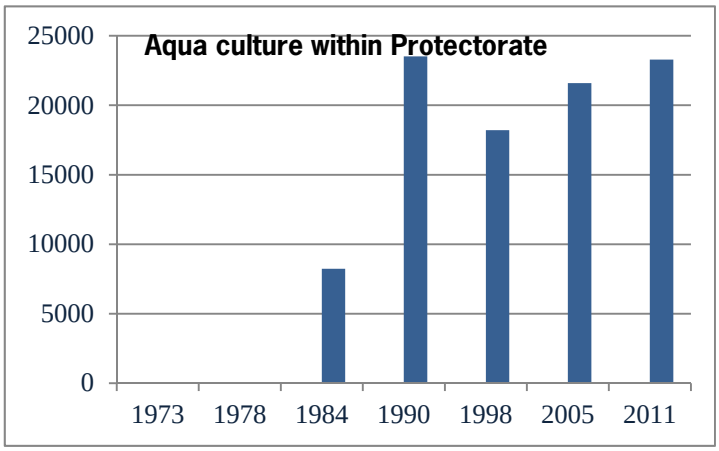
The surface covered with aqua culture ponds reached its peak in 1990 with a total surface of 41.260 hectares, while the surface covered in 2011 was 33.660 hectares.



Graph 2: The increase of aqua culture ponds in and around Burullus since 1973.

Analyses of the satellite images learn that the area covered with aqua ponds within the borders of the Protectorate was 23.521 hectares in 1990 while in 2011 the fishponds covered 23.284 hectares. Basically no increase could be noticed in this past 20 years but the area covered exceeds significantly the area indicated in the management plan of 2002.

[7] Lake Burullus; PDF, Author and Date not indicated.



Graph 3: The area of fish ponds within the borders of the Protectorate.

3.4 Agriculture

Within the boundaries of the protectorate, which includes the lake and the surrounding swamp areas the agricultural production has increased after reclamation but soon these lands were abandoned because of low soil fertility and disappointing harvests. Agriculture in the region underperforms in comparison with other regions; the average yield of rice is about 60% of the national average and the yield of cotton is about 40 % of the national average. Agriculture is therefore not very profitable and it is unclear why; possibly the degree of salinity is the limiting factor. The only profitable crops are guava, berseem and dates.

More than elsewhere also cattle breeding is part of the agricultural activities including buffalo, cow, sheep and goat breeding. The net income per capita earned by life stock breeding also seems lower than elsewhere as can be concluded by data provided in the MP.

According the management plan (2002) there was only 7,590 ha under cultivation within the limits of the Protectorate. Agricultural activity in land close to the Lake shores is rather limited because of poor soil and high soil salinity. However, land reclamation efforts continued on the western side of the inlet where the soil is predominantly sandy. Agriculture in this area is mostly rain-fed. On the eastern side of the inlet, the area near Baltim, the land is intensively cultivated, mainly with date palms and guava. Other crops include tomatoes, grapes, clover, cabbage, cauliflower, watermelons, broad beans, wheat, rice, and maize. In 1956 El-Hamul land reclamation project was initiated in the southern and south-eastern regions of the Lake. However, land in this area is neither favourable for productive agriculture nor easy to reclaim and most of the land reclaimed for agriculture has been abandoned nowadays.

Villagers keep (herds of) buffaloes, cows, sheep, goats and camels inside the Protected Area. 61 camels were recorded during a 1999 survey, making little contribution to the overall economic picture. The total contribution of raising livestock to the net annual income of inhabitants of the Burullus Protected Area is, therefore, estimated at 36.611million £E. However, the per capita net income of raising livestock is relatively low due to the limited head of stock kept by each family and the low productivity of the local breeds.

According to the management plan there are two new agricultural projects planned on the sand bar of the Protectorate. The first covers an area of nearly 2400 ha north of the international highway close to the two villages El-Sayed El-Badawi and Ibrahim El-Desouki. The second covers an area of about 1900 ha on the southern side of the international highway. Both projects are implemented by the General Authority of Reclamation and Agricultural Development, affiliated to the Ministry of Agriculture. These two projects will

certainly entail a number of human settlements, produce agricultural wastes and pollutants, and yield substantial amounts of drainage water. Disposal of these domestic and agricultural by-products and waste will undoubtedly affect the entire environmental picture of the sand bar with its characteristic habitat types and species diversity. Yet no environmental impact assessment has been carried out so far.

3.5 Firewood collection

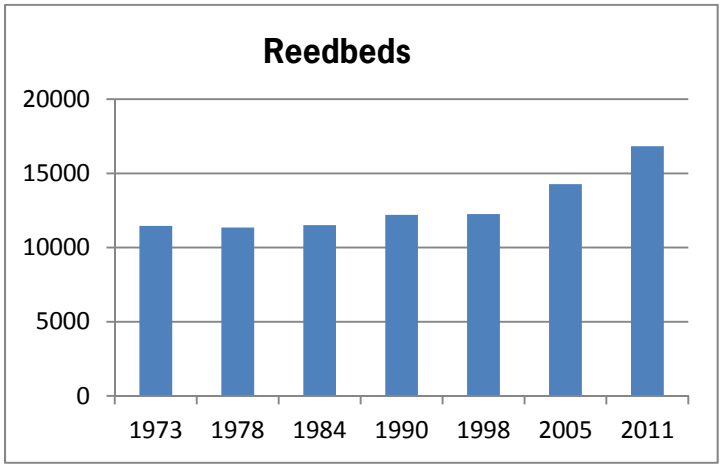
Collection of firewood is an old activity which has largely diminished as it is now replaced by natural gas for household purposes and on fishing boats staying on the Lake for several days.

3.6 Reed cutting

Substantial amounts of *Phragmites australis* reeds are cut and used for a variety of purposes. Green shoots are used as fodder for livestock. The sun-dried stems (2-3 m long) are sold for LE 0.2 – 0.6 per bundle to be used in the demarcation of the cultivated fields on the sand bar or as building materials. Some of these reeds are woven into mats and used as wind breaks, fishing nets and in bird catching. Other uses include the use for thatching roofs and using it as fuel. The ecological impact and the economic magnitude of this activity are unclear. (Shaltout *et al.*, 2002). However, with careful planning this ecosystem has the potential to be an important renewable resource for local people.

Reed cutting has both positive and negative values for nature conservation. Over-exploitation leading to the destruction of reed beds or disturbance during harvesting have a negative impact. But since reed harvesting is mostly done outside of the breeding season the disturbances remain limited. Nature conservation on the other hand benefits from reed cutting. It limits the rate of expansion by reed into new, open areas of lake and within a planned programme of rotation can produce a mosaic of beds of different age and structure, which enhances the diversity of the ecosystem. Reed cutting also improves the value of reed as a breeding habitat for wetland birds. In addition the building of aqua culture ponds limits the accessibility of reed beds along the shore lines.

As shown in the graph below, the area covered by reed is slowly increasing attributed to the large amount of nutrients flowing into the Lake. In 1973 the surface covered was 11460 hectares and in 2011 this has increased up till 16828 hectares.



Graph 4: The increase of the area covered by reed.

Reed beds do not only play an important role in providing a natural resource for the local population but also play an important role in trapping nutrients. Research elsewhere including around Lake Manzalla has revealed that the construction of artificial wetlands with a vegetation of reed and other macrophytes can trap significant amounts of nutrients thus contributing to improved water quality. Reed beds provide shade, shelter and food for many species of fish and offer breeding and resting habitat for numerous (migratory) birds.

A GEF supported project during which experiments with artificial wetlands were carried out showed that reed beds established in one of the principal agricultural drains pouring into Lake Manzala (east of the Delta) significantly decreased the level of nutrients flowing into the Lake.

3.7 Bird-hunting

Although all forms of hunting are illegal after the declaration of Burullus as a protected area, it still continues with little change. Bird hunting is largely concentrated in the autumn (quail: *Coturnix coturnix*) and winter (water birds). Quail catching is a traditional activity along the entire Mediterranean coast of Egypt, including Burullus. A variety of nets and traps are used to catch quail and other small birds during the autumn season (October – December). This activity is carried out mainly close to the water front on the sand bar. In winter, hunting targets water birds by means of nets or shotguns. The catch is usually transported to nearby towns and cities (mostly to Rosetta and Alexandria) where it may fetch a relatively higher price. Poverty, tradition, lack of environmental and legal awareness, and insufficient law enforcement all contribute to its continuance.

Illegal hunting has significantly increased especially since the Revolution of April 2011. According to the Egypt Independent (January 14, 2013) "bird hunters returned with a vengeance — due to harsh economic times, lack of security and political turbulence - and are now blatantly entering protectorates to hunt, breaking many local laws and international treaties in the process".

Bird catching is not an economically significant or stable activity in the Burullus area, although some individuals and families might resort to it on a seasonal basis only in order to augment their income. Conflicts with nature conservation arise particularly when threatened species, such as the Corncrake, are taken. Disturbance is another factor, e.g. for waterfowl that negatively impacts the value of the Lake for birds. Bird hunting particularly within a Protected Area is counter-productive to attracting eco-tourists to the area, which has the potential to bring in far more money than bird catching does.

As long as the economic development in the area is negligible is makes no sense to try to completely prohibit bird hunting. The best option for the time being is to designate parts of the Lake as 'safe havens" where hunting is forbidden but this again makes only sense if law enforcement is secured.

3.8 Tourism

The coastal sand dunes east of Baltim town are largely unspoiled, and their sweeping forms are aesthetically pleasing. The highest ones reach 13 m above sea level and dominate the landscape in Baltim and Sheikh Mubarak.

The tourism potential of the Burullus area remains largely untapped. This is mostly due to: (a) the lack of awareness on the part of both the local inhabitants and municipal authorities in the Governorate of the economic value of this industry and its potential contribution to the advancement of their well-being; (b) all Islamic sites of historical and touristic value remain to be uncovered from beneath massive sand dunes; and (c) security considerations related to combating illegal smuggling along the coastline.

However; a modest tourist industry has existed for a long time in the Burullus area. It is based almost exclusively on Egyptian tourists attracted from the Nile Delta and Cairo during the summer months of June to mid-September. Most of this activity is concentrated in the seaside resort of Baltim. There are only about 165 hotel rooms in the entire Kafr El-Sheikh Governorate. Consequently, most of the summer holiday makers in Baltim stay in temporary rentals of chalets and apartments or in privately owned residences, which are difficult to count and would not show up in official statistics.

The natural and cultural heritage of Kafr El-Sheikh Governorate, which could contribute to the development of the tourism industry, includes 6 sites of historical importance, including the pre-historic City of Butu (now known as Tal El-Pharaeen).

The Tourism Office of the Governorate is planning to establish a marina for international tourists near Rosetta and a number of new seaside resorts all along the sandbar.

3.9 Medicinal plants

Another provisioning service provided by the lake is the collection of medicine plants; fifty five plant species are collected for medicine purposes.

3.10 Biodiversity

Burullus Protected Area encompasses a wide range of natural habitats including: inshore marine waters, brackish and fresh lagoon waters, sandy shores, salt marshes, sand dunes rich in flora, islets within the Lake, mud flats, fresh water swamps and reed beds. Several man-made wetlands are also found in the protectorate including fish farms, saltpans, canals and drains carrying water from irrigated fields. The gradient between the fresh water in the southern part and the more brackish in the northern part of the lake provides a unique gradient where many marine and fresh water organisms could benefit from. However; the influence of the brackish seawater has decreased over time due to the increase of water discharged into the Lake from the upstream located agricultural lands.

The sand bar includes the two most threatened habitats in the protectorate: the sand dunes and the salt marshes. These habitats support some of the highly threatened species found along the Mediterranean coast of Egypt. No less than 51 plant and 13 mammal species have been recorded in these habitats. The salt marshes are of major importance for two subspecies of birds (the Lesser Short-toed Lark *Calandrella rufescens nicolli* and *Motacilla flava pygmaea*) endemic to Egypt.

Intertidal mudflats are utilized extensively by many wading birds both during migration and in winter, and provide important resting places for the many thousands of other water birds that pass through the region.

Reed swamps form the greatest biomass, and are of particular importance as a breeding habitat for several water birds, supporting sizeable populations of some 15 breeding species as well as holding one of the largest populations in the Western Palearctic of the Purple Gallinule *Porphyrio porphyrio* and the Little Bittern *Ixobrychus minutus*. The total number of water birds wintering in Lake Burullus and the adjacent marshes may well exceed half a million (Meininger and Atta, 1994). The only western Palearctic populations of Painted Snipe and Senegal Coucal are found in Egypt. The world's second largest known concentration of Ferruginous Duck is found in Lake Burullus.

A total of 146 bird species have been recorded at Lake Burullus. Burullus is home to six bird subspecies endemic to Egypt. They are:

- Little Green Bee-eater *Merops orientalis cleopatra,*
- Laughing Dove *Streptopelia senegalensis aegyptiaca,*
- Senegal Coucal *Centropus senegalensis aegyptius,*
- Egyptian Swallow *Hirundo rustica savignii,*
- Crested Lark *Galerida cristata nigricans,*
- Egyptian Yellow Wagtail *Motacilla flava pygmaea.*

None is considered threatened, and the Egyptian variety of the Laughing Dove and the Swallow are two of the most abundant birds in Egypt. The Egyptian Yellow Wagtail breeds in or at the edge of wetlands and therefore has rather narrow habitat requirements – which are met at El Burullus.

Five species and subspecies considered rare by Goodman (1989) occur at El Burullus. They are:

- Montagu's Harrier *Circus pygargus,*
- Cuckoo *Cuculus canorus canorus,*
- Bar-tailed Godwit *Limosa lapponica lapponica,*
- Pied Avocet *Recurvirostra avosetta,*
- Jack Snipe *Lymnocryptes minimus.*

The IUCN Red List of Globally Threatened Animals (2002) includes two of the bird species occurring in Burullus Protected Area. They are:

- Lesser Kestrel *Falco naumanni naumanni,*
- Ferruginous Duck *Aythya nyroca.*

Burullus is an internationally important wintering site for the Ferruginous Duck. The Lesser Kestrel is a rare passage migrant between European breeding and tropical African winter quarters.

From the perspective of species richness, some of the islets in Lake Burullus (e.g. El-Kom El-Akhdar and Dechimi) are characterized by high species diversity of fauna and flora species due to a variety of micro habitats. About 89 species of plants and many birds, mammals and reptiles have been recorded on these islets. They also include many rare and unique species of limited distribution elsewhere in the region[8].

A matter of concern is the proliferation of the water hyacinth (*Eichhornia crassipes*) which is rapidly occupying large parts of the Lake thus decreasing the area of open water.

3.11 Other services

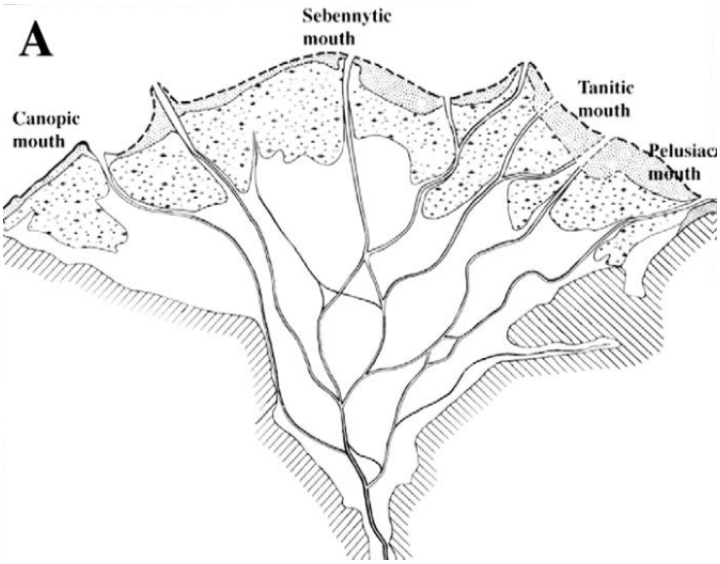
A wide spread species in lake Burullus which is economically important is *Phoenix dactylifera,* as its wood is used for the production of toothbrushes. *Tamarix nilotica* is one more plant species with economic value as the small branches are harvested as fodder for camels and goats while sheep eat the flowers of the same plant. Other species like *Azolla, Lamna* and *Eichhornia crassipes* are collected as fodder for pigs and cattle.

[8] Shaltout Kamal H., Magdy T Khalyl; Lake Burullus; Publication of the National Biodiversity Unit. No 13. 2005.

4 Coastal zone management

The coastline is dynamic and changes over time due to changing currents and sediment transportation along the coast line. Remote sensing studies (Guirguis *et al.*, 1996) and an analyses of satellite images carried out in the frame of the current project show that erosion of the coastal bar occurred during 1983 and accretion during 1985.

The changes from the Holocene period to the current time are well depicted in the two pictures below.

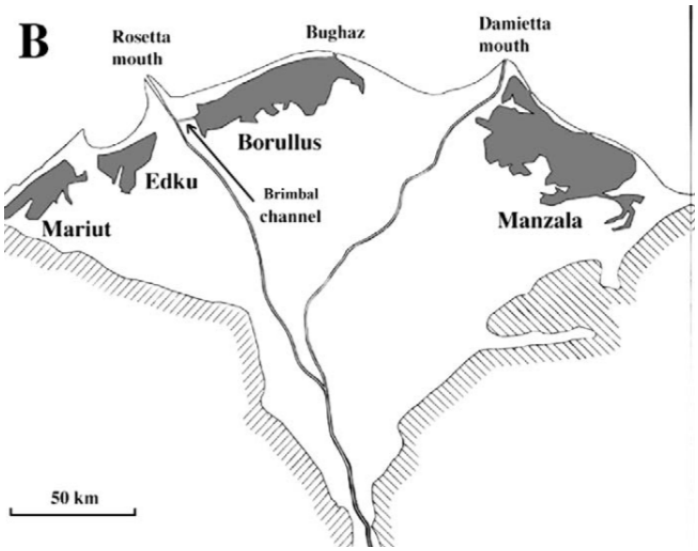


Map 3: The Nile Delta during the Holocene (source: Lake Borullus of the Nile Delta: A Short History and an Uncertain Future; Author(s) :Henri J. Dumont and Gamal M. El-Shabrawy; AMBIO: A Journal of the Human Environment, 36(8):677-682. 2007. Published By: Royal Swedish Academy of Sciences).

The Nile delta as it may have looked between the latter half of the Holocene (ca. 6000 y BC). The different Nile channels and their outlets were not all active at the same time. The coastal marshes initially formed a continuum that was gradually broken up as the river branches deposited alluvial material along their way. The mouth of the Sebennytic branch of the Nile (currently defunct) coincided with the outlet of Lake Burullus.

Below (map 4) the present Nile delta with the two main channels (Rosetta and Damietta) that remained active after 800 AD, and the four lakes that emerged from the belt of coastal marshes.

Changes in sediment transport to the delta and the coast are predominantly attributed to the building of the Ashwan Dam which resulted in a significant transformation in the delta-coast morphology. Historically, sediment brought to the delta by the river Nile led to growth of the delta outwards into the Mediterranean sea. With the construction of river control schemes, initiated in 1860s and culminated by the construction of the High Dam in 1960s, and the subsequent control of water flow to the sea, the shoreline is in retreat and the northern border of the Burullus Protected Area is prone to further erosion. Strong coastal erosion has continued in recent decades, resulting in further coastline retreat and saltwater intrusion. Many studies have also reported degradation of the ecological conditions in the coastal lakes, including increasing levels of heavy metals and nutrients, which have caused eutrophication and adversely affected the fishery (see chapter 6).



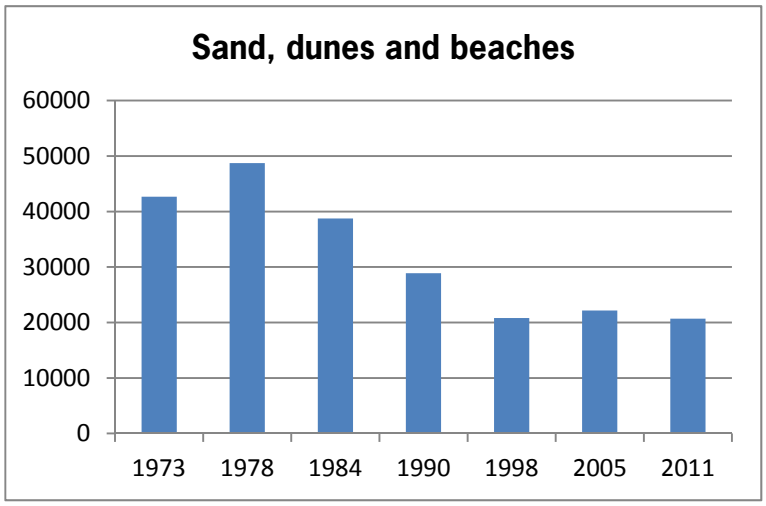
Map 4: The Nile Delta at present time (source: Lake Borullus of the Nile Delta: A Short History and an Uncertain Future; Author(s): Henri J. Dumont and Gamal M. El-Shabrawy; AMBIO: A Journal of the Human Environment, 36(8):677-682. 2007. Published By: Royal Swedish Academy of Sciences).

Erosion of the coast is still continuing despite protection measures that have been taken on the eastern side of the Bourghas inlet. Accretion occurs only on the western side of the inlet.

According to the management plan the coastline at the western side of the outlet (Bourghaz) of Burullus Lake eroded during the period from 1810 to 1971. The rate of erosion increased from 1.1 m/yr during the period from 1810 to 1909 to about 11 m/yr, during the period from 1909 to 1947 and then decreased to 4 m/yr drying the period from 1947 to1971 due to the construction of the protective measures. In 1971 / 1972 the opposite happened and the coast extended into the sea with a rate of about 7 m/yr due to the construction of the jetty on the western side of the Burullus outlet. In 1988 the sand was able to pass around the seaward end of the jetty causing siltation of the outlet. Accretion occurred again on the western side from 1992 up to the recent time, with a rate of about 7 m/yr due to the extension of the western jetty.

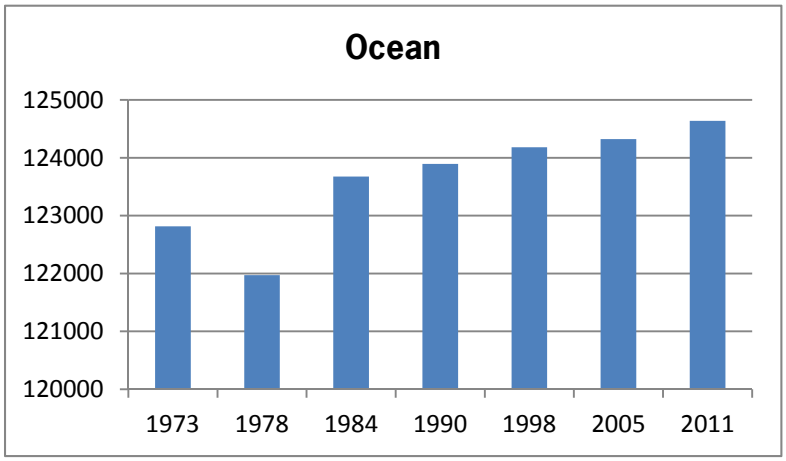
On the eastern side, in front of Burg EL-Burullus village, erosion of the shoreline prevails with an average rate of about 5 m /yr during the period from 1810 to 1909. The pace of erosion increased to 11 m/yr during the period from 1909 to 1936. After the construction of protective structures between 1936 and 1947 including the construction of a 600 m long concrete sea wall, the erosion stopped. However, erosion started again east of this wall with an average rate of about 15 m /yr between 1947 and 1964. In 1964 erosion had reached a strip of sand dunes caused by an erosion of about 10m/yr.

According to Shaltout, Kamal *et al* (2005) the shoreline retreated with rates ranging from 71.4 m (3.3 m/y) to 185.5 m (8.4 m/y), with the average erosion reached about 115.5 m (5.2 m/y). From 1978 to 2011 the erosion continued as is shown in the following graphs. (See further the results of the analyses of satellite images shown in chapter 7) The surface of the sand dunes and beaches declined further from 48719 hectares in 1978 to 20703 in 2011.



Graph 5: Decrease of the area covered by sand dunes.

At the same time the surface of the ocean ("open water") in the study area increased from 121971 in 1978 to 124640 hectares in 2011.



Graph 6: Area covered by sea water within the analysed area (depicting coastal erosion).

The decrease of the surface of sand dunes is a worrying process as it negatively impacts the protection of the hinterland against floods. The decrease of the sand dunes is partly a natural process induced by the building of the Ashwan dam due to which less sediments are transported to the delta and the coastline. But the process is also partly induced by human activity, namely the illegal digging of so called "black sand" for industrial purposes. This last activity is highly irresponsible and needs to be stopped at the highest priority as it further undermines the safety of the people living in the delta.

A National Committee for Integrated Coastal Zone Management with the focal point at the Environmental Management Sector/EEAA was set up after the Law 4/1994 was approved,. The Committee was given the task of developing an Integrated Coastal Zone Management Programme (ICZM). A workshop held at Hurghada in May 1995 laid the basis for the development of a framework programme for ICZM through a list of recommendations. The framework programme, published in December 1996 calls for the reinforcement of the national ICZM Committee and the development of four national strategies or plans:

- National Shore Protection Plan,
- National Coastal Land-use Plan,

- National Coastal and Marine Water Quality Plan,
- National Coastal and Marine Resources Preservation Plan.

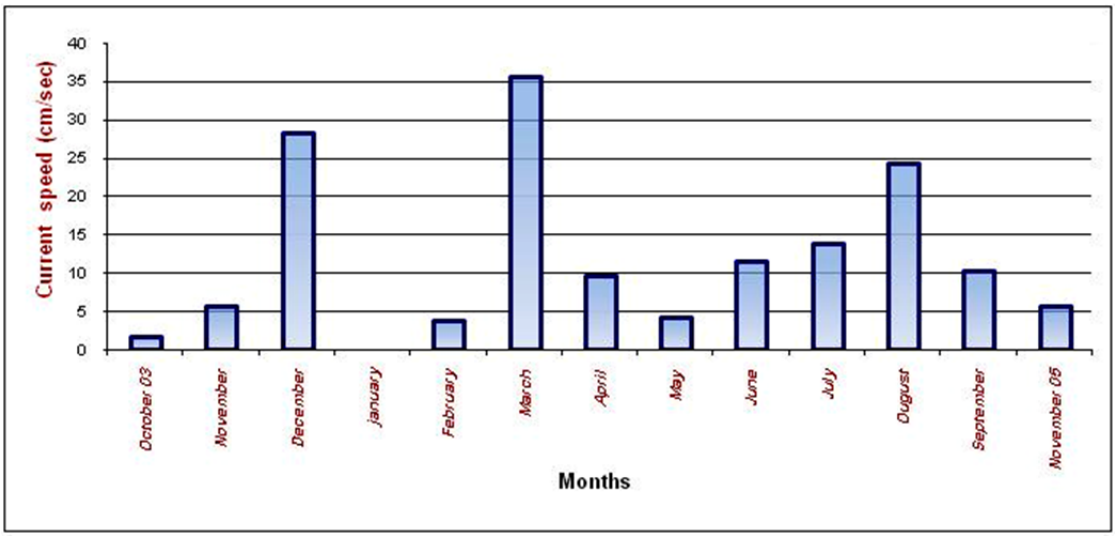
Reclamation of sand dunes is also elsewhere (e.g. Dakahliya Governate) along the coastline still on-going and huge quantities of sand dunes have been eliminated recently as a result of human activities. Comparing the area covered with sand dunes in 1984 and 2006 it becomes clear that most of sand dunes have been lost for the construction of the coastal high way, have turned into cultivated land or are now fish farms. If the current trend continues it is expected that these coastal dunes will disappear completely in next decade. (Rakha A. E. and O. A, Abdel Raouf; 2010).

In addition to the sedimentation and erosion processes that shaped the delta the process of subsidence has a big impact on the delta and especially on its vulnerability to floods. The impact of subsidence is far from negligible. It was estimated to be 40–50 cm per century. (Information provided by Dr Suzan Kholief).

5 Hydrology

The building of the High Dam in Aswan followed by the construction of the agricultural irrigation system in the delta, resulted in the higher discharge of water of Nile origin into Lake Burullus through a series of drains. This not only led to a far higher volume of freshwater entering the Lake in nearly all months, but also ended the pattern of freshwater inflow during the wetter "flood" months in wintertime and marine inflow in the drier summer months of the year. The reverse is now true: the only months in which marine water inflow may exceed freshwater inflow is during the midwinter month of January when the inflow of fresh water through all drains is at its lowest. Overall the discharge of the drains into the Lake is at the lowest from January to March.

The graph below depicts the speed of the water current in the Burghas outlet from the Lake to the Mediterranean. As can be noticed the speed in January is 0 as proof of the fact that during that month there is inflow of marine water.



Graph 7: The speed of the water flow between the Lake and the Sea (Prof Dr Suzan Kholief).

Between 1935 and 1967, the average amount of water discharged into lake Burullus was 2.3–2.7 billion m3/yr. By 1970, this had increased to 3.2 billion m3, and in 2001, for example, the lake received 3.9 billion m3 of Nile water. Not only is more water received annually, but it also flows in in a more or less regular regime. (Dumont and Shabrawy, 2008).

An analyses of the age of the individual sedimentation layers has revealed increasing sedimentation rates in Manzala and Burullus since the 1980s, which is largely a consequence of the increase of reclaimed areas in the delta. Also the particles that are transported into the Lake have become smaller which has adverse ecological consequences due the affinity of finer sediments with pollutants (Gu, Jiawei *et al* 2011).

Groundwater studies reveal that the main aquifer system of the delta contributes to the lake about 90 thousand cubic meters per day. Investigations concluded that the tide effect is negligible.

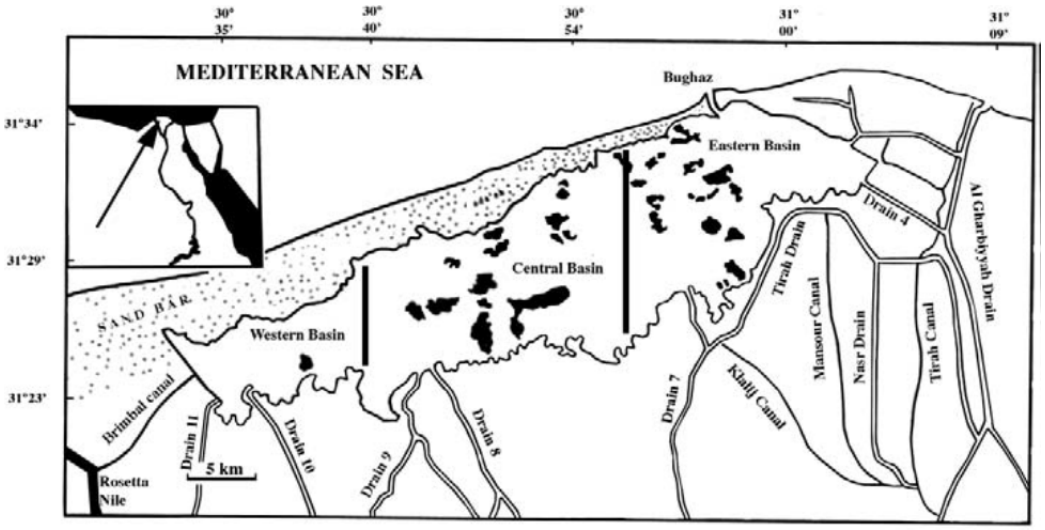
Social studies revealed that about 185.000 people are living in the villages bordering the Lake. The data about the amount of waste water discharged into the Lake are not consistent. According to the report "Water Budget Estimate for Environmental Management at Lake Burullus", Environment and Climate

Research Institute, National Water Research Centre, Egypt (no date) by Dr Ibrahim Abdelmagid El-Shinnawy, this number of people discharges a daily volume of about 28 thousand cubic meters. (= 840.000 m3 per month) Daily evaporation losses from the lake vary from 3.57 to 4.9 mm with daily average value of about 4.2 mm.

Another study calculates an estimated inflow of about 83 million m^3 /month[9] based on 185.000 people "directly" interacting with the Lake. But since the population is rapidly growing the contribution of waste water to the total water balance is steadily increasing.

Lake Burullus receives agricultural drainage water of 4 Governorates (Kafr El-Sheikh, Gharbia, Menoufia and Dakahlia) through 8 main drains and one canal (see map below).

As indicated above the drainage system discharges between 3 to 4 billion m^3 of water into the Lake. The monthly contribution of each drain and the monthly total amount of drainage inflow are given in Table 1. The maximum amount of water discharged into the Lake takes place in the summer months (July-September) during the season of rice cultivation in the catchment area. The minimum volume of inflow occurs during the winter months December-April. No less than 1500 million m^3 (or 38.5% of all drainage water received by Lake Burullus) is discharged through drains number 9 and number 11, and 1571 million m^3 (or 40.24%) is discharged by drains number 7 and "El Gharbyah Drain".



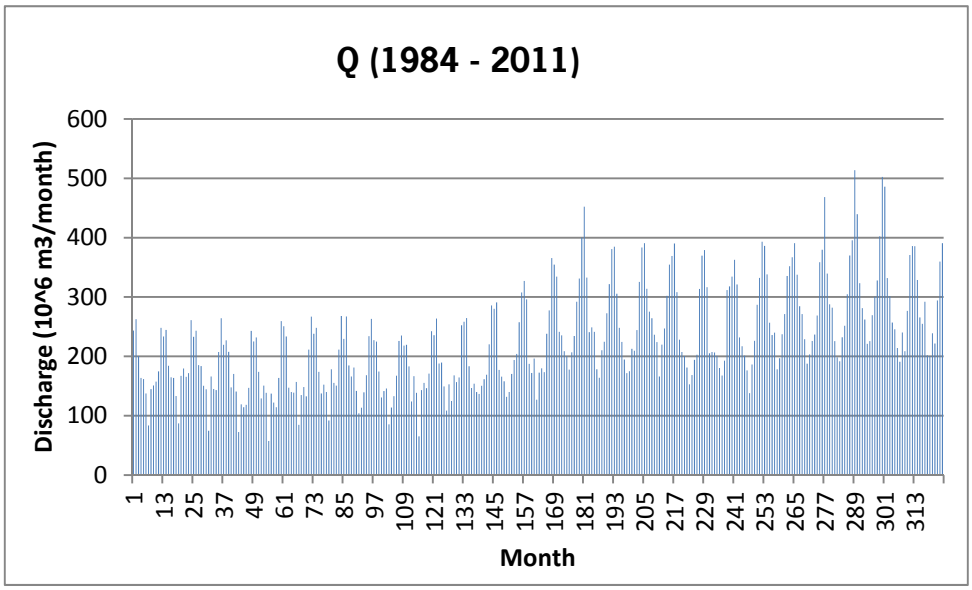
Map 5: Lake Burullus Basins (Source: Lake Borullus of the Nile Delta: A Short History and an Uncertain Future; Author(s): Henri J. Dumont and Gamal M. El-Shabrawy; AMBIO: A Journal of the Human Environment, 36(8):677-682. 2007. Published By: Royal Swedish Academy of Sciences).

[9] Shaltout Kamal H., Magdy T Khalyl; Lake Burullus; Publication of the National Biodiversity Unit. No 13. (2005).

Month	Therah	Burullus	Drain#7	Drain#11	Drain#8	Bur/West	Drain#9	Gharbia	Prenpal	Total	%
JAN	32.93	4.89	27.77	45.08	29.75	7.44	65.00	32.22	13.70	258.78	6.63
FEB	36.83	4.56	31.75	39.91	28.58	7.37	65.00	21.37	5.70	241.07	6.17
MAR	40.11	5.74	32.23	56.71	29.64	10.45	65.00	36.41	16.75	293.04	7.50
APR	41.83	4.86	39.07	51.20	28.55	9.01	65.00	33.13	14.42	287.07	7.35
MAY	55.64	5.03	36.64	65.52	32.68	12.66	65.00	31.50	16.35	321.02	8.22
JUNE	60.64	4.40	44.53	78.16	37.29	16.62	65.00	48.53	15.46	370.63	9.49
JULY	72.59	5.87	51.32	85.00	48.46	18.19	65.00	60.21	16.99	423.63	10.85
AUG	72.34	6.30	52.00	77.62	49.55	17.35	65.00	52.37	18.02	410.55	10.51
SEP	64.14	6.79	48.18	71.87	41.90	14.14	65.00	60.01	23.32	395.35	10.13
OCT	46.65	5.80	39.48	56.67	33.12	9.83	65.00	44.02	19.12	319.69	8.19
NOV	42.89	5.55	36.60	53.75	33.18	9.86	65.00	32.36	20.30	299.49	7.67
DEC	43.08	5.96	36.53	41.49	32.97	6.83	65.00	33.63	18.80	284.29	7.28
Total	609.67	65.75	476.10	722.98	425.67	139.75	780.00	485.76	198.93	3904.6	100.0
%	15.61	1.68	12.19	18.52	10.90	3.58	19.98	12.44	5.09	100.00	

Table 1: Monthly inflow of Water through the various drains (Abdelmagid El-Shinnawy, Ibrahim, Dr; Water Budget Estimate for Environmental Management at Lake Burullus; Environment and Climate Research Institute, National Water Research Centre, Egypt (no date).

The graph below is based on data provided by the DRI and depicts the amount of water discharged into the Lake through the various drains in million m3 per month. These data are in compliance with the data shown in the table above and show a steady increase of the amount discharged into the lake from around 250 mm3 to more than 350 mm3 with peaks to 500 mm3 per month.

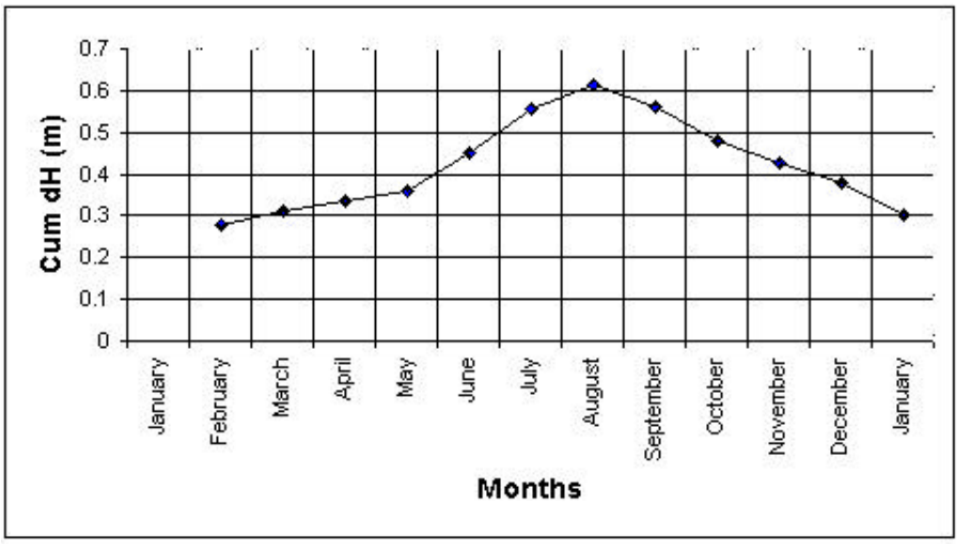


Graph 8: The amount of water discharged on a monthly bases into the Lake from 1984 until 2011.

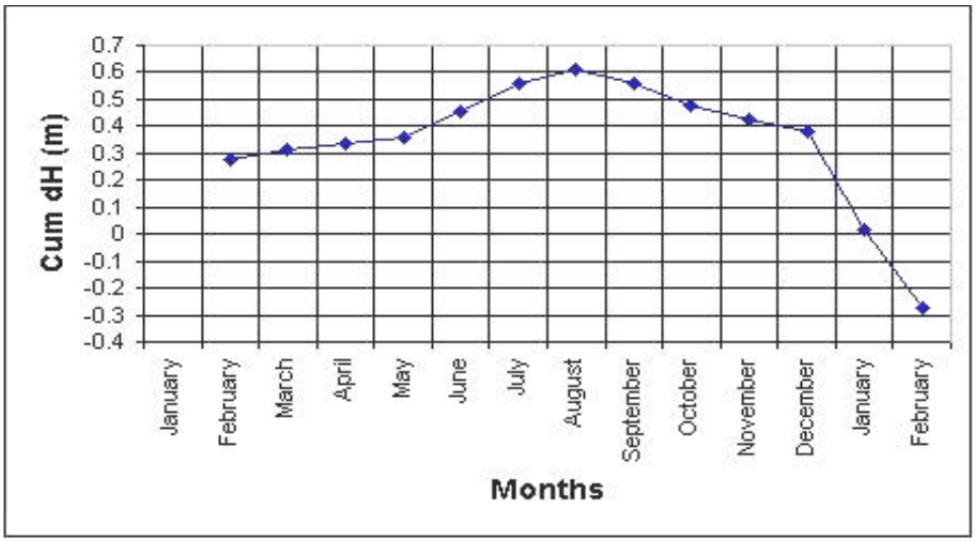
Simulation studies indicate that when the High Ashwan Dam stays open throughout the year the water level in the Lake becomes 26-61 cm higher than the average maximum of sea water level; the higher levels are reached during the months of rice cultivation. Excess water is discharged into the Mediterranean Sea through the only Burghaz outlet and the flow of saline water into the Lake is almost nonexistent throughout the year except for January. When the policy of winter closure (2-3 weeks with no flow of water in the network of irrigation canals) is adopted in January, no water discharges from the drainage system takes place and the water level falls to 26 cm below the average maximum sea water level, 110 million m^3 of

saline water enters the Lake and water salinity is restored only partially and temporarily. (Shaltout, Kamal *et al,* 2005).

The difference is water level of the Lake with or without winter closure of the Ashwam dam is clearly demonstrated in the tables below.



Graph 9: Water level fluctuation in the Lake without winter closure (from Abdelmagid El-Shinnawy, Ibrahim, Dr; Water Budget Estimate for Environmental Management at Lake Burullus; Environment and Climate Research Institute, National Water Research Centre, Egypt (no date).



Graph 10: Water level fluctuation in the Lake with winter closure (from Abdelmagid El-Shinnawy, Ibrahim, Dr; Water Budget Estimate for Environmental Management at Lake Burullus; Environment and Climate Research Institute, National Water Research Centre, Egypt (no date).

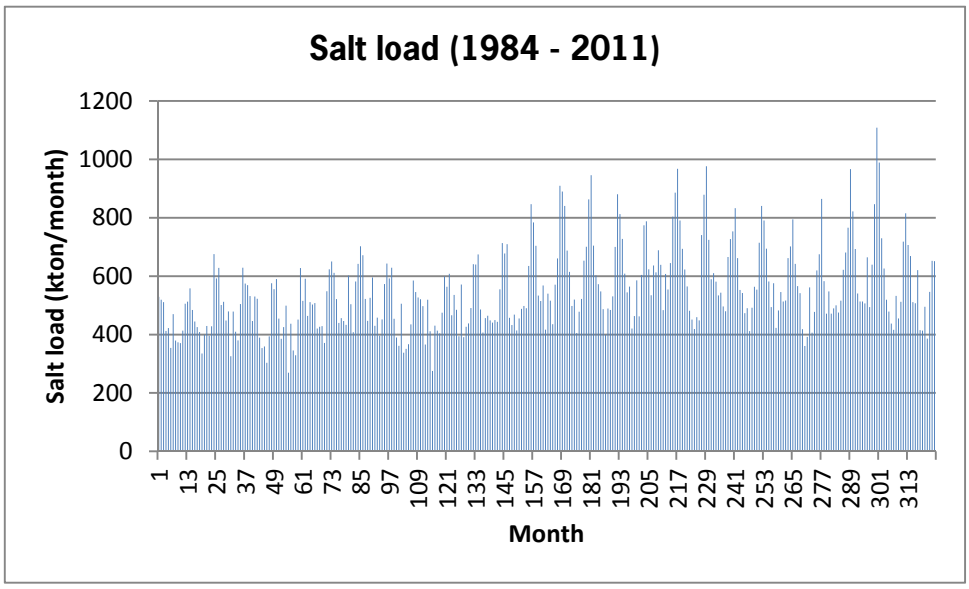
The discharge of "used" agricultural water into the lake has a major impact on the environmental condition and the ecosystem of the Lake including:

- increased volumes of freshwater changing the status of the lake from saline-brackish to brackish-fresh;
- due to near constant discharge of fresh water, the water level in the Lake is higher than the sea water level thus preventing the entry of marine water at the Burghaz;
- changes in the fish communities as a result of the inlet of Nile water and consequent invasion of Nile fish species and indirectly because of reduced salinity levels which has caused the extinction of fish species linked to saline waters;
- changes in the zooplankton because of changed water conditions, introducing freshwater species and eliminating marine ones;
- increased eutrophication levels because of the inflow of effluent of agricultural water with high nutrient levels;
- loss of open water because of the expansion of reed-beds and other aquatic vegetation as a result of eutrophication;
- invasion of exotic plants such as *Eichhornia crassipes*;
- increased pollution levels due to the inflow of untreated water from industries and households around the Lake;
- increased sediment in suspension, leading to major decreases in light penetration within the water column, which in turn has negative impacts on many aspects of the lake's ecosystem.

6 Water quality

After the building of the Ashwan dam and the construction of a dense irrigation network which discharges into the Lake, the Lake slowly changed from a salt water lake into a fresh water lake (see also the chapter on hydrology) The distribution of salinity levels in the Lake depends on the amount of water discharged from the drains, the amount of seawater coming in through al Boughaz and the degree of mixing. In September the lake can be split into two parts: one covering the eastern and western parts with salinity fluctuating between 10 and 19 ‰, a second part covering western part of the lake with salinity levels between 1.5 and 10 ‰. Generally the salinity decreases further away from al Boughaz. Also, the salinity increases from January to July due to decreasing amounts of drainage water being discharged into the Lake. The lowest levels are detected in November, when it ranges between 0.4 and 3 ‰ in all areas of the lake (Beltagy; 1966, cited by Kholief, 2013).

Based on the work carried out by the DRI in the frame of this project the following graph about the salt loads discharged into the Lake form the agricultural drains is made.



Graph 11: showing the amount of salt being discharged by the drains into the Lake.

The movement of the water inside the Lake plays an important role in the distribution of salinity. When the wind is blowing from the east, fresh water from the drainage spreads in most parts of the Lake and the degree of salinity decreases significantly. In contrast, the northern winds push the sea water to the southern parts of the Lake and the overall salinity levels increase.

In the frame of the current project the Drainage Research Institute has been contracted to analyse the latest information from the water monitoring programme of the National Water Research Center (NWRC). [10] The NWRC developed an extensive monitoring network of groundwater, Nile water and drainage water. The network includes 300 surface water and 230 groundwater monitoring points and aims at integrating

[10] Shaban Mohamed Dr; M.Abu-Salama and Eng Mohamed Darwish Ibrahim, Ministry of Water Resources and Irrigation, National Water Research Center, Drainage Research Institute, Lake Burullus (2012).

the individual monitoring activities into one coherent and consistent national information system to support decision makers on water quality issues. The key objectives of the monitoring program are summarized as follows:

- Assess the quality of water entering the Nile Delta and of that released from the Northern Lakes through the drainage system;
- Determine the seasonal variation in water quality along the main water resources (canals and drains);
- Quantify the variation in the water quality in relation to the existing pollution sources; and
- Identify the quality and quantity of drainage water reuse in agriculture.

For surface water quality monitoring, the measured parameters are categorized into four main packages namely:

- **Oxygen Budget:** Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen and Oxygen Saturation.
- **Salts (macro-ions):** Electrical Conductivity, Total Dissolved Salts, Calcium, Magnesium, Sodium, Potassium, Carbonate, Bicarbonate, Sulphate and Chloride.
- **Nutrients:** Nitrate, Ammonia, Total Nitrogen, Total Phosphoresces.
- **Physical Parameters:** Temperature, Acidity, Total Suspended Solids, Total Volatile Solids, Turbidity, Visibility disc, Odor and Color.
- **Bacteria:** Coliform Total bacteria and Fecal Coliform.
- **Metals:** Cadmium, Manganese, Copper, Iron, Zinc, Nical, Lead and Boron.

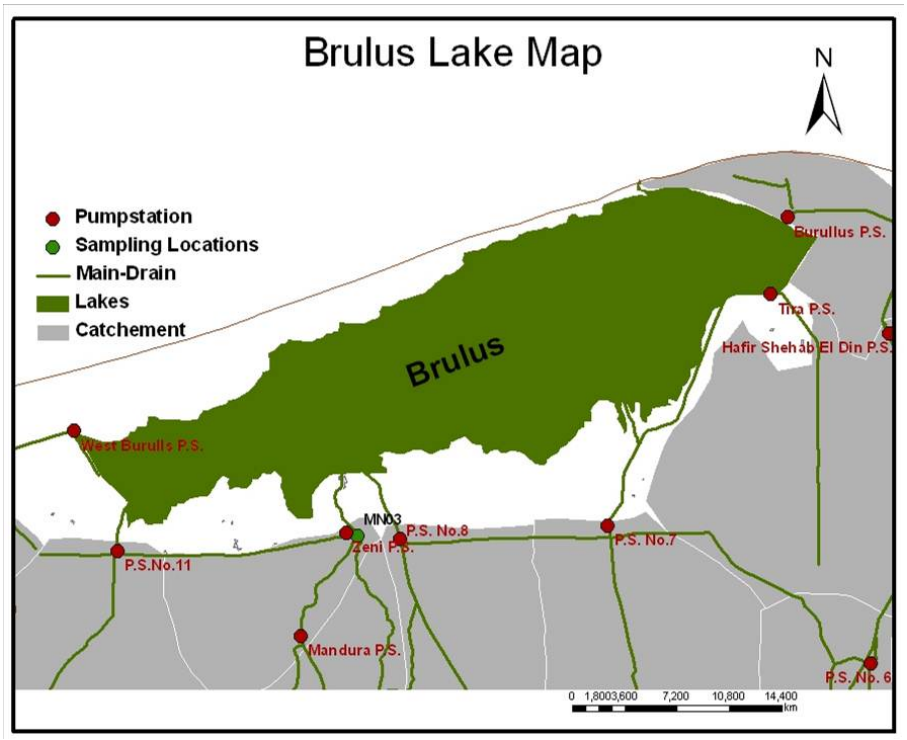
Earlier reports have already referred to the significant increase of the amount of nutrients that are being discharged into the Lake and which have had an even bigger impact on the fish population than the impact of the reduced salinity levels.

Year	NO_2-N	NO_3-N	NH_3-N	PO_4-P	SiO_3	Reference
1987	11	56	80	50	1870	Abdel-Moati *et al.* (1988)
1997	29	80	120	90	1325	Radwan *et al.* (1997)
2001	15	39	150	40	1168	Radwan (2004)
2004	166	671	906	286	3151	Present data

Table 2: Influx of nutrients into the Lake: Source Mohamed El-Sherif Mohamed Goher; National Institute of Oceanography and Fish, Fish Reasearch Station, El-Kanater El-Kharia Cairo; Chemical assessment of water quality and some heavy metals in Lake Borullus (Egypt); Acad. Soc. Environ Develop 10-4 (2009).

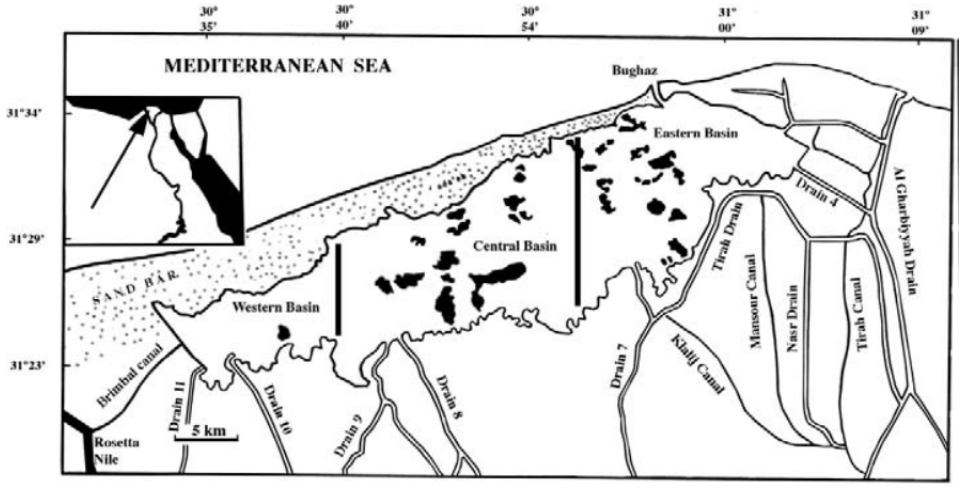
For the purpose of this project data from monitoring stations which are part of the Egyptian National Water Quality Monitoring Network (see the map below) are analysed for assessing the drainage water quantity and quality of the main drainage feeders to Burullus Lake.

The lake is divided a relatively small western (west), a large middle (centre) and a medium-sized eastern (east) sector. The sectors differ in depth, with the western sector the deepest (up to 2m) and freshest, and the eastern the shallowest (40-75 cm). The eastern sector of the lake opens to the Mediterranean Sea by a short canal, Al-Boughaz, 250 m long kept open by dredging to prevent it from silting up.



Map 6: Location of the monitoring stations in the various drains that discharge into the Lake. (Taken from the DRI report on the water quality of Lake Burullus, 2012).

The map below shows the delineation between the three sectors of the Lake.



Map 7: Lake Burullus Basins: Source: Lake Borullus of the Nile Delta: A Short History and an Uncertain Future; Author(s) :Henri J. Dumont and Gamal M. El-Shabrawy; AMBIO: A Journal of the Human Environment, 36(8):677-682. 2007. Published By: Royal Swedish Academy of Sciences.

Map 6 shows the location of the monitoring stations at the tail ends of the main drainage feeders of the lake (Drain no. 7, Tira Drain, Burullus Area, Drain no. 8, Nashart Drain, Zaghlol Drain and Drain no. 11) in relation with each lake zone.

- East section is presented by M701 (PS NO 7), MT01 (TIRA PS), AND MB01 (Burullus PS).
- Middle section of the Lake is presented by MN04 (Gharb Brulus PS) and MN02 (Mandura PS), MN01 (Upper PS NO 8) and M801 (Lower PS NO 8).
- West section of the Lake is presented by MB02 (Gharb Brulus PS), and M111 (PS NO 11).

The data provided are for the individual drains, and as total/average per Lake Burulus sections, and for the Lake as a whole.

A summary of selected monitored parameters is presented in Table 3. DRI staff has collected the monitoring data during the routine trips, on monthly basis, and in the meantime, the Water Level Recorders and the EC-meters were checked and calibrated. The staff also collected water samples at all locations to carry out the planned analyses at the Central Laboratory of Environmental Quality Management (CLEQM).

Group	Parameter		
	Name	**Symbol**	**Unit**
Oxygen Budget	Biological Oxygen Demand	BOD	mg/l
	Chemical Oxygen Demand	COD	mg/l
	Dissolved Oxygen (field)	DO	mg/l
Nutrients	Nitrate	$N\text{-}NO_3$	mg/l
Physical Parameters	Temperature (field)	T	^{o}C
	Acidity (field/lab)	pH	-
Bacteria	Total Coliform bacteria	Coli	MPN/100ml
Metals	Cadmium	Cd	mg/l
	Manganese	Mn	mg/l
	Copper	Cu	mg/l
	Iron	Fe	mg/l
	Zinc	Zn	mg/l
	Lead	Pb	mg/l

Table 3: Overview of the parameters that were analysed (taken from the DRI Report).

To be sure that the fieldwork will acquire the target data and information, pre-designed field forms were developed, pre-field trip calibrations of equipment were conducted, and debriefing procedure between field and laboratory teams took place.

A significant advantage of field measurements is that tests are carried out on fresh samples whose characteristics have not been contaminated or otherwise changed because of storing. The field observations were reported carefully to support the evaluation of the laboratory results.

6.1 Approach to determine current water quality

- Monthly water and salts discharges to Lake Burullus through the monitored drains for the period 84/85 to 10/11 are provided for the analyzed data in a spread sheet (see Annex 2 to this report).
- Monthly water quality data of DO, BOD, COD, Coliform, N-total, Fe, P, CD, Cu, Pb, and Temperature are provided for the drains leading to Lake Burullus. The data provided are collected for the period 97/98 to 10/11 and presented in a spread sheet (see Annex 2 to this report).
- A summary of the water quality, based on the yearly total discharges, average weighted salinities and the salt loads for the Middle Delta is presented below in Tables 4, 5, and 6.

Parameter	Max.	Min.	Average
Temp (C°)	32	12	22
DO (mg/l)	7.78	1.1	4.15
Pb (mg/l)	0.226	0.000*	0.010
Zn (mg/l)	0.947	0.000*	0.047
Fe (mg/l)	2.860	0.000*	0.638
Cu (mg/l)	0.414	0.000*	0.043
Cd (mg/l)	0.039	0.000*	0.005
P (mg/l)	3.060	0.040	0.545
N-Total (mg/l)	65	0	11
BOD (mg/l)	100	10	34
COD (mg/l)	655	5	60
Coliform (MPN/100ml)	29500000	1200	419094

*Under the detection limit

Table 4: Water quality statistics for East zone.

Parameter	Max.	Min.	Average
Temp (C°)	34	12	22
DO (mg/l)	7.7	1.00	3.78
Pb (mg/l)	0.148	0.00*	0.011
Zn (mg/l)	1.060	0.00*	0.037
Fe (mg/l)	3.640	0000*	0.707
Cu (mg/l)	0.312	0.00*	0.038
Cd (mg/l)	0.110	0.00*	0.005
P (mg/l)	3.180	0.00*	0.586
N-Total (mg/l)	78	0*	12

BOD (mg/l)	100	10	36
COD (mg/l)	442	1	62
Coliform (MPN/100ml)	250000000	1100	1514594

*Under the detection limit

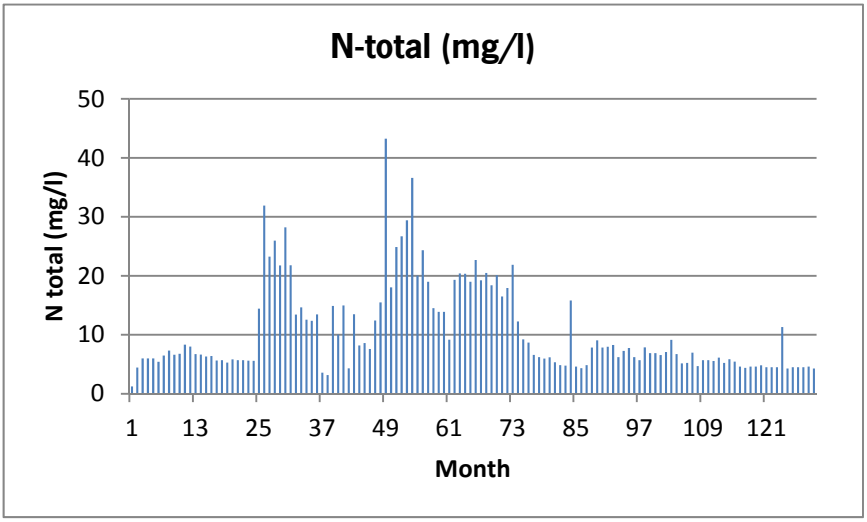
Table 5: Water quality statistics for Middle zone.

Parameter	Max.	Min.	Average
Temp (Co)	30	12	22
DO (mg/l)	7.7	1.03	3.61
Pb (mg/l)	0.115	0.00*	0.009
Zn (mg/l)	0.476	0.00*	0.037
Fe (mg/l)	2.890	0.00*	0.649
Cu (mg/l)	0.245	0.00*	0.029
Cd (mg/l)	0.190	0.00*	0.004
P (mg/l)	3.300	0.00*	0.500
N-Total (mg/l)	50	1	9
BOD (mg/l)	98	10	33
COD (mg/l)	400	9	61
Coliform (MPN/100ml)	120100000	2300	888875

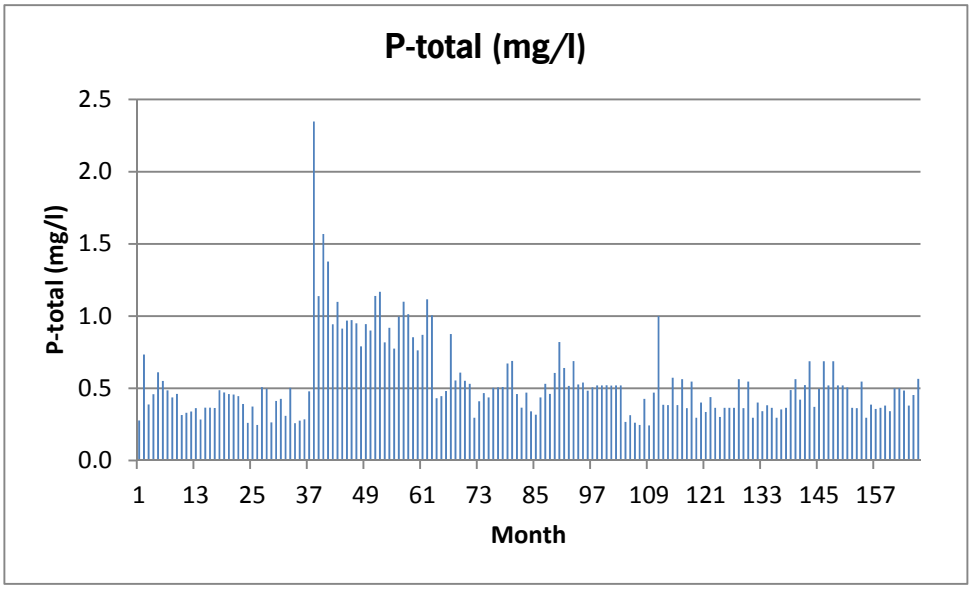
*Under the detection limit

Table 6: Water quality statistics for West zone.

Translating the data gathered by DRI into a graphs depicting the trends in N and P being discharges into the Lake leads to the following pictures.



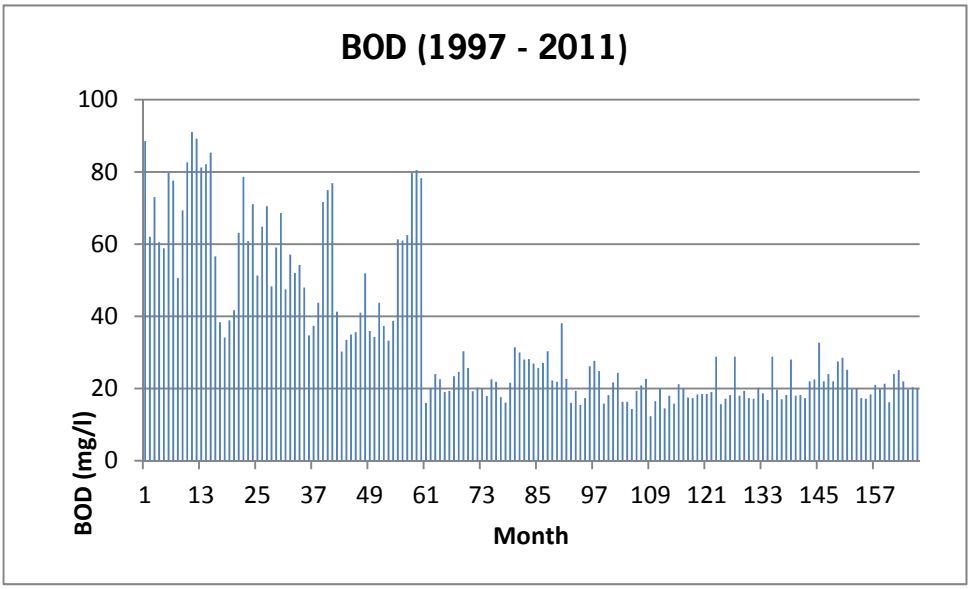
Graph 12: N-total discharged into the lake for the given period.



Graph 13: P-total being discharged into the lake for the given period.

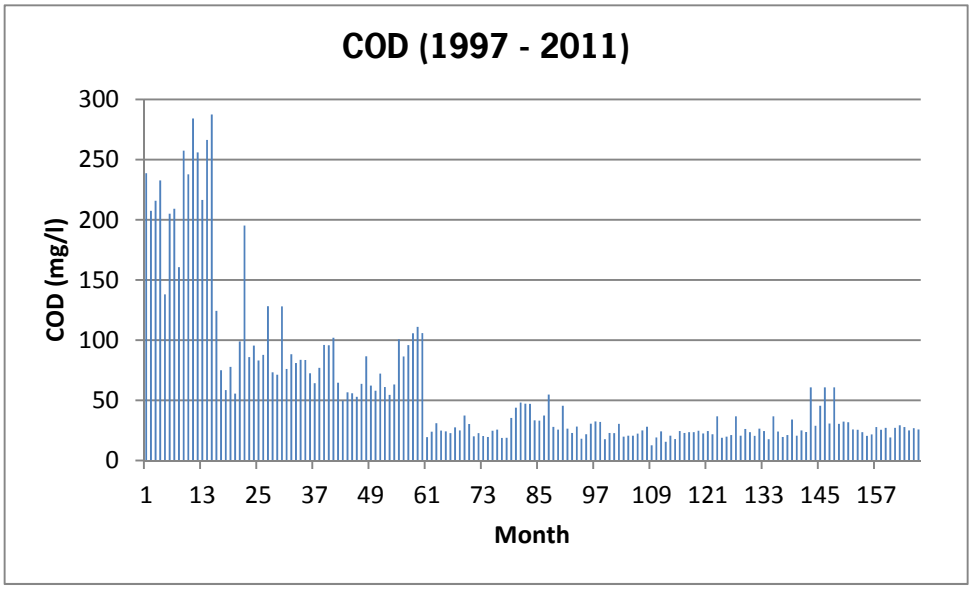
Despite the fact that there are various gaps in the data the conclusion drawn from the above data is that in recent years there has been no increase in the amount of N and P discharged into the Lake.

When looking at the biological oxygen demand the conclusion is that this has decreased in recent years which can be a result of lower biological pollution levels.



Graph 14: Oxygen demand over the past 14 years.

The chemical oxygen demand has significantly decreased soince 1997 as is shown in the graph below.



Graph 15: Chemical oxygen demand for the period between 1997 until 2011.

According to an article of Zhongyuan Chen *et al* (2010) the pollution and eutrophication are increasingly threatening the ecosystems of the region (the Nile Delta). The study revealed that the highest concentrations of Cu, Zn, Ni and Fe are found in the upper levels of the lake bottom. This reflects the changes in the way the lake receives its water since the construction of the Ashwan Dam and the industrial and agricultural development upstream of the Lake. Still the study concludes that the level of Pb and Cd concentrations are much lower than in other coastal lakes (like Lake Manzalla). However, the study highlights the increase of toxic heavy metals in the Lake in recent years. The study underpins the need for action to improve the situation and establish purification plants and decrease pollution through run off from agricultural lands and from the effluent from aqua ponds in order to maintain the Lake as a healthy source for fish and a refuge for wildlife.

The changes in the character of the water are also reflected in the zooplankton population. Dumont and Elshabrawy conclude that, from the early onset of dam-construction in the Nile valley, slight changes happened in the zooplankton of Lake Burullus and three other delta lakes. The construction of the Aswan dam strongly reduced the marine influence in the lakes, resulting in the elimination of some large grazers by freshwater fish. The major changes occurred in the late 1980s and 1990s. They were caused by an intensified agriculture that made the Lake eutrofic and eliminated several large to medium-sized species of zooplankton. These were replaced in a small measure by northern immigrants, but largely by small “filtrators”, in particular rotifers.

Further increase of the nutrient levels in the Lake increases the likelihood of blue-green algal blooms and anoxia which can induce a sudden collapse of the ecosystem and can cause the dying of a great deal of the fish population.

The water quality is also impacted through direct dumping of waste from the Baltim city by waste transport cars. Also other the villages neighbouring the Lake drop all kinds of agricultural waste in the Lake.

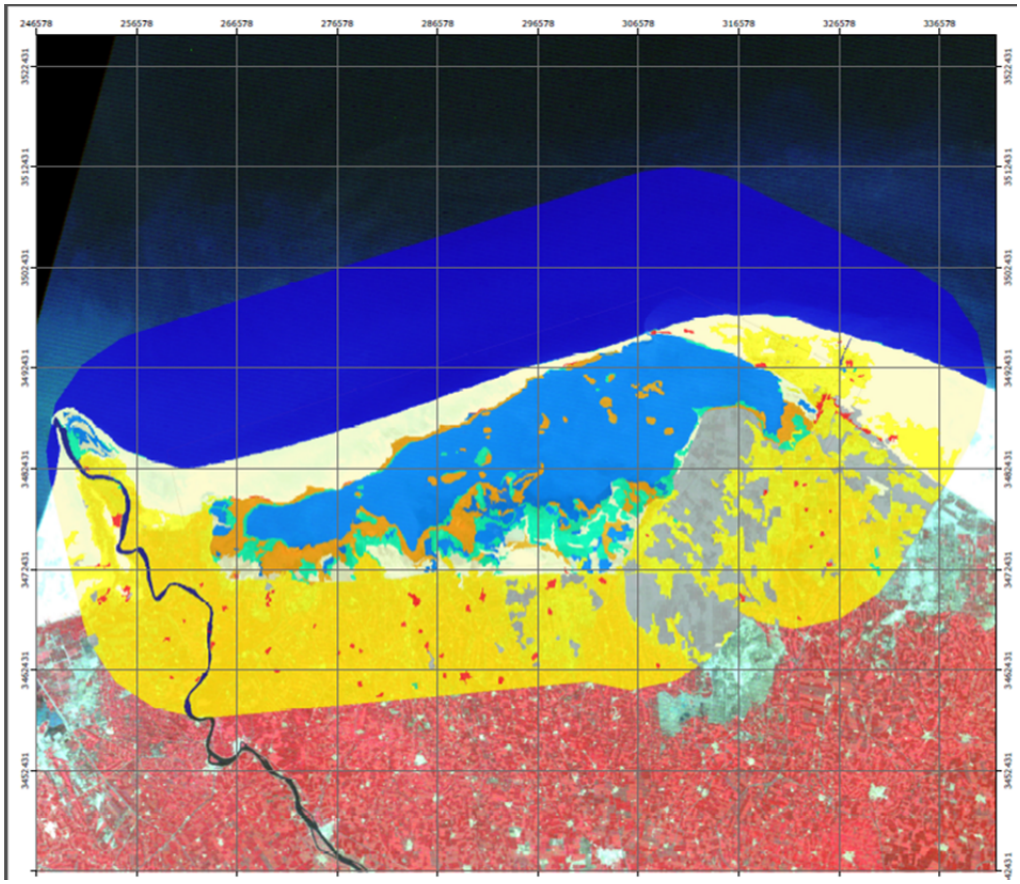
Both ground water and surface water in the delta and in the Lake are impacted by an increasing amount of salt intrusion due to sea level rise. This may be positive for the Lake, for the agricultural production this will have a very negative impact when this trend continues. According to one study the concentrations of major cations for all collected water samples in drains the content is very high compared to values in normal fresh water. The concentration of calcium is found in values ranging from 133 ppm to 220 ppm.

7 Land use changes

The shoreline and size of the Lake have always been rather dynamic. In 1810 the recorded size of the Lake was 1092 km^2 and gradually the Lake size decreased from 50.270 ha in 1984 to 41.000 ha in 1997 and the circumference from 160.0 km to 143.0 km in the same period. Other information indicate a surface of 57.120 ha in 1953 and 42.420 ha in 2000. The management plan[11] (2002) indicates a surface of the Lake of 41.000 hectares and the surface of the open water of 37.000 hectares. According to analyses of satellite images performed in the frame of the current project the surface of open water is 32.460 hectares (in 2011), reed beds occupy 16.828 hectares and marsh vegetation 3506 hectares; total: 52.898 hectares. If all data are correct the latest information shows a decline of the open water of about 4.500 hectares in the past 10 years! One has to bear in mind however that it is not clear where the border of the Lake is precisely located; it is for instance not clear whether the reed beds have in all studies been included as part of the "Lake area".

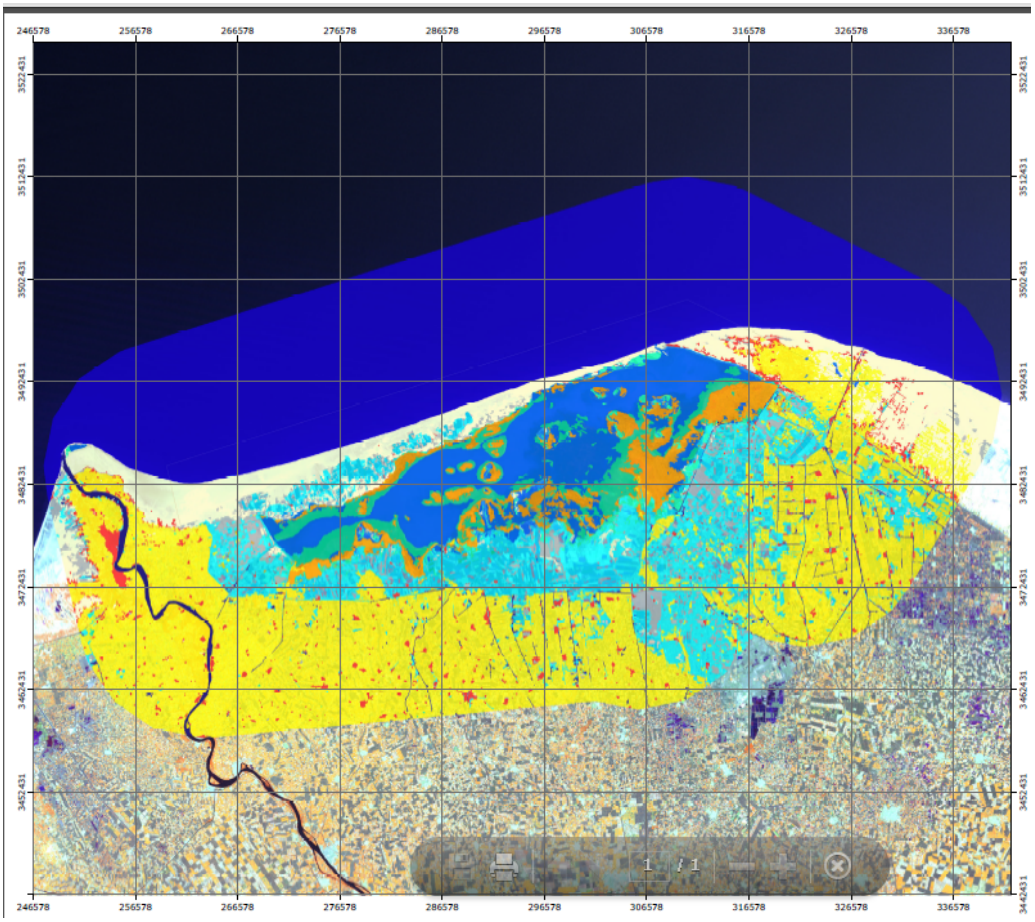
According to the Management Plan the Lake area decreased during the period 1983 to 1991 with an average rate of 8.600 hectares per year. From 1983 to 1985 the area decreased with 5500 hectares and towards the 1990 the rate decreased further.

Map 8: Land use in 1973 based on an analyses of satelite image.

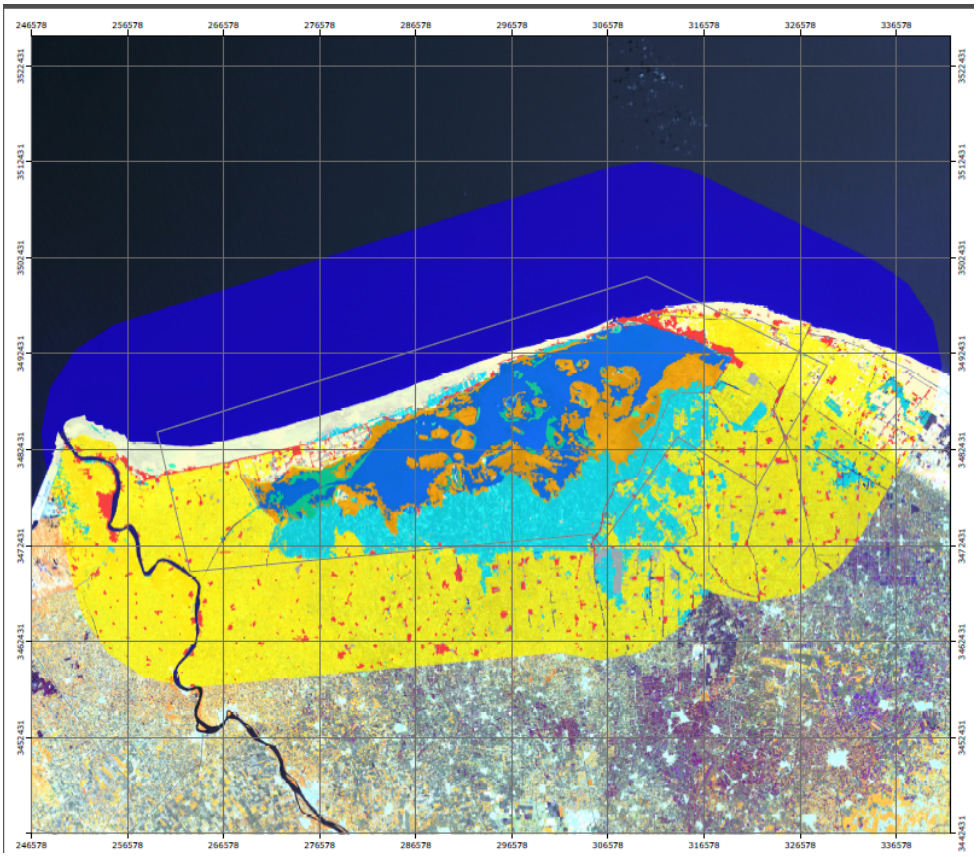


[11] Kassas, M. *et al.* Management Plan for Burullus Protected Area. Med Wet Coast, Global Environment Facility & Egyptian Environment Affairs Agency, Cairo (2002).

Legend used.



Map 9: Land use in 1990 based on an analyses of a satelite image.



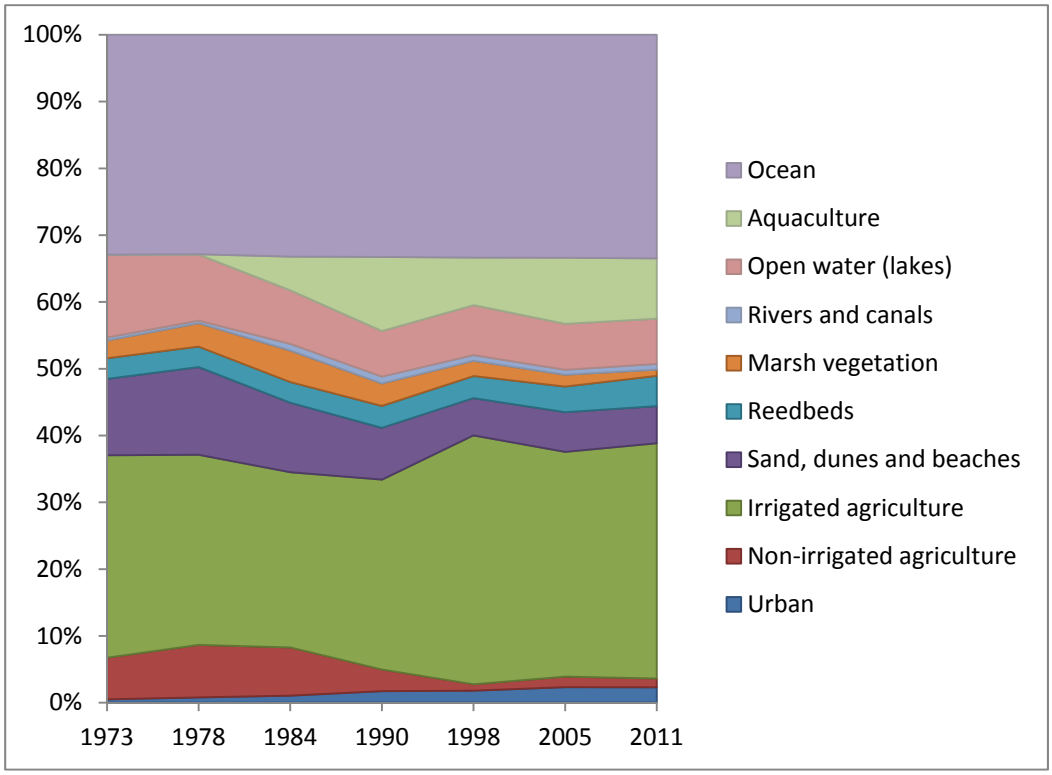
Map 10: Land uses in 2011 based on an analysesof the satelite image.

Based on the analyses of satellite images the following conclusions can be drawn:

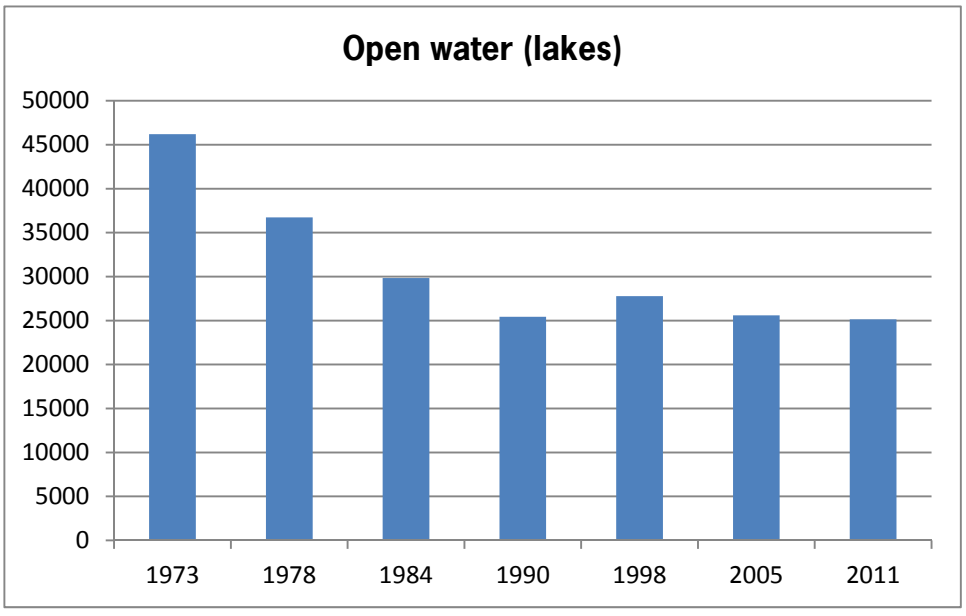
The surface covered with aqua culture ponds has increased dramatically since 1980 and reached its peak in 1990 with a total surface of 41.260 hectares. However since 1990 the surface decreased and in 2011 the surface covered with aqua culture ponds was 33.660 hectares. During field visits in 2012 it became clear that especially along the northern shore new aqua culture ponds were established at an upsetting pace.

The area covered with reed increased also remarkably from 11.460 hectares in 1973 to 16.828 hectares in 2011. The biggest changes are however in the area used for irrigated agriculture while at the same time the area used for non-irrigated agriculture decreased. However during the last years both areas are more or less stable. Irrigated agriculture increased from 113.037 hectares in 1973 to 131.211 hectares in 2011, while non-irrigated agriculture decreased from 29.132 hectares in 1978 to 4.855 hectares in 2011. In 1998 the area used for irrigated agriculture was at its peak with an area of 158.757 hectares

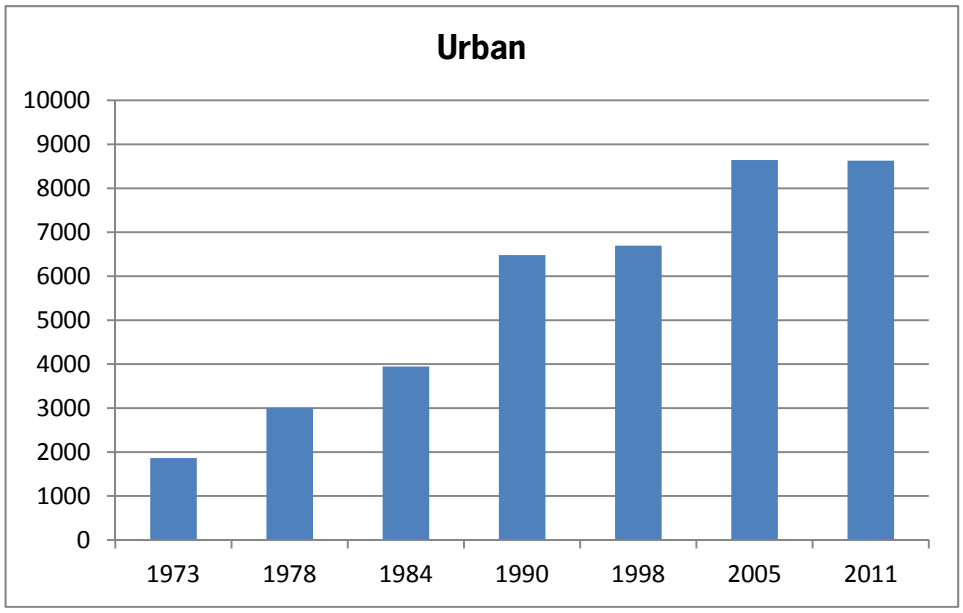
The built up area increased from 1.862 hectares in 1973 to 8.627 hectares in 2011 reflecting the rapid pace of population growth in the area.



Graph 16: Land use changes from 1973 to 2011 in the study area.



Graph 17: Decrease of open water n the period 1997 to 2011.



Graph 18: Growth of urbanized area in the studied area.

Analyzing older maps reveals that around 1963 vast tracts of swamps along the southern coast had been reclaimed but that over time until 1988 these areas have been abandoned again and are today depicted as “areas with natural vegetation”.

8 Climate change

Funded through the United Nations Development Programme and the Government of Egypt the project "Adaptation to Climate Change in the Nile Delta through Integrated Coastal Zone Management" is currently implemented (2011-2014) Much of the following information is from the project document.

The Coastal Research Institute and the Egyptian Shore Protection Authority under the Ministry of Water Resources and Irrigation is coordinating the implementation.

The dominant feature of Egypt's Northern Coastal Zone is the low lying delta of the River Nile. One of the most certain consequences of global warming is a rise of the mean sea level. The IPCC's Fourth Assessment Report (2007), indicates an upper boundary for global sea-level rise by 2100 of 0.59 centimeters but that does not take ice-sheet dynamics into account. As a result it is estimated that in the coming decade 3.3% of total land area of the Nile Delta will be lost to the sea including the loss of approximately 16 km^2 of valuable cultivated land. Egypt's Mediterranean coast and the Nile Delta have been identified as highly vulnerable to abrupt SLR.

The Nile Delta's coastal lagoons, or Lakes, are key ecosystems that act as a protective zone for inland economic activities. Lake Manzala, lake Burullus, Idku, and Maryut, are only separated from the Mediterranean by 0.5- 3km wide slowly but steadily eroding and retreating coast and dune system. Rising seas are likely to further weaken the shore line, which has already been weakened by reduced sediment flows after the construction of the Aswan Dam in 1964. The dune system protects the lagoons and low-lying reclaimed land and further weakening of the beaches and dunes by erosion and human activity will further undermine the ability to protect the settlements, agricultural lands and tourist facilities. In addition, due to salt intrusion, agriculture will become difficult and livelihoods will suffer.

The UNDP funded project will have three major outcomes. First, the regulatory framework and institutional capacity to improve resilience of coastal settlements and infrastructure will be strengthened. Second, strategies and measures that facilitate adaptation to climate change impacts, with sea level rise (SLR) in particular, will be implemented in vulnerable coastal areas in the Nile Delta. And third, monitoring/assessment frameworks and knowledge management systems will be established to facilitate adaptive management in the face of unfolding climate change impacts.

The first and third outcomes target the adaptive capacity of the institutions responsible for coastal zone management. The second outcome targets the implementation of proactive adaptation measures to enhance the resilience and adaptive capacity of coastal lagoons in the Nile Delta that are both highly productive and particularly vulnerable to future sea level rise and have been identified through stakeholder processes as environmental hotspots and priority areas for adaptation. The second outcome will be achieved through installation of a set of innovative shoreline protection strategies modeled after the "Living Shorelines Approach" in the Idku, Burullus, and Manzala coastal lagoons. The third outcome will capture key lessons and transfer through various national and international platforms for further replication of good practices and scaling up.

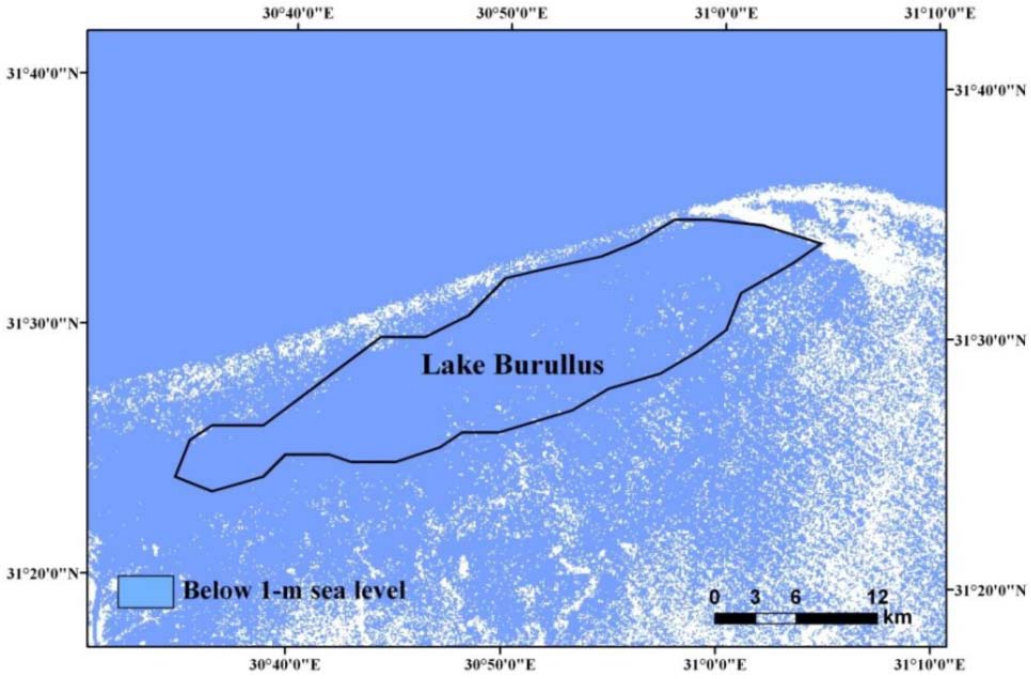
The major impediment for effective coastal zone management and the design and implementation of effective shoreline protection and climate change adaptation measures is the lack of cooperation and coordination and an ongoing debate about the sharing of responsibilities of all institutes and organizations involved. On top of that due to the political turmoil the project has basically come to a standstill.

According to Law No 4 for the year 1994, EEAA was given specifically the authority to prepare a National Integrated Coastal Zone Management Plan for the Mediterranean Sea and the Red Sea coasts and to

coordinate national ICZM activities in close cooperation with the concerned agencies and ministries. A National Committee for Integrated Coastal Zone Management (NCICZM) was set up, and the Secretariat of this Committee was established under the Environment Management Sector of the EEAA. One of the major tasks of the National Committee for ICZM is to develop a programme for the development of a national ICZM Plan. The role of EEAA in the Committee is to review the Environmental Impact Assessment reports and provide the environmental license for all projects located within the coastal zone area, develop coastal zone management guidelines as well as chairing the National Integrated Coastal Zone Management Committee (NICZMC).

Today we can conclude that National ICZM Plan has not been finalized and that appropriate management actions are lacking. The coastal committee (CZMC) has been inactive for several years leading to a reduction in policy dialogue and consistency analysis between governmental stakeholders with different visions on the use of coastal areas. These delays in plan adoption, inability to reach objectives, and inactivity of the CZMC, can be attributed to several underlying causes.

The impact of sea levels rise is accelerated because of subsidence of the delta itself which makes the delta to one of the most vulnerable areas of the world.



Map 11: The DEM of the Burullus lagoon showing the location of the sea if it rises 1-m above its level (Hesham M. El-Asmar, Mohamed E. Hereher, Sameh B. El-Kafrawy (2012).

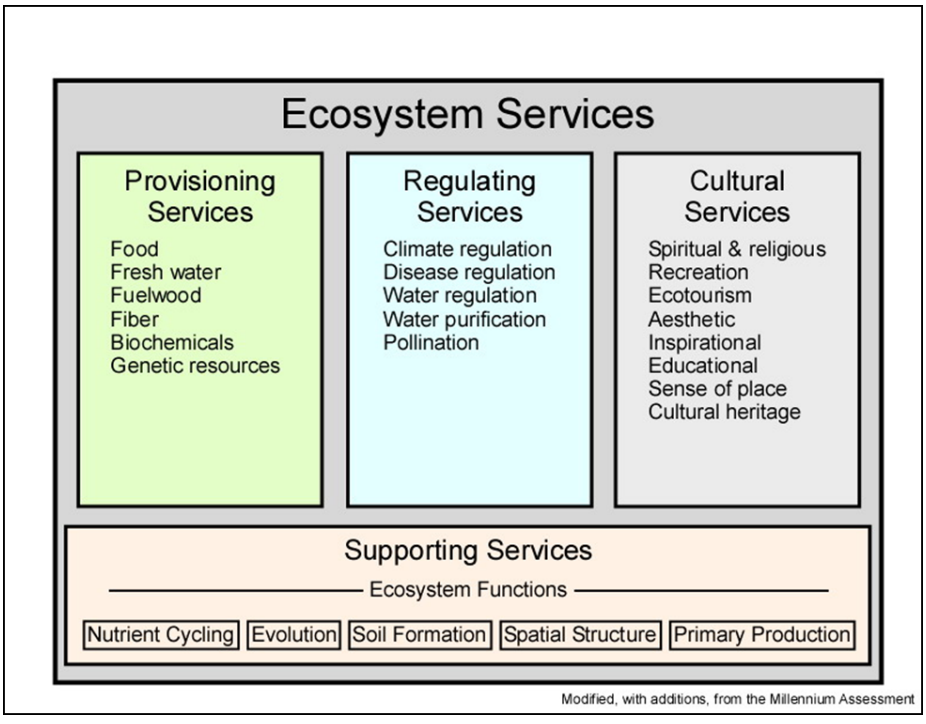
9 DPSIR analyses and possible responses

9.1 Introduction to the DPSIR

The following chapter presents an analysis of the recent changes in the environmental conditions of the Burullus Lake applying the DPSIR analytical framework. The elements of the DPSIR framework are Drivers, Pressures, State changes, Impacts and Responses. The framework allows to look at any ecosystem from the perspective of its potential to deliver ecosystem services, and to understand how changes in the state of an ecosystem, and therefore of the services it is capable of delivering, has an impact on the people and communities that depend on these services. It further allows formulating responses to address the drivers of change, the pressures on an ecosystem and the state of an ecosystem and its socio-economic conditions.

The DPSIR methodology has been adapted to analyse the interactions between agriculture and wetlands in a joint FAO/Ramsar initiative carried out between 2006 and 2008. (FAO, 2008). The study used the concept of ecosystem services as introduced in the Millennium Ecosystem Assessment (MA, 2005). The MA shows that wetlands provide five main groups of services:

- Provisioning – crop production, fish, grazing, domestic water, reeds etc.
- Regulating – flood control, water infiltration, groundwater recharge, etc
- Cultural –religious, recreational, tourism, etc
- Support – soil formation, cycling of nutrients, carbon storage, etc.
- Biodiversity – natural habitats for plants, animals and insects.



Source: http://besurbanlexicon.blogspot.nl/2012/06/ecosystem-services.html

Although the DPSIR methodology helps us to gain insight in the driving forces behind the changes in the Lake and to design response strategies to restore the balance between the various services provided by the lake, it does not to the full extent provide insight in the decision making processes and the power relations that drive the changes. Insight in the decision making process requires an in depth analyses of the institutional and organisational setting in and around the wetland. This holds especially true in the case of Lake Burullus where the institutional and organisational setting, also due to the changes caused by the January revolution in Egypt, is highly unclear and blurry. This implies that besides the DPSIR method, a thorough stakeholder analysis, including an analysis of stakeholders' needs, interests, powers, and institutional linkages has to be carried out. The power dynamics (across societal perspectives – social, political, economic, institutional, and across scales) may require additional methodologies to generate the necessary understanding (CDI; Internal document, 2010). Interventions in the process that leads to skewed ecosystem services can therefore only be successful if the responsibilities for the management and wise use of the Lake are clearly mapped out while the problems caused by skewed ecosystem services are recognized, understood and accepted by the all stakeholders.

Another question that arises is how to weigh the importance of the various services provided by the ecosystem. For instance, how to weigh the provision of fish against the provision of biodiversity. Different methods have been developed to gain insight in the economic value of the various services especially of non-provisioning services. Although it is possible to assess the value of the various services provided, the problem remains how stakeholders can benefit from for instance biodiversity or clean water in financial terms. Or in other words; how to compensate a farmer for applying less chemicals to keep the water clean. Policy frameworks that allow for payment of ecological services require a number of pre-conditions which are often difficult to find in developing countries and include a sound tax collection and redistribution system, a reliable government without corruption and effective inspection and control mechanisms. In the case of lake Burullus; how can the fishermen benefit from the fact that Lake Burullus is contributing to limit the excess of polluted water to the Mediterranean or providing additional safety to the hinterland for the rising sea level.

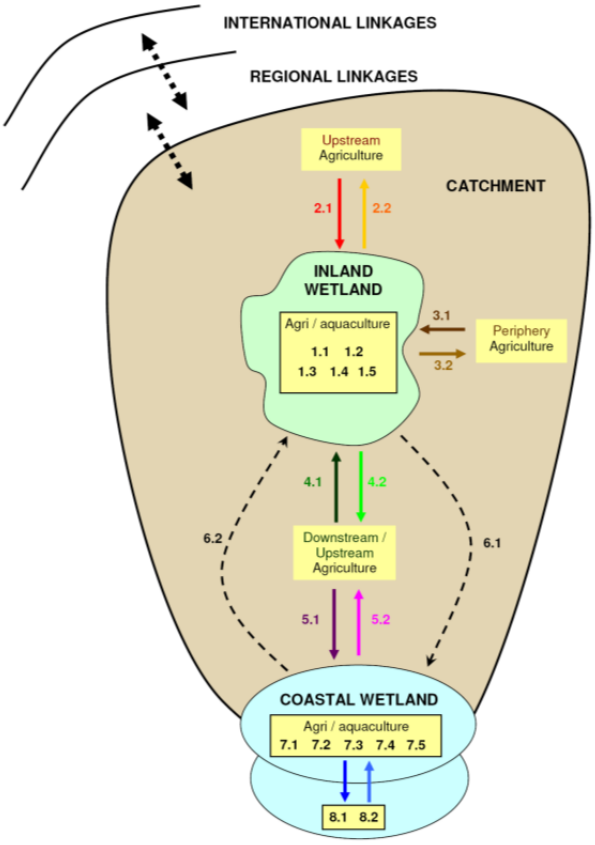


Image showing interactions at a catchment level. *Source:* Scoping Agriculture-Wetland Interactions; Towards a sustainable multiple response strategy; FAO report 33; Rome, 2008.

Pressures can either occur in *situ* or *ex situ*. (see picture below) Direct interactions that occur *in situ* include among others the creation of aqua-culture ponds, increased pressure from capture fisheries and farming. The impact of *in situ* agriculture and fisheries differ from complete transformation of wetlands (some types of aqua culture, land reclamation for agriculture) to harvesting of products the wetland produces in a natural or near natural state like harvesting reed and medicine plants, cattle breeding and fishing.

Indirect or *ex situ* interactions take place at a basin (catchment) level outside the wetland and include water abstraction, nutrient pollution, erosion, pollution with residues of pesticides and other chemicals, sedimentation, changes in the

water dynamics and changes in ground water levels. When striving to balance the ecosystem services an ecosystem delivers we therefore cannot limit the DPSIR analyses to the wetland but need to look at the catchment the system is part of.

9.2 Elements of the DPSIR methodology

The DPSIR tool includes an analysis of the following elements: (derived from the FAO/Ramsar study).

Drivers are any natural (biophysical) or human-induced (socio-economic) process that lead directly or indirectly to a change in the wetland ecosystem. Drivers are the root causes that lead to pressures on wetlands or agriculture–wetland-related interactions. Examples are: population dynamics, market development, natural environmental processes, government policies, and community behaviour. Drivers are in essence society's articulation of socio-economic needs in the form of demands for deriving benefits from ecosystem services – e.g. population dynamics & food security, market demands, nature conservation ordinances, etc.

Pressures are the means by which ecosystem services are exploited and through which the needs and demands from the drivers are satisfied – e.g. irrigation, crop intensification, aquaculture, water extraction, vegetation clearance, tourism, designation of a protected area, etc. Each particular method by which the ecosystem service is exploited will in its turn determine the way in which the ecosystem is influenced though its particular utilization of its biological and physical resources.

State changes in the (wetland) ecosystem are described in terms of state of the ecosystem services that are being used or the wellbeing or benefit of the society be it the provisioning service or the non-provisioning services. They very much focus on the quality of the ecosystem. So the analysis focuses on how each pressure impacts the biological or physical features of the wetland and the services provided especially its regulating and supporting services. Examples are: water resources, water quality and pollution, soil characteristics (chemical and biological), and biodiversity.

Impacts are the socio-economic and environmental conditions that result from changes in the state of the wetland environment. The emphasis of the analyses is on providing a socio-economic characterization of society in terms of: (i) who derives which benefits from which ecosystem service; and (ii) whose / which benefits (whether private or public) are affected negatively through the ensuing state (changes) of the ecosystem (Wood; 2010). Impacts describe how the socio-economic characteristics and condition of a wetland society are affected, especially the provisioning services.

Examples are: livelihood gains from market-oriented production, food and nutritional changes in subsistence situations, socio-economic differentiation and conflicts, and recreational development.

Responses are the actions in response to drivers, pressures, state changes and impacts. These may be technical and institutional and involve policies and planning. They can be implemented by a range of actors. Responses may originate from the socioeconomic environment itself, as people seek to improve the beneficial impacts they derive from the wetland ecosystem service, but they may be initiated by government agencies or NGOs working with communities. In this way positive or negative feedback loops in the utilization of wetland ecosystem services are formed.

9.3 DPSIR analyses of Lake Burullus

9.3.1 Drivers

Population growth

Egypt's population is growing at a fast rate. Projections of future population growth differ; based on different scenario assumptions and the uncertainty in the future size of the population is large. The maximum prediction of the population indicates a growth from 80 million in 2010 to 150 million in 2050. And up to 90% of Egypt's population is living in the Nile delta; the population in the Nile Delta has grown from 35 to 73 million in thirty years. An increase of food production can only be realized by transporting Nile water to the desert, which goes at the account of water in the delta, or by reclaiming wetlands like Lake Burullus. The population density in the area with 707 persons/km^2 belongs to the highest of rural Egypt.

Market developments

The fish from the aqua culture facilities that have been developed along the fringes of and also in the lake since the past 20 to 30 years is for a big part transported to markets outside of the region. (mainly tilapia). The construction of roads has fuelled the access to the markets and the development of the aqua culture activities.

International conventions

Egypt is a signatory to a number of international conventions including the Convention on Biological Diversity and the Ramsar Convention while it is also committed to the Millennium Development Goals. As a result the government of Egypt has designated lake Burulles as a Ramsar site (wetland of International importance) and as natural protectorate (since 1998) but also pursues policies to eradicate poverty and increase food production.

The Ashwan dam

The building of the Ashwan dam has helped Egypt significantly to increase its food production and to achieve economic growth. The building of the dam however brought about significant changes in the hydrology and sedimentation processes most notably in the sedimentation and erosion processes along the coastline. The amount of silt transported to the Mediterranean nearly entirely disappeared disturbing the balance between sedimentation, accreditation and erosion along the coast. Now erosion prevails and the sand barriers (dunes) between the lakes (and the delta) are getting thinner and thinner ultimately leading to its disappearance threatening the hinterland to be flooded. Another pressure resulting from the building of the Aswan dam is the construction of an intensive drainage and irrigation system upstream of the lake that has led to a significant increase of the inflow of fresh water into the Lake.

Climate change

Predictions about the impact of climate change indicate that the sea level will rise causing increased salt intrusion and floods which will have a serious impact on the livelihoods of the region.

Governance structure and political instability

Chapter 2 presents insight in the lack of clarity about responsibilities for management and protection of the Lake. Although steps were made to improve the situation though the establishment of a cross sectoral management committee, in which all relevant stakeholders are represented, this body has shown to be ineffective. Recently another attempt has been made to improve the situation through the signing of a Cooperation protocol in 2012 but the political instability has also prevented this initiative to reach anything tangible. Also the interests of the local communities are not taking seriously into consideration into any of the initiatives. And last but not least participation in the deliberations is limited to organizations directly related to research and management of the lake but do not include representatives of upstream

stakeholders, who are responsible for the pollution of the Lake. Cooperation with the ongoing World Bank Project though which investments are made to improve the drainage and irrigation structure upstream of Lake Burullus is a necessity if a sustainable solution for the pollution of the Lake it to be found.

9.3.2 Pressures

Land reclamation

Land reclamation causing pressures on the Lake's ecosystem services are occurring *in situ* and *ex situ.* The decrease of the size of the Lake is caused by the turning the Lake into either agricultural lands or aqua culture ponds According to the management plan and additional information gathered during this project aqua culture ponds are still being built in the Lake and sand dunes and salt marshes are still being reclaimed for agricultural purposes. Also upstream of the Lake areas earlier frail for agriculture could be reclaimed for agriculture because of the availability of fresh water all year round after the building of the Ashwan dam. Many drainage canals discharge their water into the Lake leading to a rising water level of the Lake and thus halting back the inflow of water from the sea.

Reed beds encroaching in the Lake

Due to the inflow of nutrients from the upstream agricultural lands reed has rapidly encroached into the Lake causing a further decrease of the open water surface. In recent years the reed coverage has decreased a little possibly because of intensive harvesting and burning. It is feared that reed encroachment will cause fragmentation of the lake into various smaller parts on the long term.

Over exploitation of the fish stock

The massive increase of the fish caught in the lake combined with increased illegal fishing activities among others by the catching fry to be used in the aqua culture, will ultimately lead to decreased fish harvest and fish species diversity.

Water pollution

Water pollution is caused by inflow of untreated domestic waste water, affluent from the aqua culture ponds along the shores of the lake and the inflow of water from upstream irrigated agricultural lands. Nutrients and heavy metals are recorded at increasing levels.

Poaching

Despite the fact that it is forbidden to hunt in the protectorate hunting of water fowl and other bird species is still quite commonly occurring. Poaching and illegal fishing includes using illegal fish gear, catch fry to be sold to the fish farms, catching small size fish not for human consumption but for the fish industry.

Hunting

Waterfowl is being hunted all over Egypt and Burullus is no exception. Two types of hunting can be distinguished; commercial hunting and sports hunting both practiced mainly during the winter season when an abundance of water birds are flocking Egyptian wetlands. Both are illegal in the protectorate.

Increased inflow of fresh water

Currently the amount of fresh water is exceeding the amount of salt/brackish water coming to the lake which has caused the lake to change from a brackish lake to a fresh water lake.

Encroachment of aquaculture

Aqua culture is practiced in so called Hosha's which are areas closed off from the Lake by dikes/dams with one or two openings to the lake. In some cases and especially for smaller Hosha's fish swims simply into the Hosha which is then closed off and after a while the water is pumped out and the fish caught. Many Hosha's are populated by fry caught in the Lake. The main fish produced is Tilapia.

Changed hydrological dynamics
The building of the Ashwan dam induced melioration works and the building of an extensive irrigation and draining infrastructure that caused on its turn a change of the quantity and quality of the water discharged into the lake. The ongoing irrigation project (the IIIMP project) might further change the dynamics and quality of the water coming to the lake.

Garbage dumps and affluent of households
Garbage dumped along the water line and the affluent of untreated waste water from approximately 185.00 people living around and in the lake presents a real pressure to the lake.

Fragmentation and removal of the natural sand dunes and salt marshes to be used for agriculture The causes the depletion of natural habitats and biodiversity

9.3.3 State changes

Decreased surface
In 1810 the recorded size of the lake was 1092 km^2. In 1984 lake surface was 502,7 km^2 and in 1997 410 km^2 while the circumference dropped from 160.0 km to 143.0 km in the same period. It is difficult to compare these date because it is unclear what have been included as "Lake"; was this only open water or did it include reed and marsh vegetation. The surface of open water dropped from 37.000 hectares in 2002 to 32.460 hectares in 2011. Further the water depth has decreased over the years because of sedimentation of deposits from upstream areas and biomass being accumulated.

Water quality
Chapter 6 shows clearly how the water quality has deteriorated during the past decades and how this deteriorating water quality has impacted the biodiversity and the fish community living in the Lake. The absence of inflow of seawater has seriously changed the character of the Lake from a brackish water lake into a fresh water lake.

Biodiversity
Up to date biodiversity data are difficult to obtain due to an ineffective biodiversity monitoring program.Over exploitation and habitat loss is considered the main driver for a decrease in herpeto-fauna, while poaching is possibly resulting in a decrease in the number and/or variety of bird species. Also water pollution and locally intensive grazing is posing a threat to the species diversity of the herpeto-fauna. Birds breeding in colonies are absent in and around Lake Burullus which might be attributed to the high level of disturbance by human activities. On the other hand the increase of the coverage of reed vegetation has increased the habitat variety and adds to the suitable habitat for many wetland birds species.

Tourism
The current situation does not present favorable conditions for developing a vibrant tourism industry that could provide additional income to the local communities.

9.3.4 Impacts

9.3.4.1 Provisioning services

Fish
Fish catch has increased tremendously; from 6000 in 1970 to 59.000 tons in 2010 while in addition the yields of aqua culture increased from 0 to over 155.000 tons of fish annually in a time span of 30 years. Fishermen are however complaining because high value fish has disappeared from the lake as a result of the change of the character of the lake from brackish into a fresh water lake which caused the

disappearance of 7 most valuable fish species. Also the fish catch per fisherman has decreased significantly due to a massive increase of the number of fishermen.

Biomass

The biomass production has also increased significantly especially the amount of reed. As a result of the inflow of nutrients also the area covered with reed has increased considerably at the account of the open water. Although reed is limiting the opportunities to catch fish it also offers a source for income when used as building material and as bio-fuel. In ancient Egypt reed was an important source for matting, wind breakers and as a bases for handy craft products. Regrettably the local communities have not yet grabbed the full potential of the reed as potential material to thatch roofs or to use as fodder, fuel or biomass for improving soil fertility. The claims of ownership on the shorelines and parts of the Lake exercised by influential and powerful individuals and often supported by armed guards might however also negatively impact the possibilities to harvest reed and other natural resources.

Cattle grazing

Cattle grazing is occurring mainly on the islands and there are no date whether this has increased, decreased or is stable.

Medicinal plants

Harvesting of medicine plants is still happening and no data showing changes in the amount or in the species collected have been found.

9.3.4.2 Regulating – flood control, water infiltration

Mitigating sea level rise

The possibilities of the Lake to mitigate sea level rise and provide safety for the rising sea level have decreased as a result of the increase of water discharged, resulting in a higher water level, the sedimentation of eroded particles from upstream areas and the encroaching reed beds.

Cultural – religious, recreational, tourism, etc

Tourism is weakly developed although the Lake has a potential to develop bird watching and related touristic activities.

There is no information about cultural or religious services provided by the lake.

Support – soil formation, cycling of nutrients, carbon storage, etc.

Reed supports the natural purification process of water and traps nutrients. The purification capacities might have increased but the amount of nutrients and other pollutants have also increased so the net result might be zero and whether the water quality discharged into the sea has deteriorated is not known.

Biodiversity – natural habitats for plants, animals and insects

According to the Ramsar Convention basic elements of why the lake was designated as a Ramsar site are under threat. Available data show an decrease of the herpeto fauna species. Experiences from other wetlands have learned that pollution, poaching and overfishing have a negative impact on the biodiversity.

The hosha fishery negatively impacts the biodiversity of the shore line and shallow coastal waters of the lake because it destroys and occupies natural habitats and pollutes the water with its affluent.

9.4 Proposed responses

In the past and also today a variety of management activities have been carried out to address the problems caused by the deteriorating environmental situation of the Lake, including the removal of reed and the dredging of the Bourghaz inlet to allow sea water to flow into the Lake. Various attempts have also been made to remove illegally constructed fishponds but according to investigations done in the frame of this project and to newspaper articles the removed ponds were very soon constructed again. These activities will help for a short while but won't solve the problems on the long run and are thus not sustainable.

Some of the drivers, like climate change and sea level rise, that are responsible for the down going quality of the Lake are laying outside of the immediate influence of the management and even outside of the direct influence of the Egyptian government. Other drivers like population growth can only be changed on the long run and through targeted and sustained political will. The only driver where political will and commitment can bring about change and can have an impact is on the governance structure. Most management interventions are likely to have much more effect when targeting the pressures. Besides agreeing on a clear division of responsibilities and constructing a strong and effective governance structure, interventions on land reclamation activities including the building of fish ponds, the discharge of polluted water from households, industries and agriculture, the control on poaching and waste dumps, the change of water dynamics in the Lake will all contribute to improve the situation and at least halt further deterioration. However; all these interventions are impossible to plan, finance and implement without a clear, transparent and accountable decision making structure.

9.4.1 Cooperation Protocol April 2012

The Cooperation Protocol signed between in April 2012 is a good start to arrive at more effective management. In 2012 the Cooperation Protocol between the Ministries of State for Environmental Affairs, the Ministry for Scientific Research and Technology, the Ministry of Agriculture and Land Reclamation and the Ministry of Irrigation and Water Resources was signed "for the rehabilitation of the Lake" but whether the protocol has led to anything tangible is unknown. The text of the Cooperation Protocol is not clear about which Ministry will have the leading role in the implementation of the Protocol; the text refers only to the importance of cooperation. The Egyptian Environmental Affairs Agency, the Institute for Oceanography and Fisheries, the Remote Sensing Authority, the General Authority for Fish Resources Development and the Water Research Center (Coastal Research Institute) are mentioned as the implementing agencies again without indication of who is coordinating.

Attached to the protocol is an action plan with the objective "to restore and rehabilitate of the northern lakes, raise living standard, conserve natural resources and water surfaces". It aims to achieve the following goals:

1. Integrate the activities among stakeholders and avoid repeating actions, leading to rationalization of government budget.
2. Promote cooperation and coordination between the scientific communities and civil service of relevant ministries and agencies.
3. Maximize economic returns and social dimension of the northern lakes.
4. Better use of different potential expertise available among various parties.

The activities listed to achieve the aims are the following:

1. Comprehensive review of all legislations and institutional structures in charge of for the lakes.

2. Comprehensive review of all available information, data and digital maps (GIS) for each lake including projects, plans, programs and preparation of an integrated database.
3. Identify the environmental characteristics of each lake.
4. Identify the sources of pollution for each lake and propose mechanisms to reduce their water pollution.
5. Identify causes of economic and environmental deterioration of each lake and propose mechanisms to reduce their deterioration.
6. Develop monitoring programs of water quality for each lake of the northern lakes and develop monitoring database.
7. Study the impact of climate change on northern lakes.
8. Organize and conduct training workshops to support institutional capacities and develop plans and programs for the management of the northern lakes.
9. Identify training programs that will be implemented within duration of the program.
10. Develop indicators for monitoring, analysis and follow-up.
11. Develop plan for land uses.
12. Prepare an Integrated Coastal Management Plan for each lake.

A working group with representatives of the implementing institutes mentioned in the Protocol (the Egyptian Environmental Affairs Agency, the Institute for Oceanography and Fisheries, the Remote Sensing Authority, the General Authority for Fish Resources Development and the Water Research Center (Coastal Research Institute) have met a couple of times and presented the following recommendations to enhance the implementation of the Protocol:

1. Formation of a ministerial committee membered by four ministers who signed the protocol and the governor who's responsible for each lake boundary under the chairmanship of Prime Minister, this committee will oversees the implementation of the program and issue the appropriate decisions to facilitate the work.
2. Formation of a steering committee membered by of the Head of the six implemented agencies and Institute "Egyptian Environmental Affairs Agency, National Institute of Oceanography and Fisheries, Remote Sensing Authority, General Authority for Fish Resources Development, Coastal Research Institute and Drainage Research Institute and chairmanship by the Minister of State of Environment.

The compilation of the proposed steering committee resembles pretty much the existing cross sectoral management committee apart from the fact that it is lacking local representation. Whether there is a role foreseen for the existing cross sectoral management committee is unclear or maybe it simply has ceased to exist.

9.4.2 Other proposals

The new Cooperation Protocol goes further than the Ministerial degree through which the cross sectoral management committee was established. (See chapter 3) Contrary to this degree the Protocol is signed by 4 Ministers and has therefore a broader base than the existing cross sectoral management committee which was established by the State Minster for Environmental Affairs. Pleading against the success of the Protocol is the fact that local stakeholders are not involved and it is absolutely unclear how the stakes of the local fishermen will be presented. As indicated before the deteriorating quality of the environmental conditions of the Lake and the skewed services provided by the Lake cannot be tackled without a catchment based approach. This implies that also relevant parties from upstream areas including the IIIMP World Bank Project, will have to take part in the discussions and should consequently be invited to participate in the newly established structure of committees and working groups.

The most urgent and important task of the newly established "steering committee" and of the Cooperation Protocol is to arrive at commonly supported objectives for the future use and management of the Lake and its catchment. The challenge is to strike a balance between the various demands for the services the lake provides and to present a framework in which no service is exploited to extent that other services disappear or are marginalized. The challenge is to accommodate the demands of the fishermen to catch good quality and quantity of fish, of the farmers to produce crops, of the cattle breeders to graze their animals and collect fodder, of the plant and bird species to find refuge, of the hosha fishery to do business and of the citizens who want the Lake to protect them against the rising sea level and to enjoy the beauty of the Lake for relaxation.

It is of course immensely important to set up a sound monitoring program that allows for assessing the current status of the quality of the Lake and of the ecosystem services provided and to monitor the success of proposed interventions and management measures. But not much energy and money should be devoted to further research; the causes of economic and environmental deterioration of the Lake are clear as are the sources of pollution. No regret measures to stop the deterioration can and should be designed quickly and include:

- Waste water collecting and purification.
- Reduce the influx of nutrients. This could be done through the construction of artificial wetlands at the end of the drainage canals before the water is released into the Lake. These artificial wetlands could be used as fish ponds at the same time under environment friendly management in order to not pollute the Lake.
- Stop the dumping of solid waste.
- Stop proliferation of aqua culture ponds further into the Lake and dismantle those who are illegal according the legislation of the Protectorate.
- Support the fishermen's cooperatives to become real cooperatives that serve the interest of the fishermen.
- Impose urban planning according to strict regulations about where to build and where not.
- Reduce the amount of water being discharged into the lake by diverting some drainage canals so they discharge directly into the sea in close cooperation with the World Bank IIIMP Project. This helps to allow improved exchange of the water of the Lake with the sea.

Another measure proposed by the Coastal Research Institute is to create a new opening to the sea close to the western edge of the Lake. This could help to increase the water circulation in the Lake. It is worthwhile to investigate the impact of this plan in combination with other measures mentioned above.

The most important challenge is however to embark on an intensive process of mediation and negotiation under the responsibility of the State Ministry of Environmental Affairs in which all stakeholders participate and that will result in a common vision that allows the Lake to provide all its ecosystem services in a balanced manner.

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Appendix 1

Contact persons important for the project on Lake Burullus

- Dr. Moustafa Fouda; Advisor to the Minister; Nature Conservation Sector; Egyptian Environmental Affairs Agency: foudamos@link.net; drfoudamos@gmail.com.

- Dr. Adel Abd Alla Soliman: adelnbu@yahoo.com; Nature Conservation Sector; Egyptian Ministry of Environmental Affairs.

- Dr. Khaled Allam Harhash; Head of the Planning Unit, Nature Conservation Sector, Egyptian Environmental Affairs Agency;+ 202 25271391; mob +2 010 1288508 Mob. +2-010-1288508 Tel. +2-02-23744921; Email: khaledallam4@hotmail.com.

- Mr. Ahmed Ali of the Ministry of Environment; Head of the Central Department of Protected areas; e.ahmedali_ncs@hotmail.com.

- Mr. Fayed El-Shamly; Manager of the Protectorate of Lake Burullus; fayed_1960@yahoo.com.

- Prof. Dr. Ibrahim Abdelmagid Aly Elshinnawy Director of Coastal Research Institute; Alexandria; coriegypt@yahoo.com.

- Dr Mohammed Aly Borhan; project manager of the UNDP/GEF funded project "Adaptation of the Nile Delta to Climate Change and Sea level Rise through ICZM; Based at CORI; 15 Pharaana Street, Sllalat, Alexandria; e-mail: noscp@link.net; mobile: +20 1001225140.

- Dr. Ashraf El-Sayed Ismail; Deputy Director of the Drainage Research Institute (NWRC); ashsayed@hotmail.com.

- Alaa A. Abdel-Motaleb; Professor & Director; Drainage Research Institute; Delta Barrage, Kaliobia, 13621; EGYPT; Mobile + 20 1221056331; Alaa Abdel-Motaleb alaamotaleb@yahoo.com.

- Dr Ahmed El Hawary; Drainage Research Institute; Delta Barrage, Kaliobia, 13621 a_elhawary@dri-eg.com tel; Mobile: +201110069122; Constructed Wetlands, water purification and aquaculture.

  Prof Dr Gamal El-Shabrawy; elshabrawy_gamal@yahoo.com; National Institute of Oceangr. & Fisheries Research Station; Fish research station; ElKanater ElKharia; Cairo; Egypt
  Mobile 002-01006884922.

- Dr Suzan E.A. Kholeif; National Institute of Oceangr. & Fisheries Research Station; Head of Marine and Geology lab and project manager of the FORCE Project (www.forceproject.eu) MEDINA Project (www.medinaproject.eu)and PEGASO Project (www.pegasoproject.eu); mobile: +20106635389; suzan_kholeif@yahoo.com; suzan_kholief@hotmail.com.

- Hisham El-Shafieay; Program Development and Monitoring Officer, ANR / CARE Egypt; HELShafieay@egypt.care.org.

- Dr. Francois Mole (IRD and IMRI); François MOLLE francois.molle@ird.fr; Good contacts in the water sector in Egypt.

- Mr. Tim Young, Team Leader of the Mediterranean Hotspot Investment Programme t.young@mehsip-ppif.eu.

- Mr. Moustafa Moussa; Local Coordinator of the Waste Water Expansion Project for Kafr El Sheikh Governorate. m.moussa@unesco-ihe.org.

- Mohamed Abdrabo; Director of the Adaptation Research Centre in Alexandria - environmental economist, IPCC WG2 author, his email address is mabdrabo@hotmail.com.

- Dr. Amr Farouk Abdelkhalik; member of the Strategic Planning and Technical Support Office; Ministry of Scientific Research; aabdelkhalik@gmail.com.

- Dr Mohamed Elaraby; GAFRD Chairman Office -Technical Support; MADE Project Technical Coordinator & Extension service 4,Tayaran St.- Nacer City - Cairo - EGYPT Tel:-(+2)0222620130 - (+2)01227733705) elarabyfish@yahoo.com.

- Dr. Ahmed Salem; General manager of Information Center, GAFRD; 4,Tayaran St.- Nacer City - Cairo – EGYPT. Tel:-(+2)0222620130 - (+2)01227733705; AhmedSalem.GAFRD@gmail.com.

The overall objective of the project is to support the State Ministry of Environmental Affairs of Egypt in its task to protect and manage the Lake Burullus and to halt the ongoing deterioration of the condition of this important Lake which is designated as a Wetland of International Importance under the Ramsar Convention. The project has gathered and analyzed water quality and water quantity data, data about land use changes, socio-economic data of the fishermen living around the Lake and information about the responsibilities and governance structure for management of the Lake to identify the drivers behind the deteriorating quality of the Lake and to design solutions to stop the loss of biodiversity and the decreasing value of the Lake for catching fish and providing animal protein and income to the livelihoods living around the Lake. An important component of the project was to gather and analyze information about the attitudes and expectations of the local population and in particular of the local fishermen with respect to the management of the Lake.

More information: www.wageningenUR.nl/cdi

Centre for Development Innovation
Wageningen UR
P.O. Box 88
6700 AB Wageningen
The Netherlands