

Socio-Economic Stakes and Perceptions of Wetland Management in an Arid Region: A Case Study from Chott Merouane, Algeria

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Abstract The objective of our study was to identify how actors from the main socio-economic sectors perceive their interactions and impacts on a sensitive wetland in an arid climate, specifically the salt pans of Chott Merouane in Algeria. The results revealed that there are three main economic stakes including agriculture, livestock production and salt mining, each activity providing a great benefit for local and national populations. The local population perceived that the current activities are conducted in such a way that they created conflict between socio-economic sectors and caused a threat for long term sustainability of the wetlands. The results highlighted the need to initiate an integrated management approach between the different sectors and to develop a shared vision for the territory.

Keywords Chott · Conservation · Integrated management · Protected areas · Socio-economic stakes · Wetlands

INTRODUCTION

Wetland habitats are valuable for the services that they provide in water storage as well as for safeguarding innumerable species of plants and animals (MA 2005). Despite the varied nature and typologies, there are some common threats facing all wetlands. Since 1900, more than half of the worldwide wetlands have been converted for agricultural production and infrastructural development (Schuyt 2005). During the twentieth century, Mediterranean

countries have lost 50–70% of their wetlands (Bonnet et al. 2005).

Rappe and Hammee (1986) highlight that the progressive disappearance of wetland biotopes can be qualified as a disaster for wildlife. In a world reeling under the full brunt of global changes (human encroachment, loss of habitats, climate change, fragmentation, invasive species, etc.), Algeria is no exception and the country has exhibited over the last decades a marked erosion of valuable wetlands (Samraoui et al. 1992, 2011; De Bélair and Samraoui 1994). In addition, Wanzie (2002) reports that the destruction of wetlands leads not only to the disappearance of species, but also to the loss of social and economic benefits of the local populations who depend on wetlands for their livelihoods.

Algeria contains a great number of wetlands (Samraoui and De Bélair 1997; Samraoui and Samraoui 2008), including freshwater and brackish marshes, lakes, and salt pans. The largest wetland surface area is made up of salt pans, spread out from the coastal area to the northern Saharan fringes and across the High Plateaus. The term chott is employed readily for salt pans in North Africa, whereas in South Africa the same habitat is designated as salt pans and in North America as salines (Direy 1960). This article uses the term chott, given the geographic territory that the study covers.

The largest Algerian chotts are located in the Great Oriental Erg, in the north-east of the Sahara, Chott Melghir and Chott Merouane are the two largest individual chotts in this area. These chotts, constitute a vast band which spreads from Southern Tunisia to the Atlas Mountains (Mahowald et al. 2003). Chotts are fragile spaces characterized by climatic and edaphic constraints. Nevertheless, the ground structure around the chotts allows the colonization of halophilic plants which are able to complete their

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life cycle under extreme conditions. Various plant species are distributed throughout the chotts according to salinity levels, with a higher density of plant cover in areas with lower salt concentrations (Larfa 2004). Wetland management is extremely critical as any changes or development could have a severe impact on the limited water resources (Hollis 1990).

Adaptation of natural resource use has been necessary to fit the harsh conditions in the desert, creating a local “know how” for local economic activities. The main socio-economic activities found in and around the chotts are agriculture, livestock rearing (Djennane 1990) and salt production (Hacini et al. 2009).

Agriculture is the principal economic activity, with important date palm *Phoenix dactylifera* L. plantations. The land reclamation policy in Algeria has transformed many of the Saharan oases into intensive agricultural zones. The agricultural surface area of the study zone passed from 3259 to 6518 ha between 1992 and 2009. Livestock production is the second most predominant economic activity. Nomadism, once prominent in the region, is now being replaced with sedentary agriculture but, nevertheless, the number of sheep *Ovis aries* L. found in the region has continued to increase (Guillermou 1990).

Evaporation during the dry season creates salt crystals made up primarily of sodium chloride, which turns the zone into a significant salt mine. The government has held a monopoly on salt exploitation until 2003. The mining policy was since reformed, opening access to the private sector. Small scale international tourism can also be found in the area, with groups of hunters (high profile guests from the Gulf region invited by governmental authorities) setting up hunting expeditions for the Houbara bustard *Chlamydotis undulata* Jacquin and Dorcas Gazelle *Gazella dorcas* L.

The objective of our study was to identify how actors from the main socio-economic sectors perceive their interactions and impacts on a sensitive wetland in an arid climate. In order to reach this objective, we developed two research questions each with a separate hypothesis: First, what are the economic stakes and how do they impinge on the vulnerable wetlands? In order to answer this question we developed our first hypothesis: The economic activities in their current forms do not have a negative impact such as resource overuse on the environment and activities are well integrated within a framework of sustainable use of the protected zone. Our second line of research was to identify the perception of the local population concerning the sources of conflicts which might threaten the ecological integrity of local wetlands. Our hypothesis was that the economic stakes in a region with severe climatic conditions are a potential source of conflict between users and thus have a negative effect on the wetlands. Resource overuse

can lead to conflict between users due competition for the limited water resource and lack of management. This may be in accordance with Hardin’s (1968) theory on the tragedy of the commons. The results could provide indications for future management of wetlands in arid areas to insure sustainable ecosystem services and sustained socio-economic activities.

METHODS

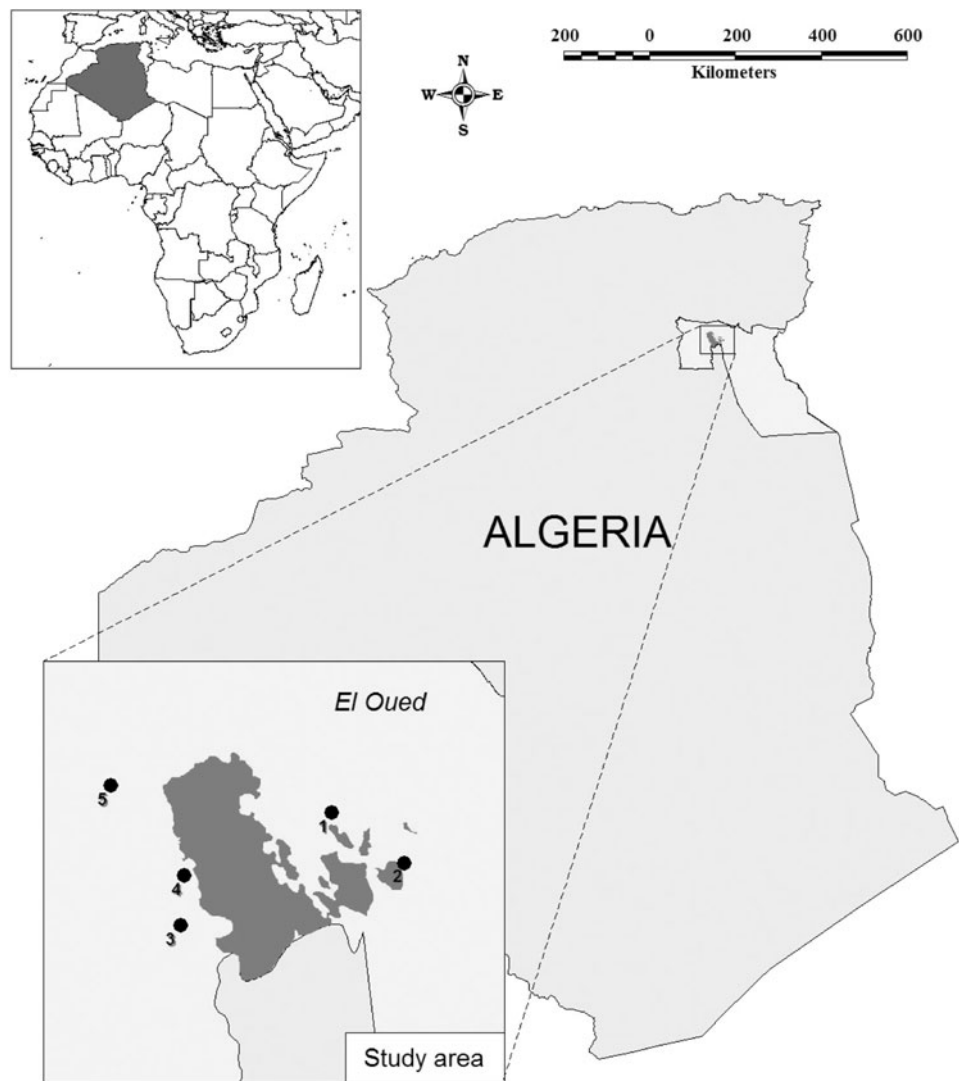
Description of the Study Area

Chott Merouane (34°10.63’N, 6°17.32’E) is one of the largest chotts of Algeria; administratively it is attached to the Wilaya of El Oued (Fig. 1) and covers 337 700 ha. The chott it is fed by three principal water sources: the drainage channel of Oued Righ, ground water and rainfall (Hacini et al. 2009). The chott benefits from flood waters coming from El Bibane. This zone encompasses several smaller chotts including: Chott Eddar, El Ghaba, and El Magtaâ. The region is valued for its ecological, cultural, and economic worth at national and international levels. In 2001, the zone was designated as a RAMSAR site and is classified as an Important Bird Areas (IBA). The Chott harbors most significant concentrations of wintering stopovers and provides a breeding ground for many water birds (Samraoui and Samraoui 2008; Bouzid et al. 2009; Béchet and Samraoui 2010; Samraoui et al. 2010). Some of the water birds that are commonly found in Chott Merouane are shown in Appendix 1 in electronic supplementary material. The highly saline water also promotes the production of large branchiopods such as *Branchinella spinosa* Milne Edwards, *Branchinectella media* Daday, and the brine shrimp *Artemia salina* L. (Samraoui et al. 2006).

Methodology

This research used a holistic approach combining a bibliographic study with a field case study. The first stage was built on an iterative process between field and theory. We tried to establish baseline information by gathering demographic and economic information from each of the sectors through key informant interviews. We interviewed the mayor of each district (five people in total) concerning the relation of the district with the chott. The interviews took an average of 2 h and had two objectives. The first was to explain the aim of the study and the second to obtain statistics on farms number and size, farmers and shepherds number and their distribution. We then proceeded to interview other official services (Direction Générale des Forêts, Direction des Services Agricoles, Conservation des Forêts and Direction des Mines) to collect information on

Fig. 1 Geographical situation of the study area and sampling site. 1 Hamraia, 2 Sif El Menadi, 3 Dendouga, 4 Nessigha, 5 Oum El Thiour, ■ Chott Merouane



the study area. In total, we conducted eight interviews with these various services in 2009 and 2010.

We carried out our field work to characterize the social groups and gather up the information concerning the main activities of the region; to identify the socioeconomic and financial stakes which they generate; and to identify the perception of the effect of the different uses on the wetland. A standardized questionnaire (composed of 40 questions) was implemented for each socio-economic sector using open and closed ended questions. The questionnaire was divided into three principal parts, (1) demographic information (age, gender, family size, and educational level), (2) economic activity (main activity, agriculture, livestock production, salt mining), and (3) stakes and perception of the users of the protected region and the effects of the current practices on their well-being (Appendix 2 in electronic supplementary material).

In this area, considering the local cultural traditions, the participation of women in economic activities outside their

home is rare, causing a participation bias for men. We interviewed a total of 110 people in situ. We randomly selected respondents based on archives of the different sector activities (Direction des services agricoles, Direction des mines), limited to a 15 km radius from the chotts. Given the disparity of the number of the socio-economic sectors, we surveyed 4% for the agricultural and livestock sector; however, for the salt mining we sampled 55% (only nine salt users are found in the entire zone). Of 110 respondents, 55% were farmers, 17% stockbreeders, 23% farmers-stockbreeders, and 5% salt miners. The interviews were conducted in Arabic and the interview time varied from 1 to 2 h.

Focus group discussions were conducted with the population in each agglomeration of the chott. Heterogeneous socio-professional groups were formed with either women or men (with five to eight people per group) as inspired from Grudens-Schuck et al. (2004). We carried out 5 focus group discussions with a total of 39 participants. The

discussions were based on open-ended questions focusing on perception and behavior toward the protected area. The discussion time for each focus group lasted approximately 2h.

The questionnaires were analyzed using pivot tables in EXCEL and STATISTICA 9 Software, and then tested for significance using ANOVA and χ^2 tests. MapInfo and Illustrator were used to produce the various maps.

RESULTS

Description of the Users

Four major economic stakes can be identified within the study area (Fig. 2). The activities are principally male dominated with only 2% of the women taking part in agricultural activities. The majority of respondents are farmers (50.09%), followed by farmer–livestock producers (24.76%), livestock producers (12.38%), and salt miners (4.76%). The average age of the users is 45.9 ± 14.0 years. The age of the respondents varies from 18 to 75 years. The farming–livestock producer’s activity is practiced by a relatively young population (37.4 years), whereas farmers tend to be older, with an average age of 50.1 years. The age difference between these two populations is highly significant ($F=547.58$; $p=0.0007$). The average family size

ranges between 7.4 and 8.2 individuals, however, the difference is not significant between the populations of the various activity sectors.

The livestock producers (Table 1) have a lower income compared to the other users; it is four times lower than that of the farmers and six times lower than that of the farmer–livestock producers and almost 100 times less than that of the salt miners.

The education level of the respondents varies among socio-professional groups. Livestock producers have the highest levels of illiteracy (92.3%), however, more than half of the farmers (55.7%) have only a primary education level (they can write their names and read the Quran). The college level is represented more by the farmers–livestock producers, the majority of salt miners have secondary and university education levels.

Agriculture

Eighty percent (80%) of the local population generates their income from date production. The average farm size is 3.41 ± 5.28 ha, with surface areas ranging from 0.25 ha to 40 ha. 49.2% of the farmers inherited their farming plot, others obtained theirs by land reclamation (36.1%) within the agricultural policy framework; the remainder (14.8%) obtained their land by both inheritance and land reclamation.

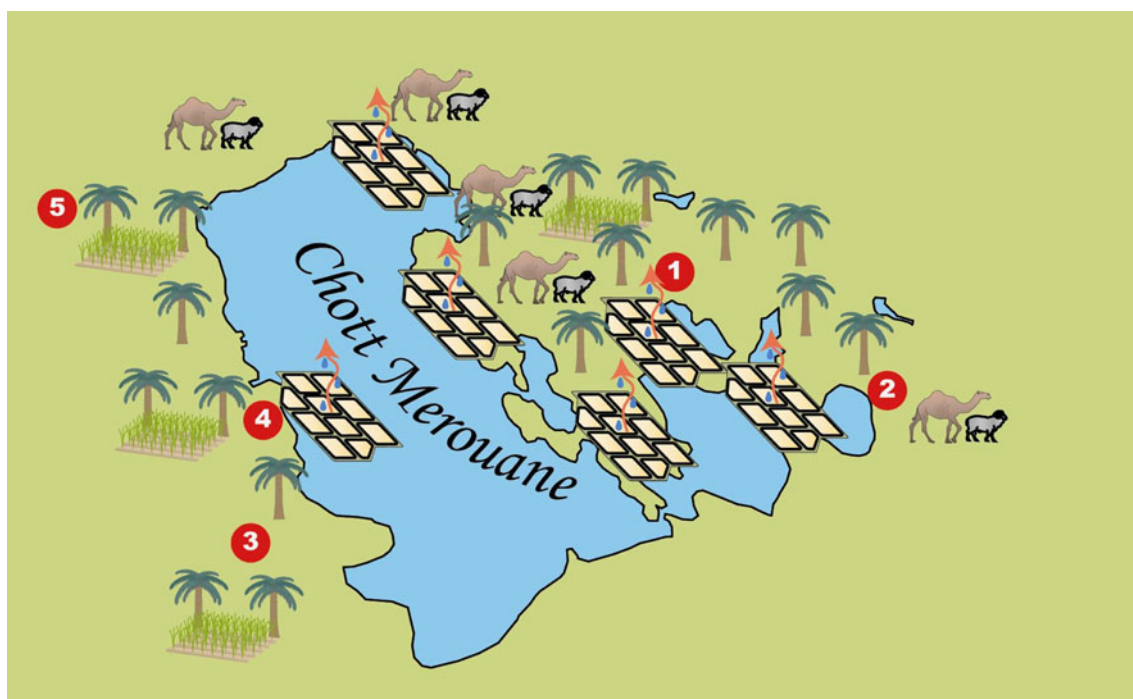


Fig. 2 Illustration of the major economic activities in the study area. , Grazing areas; , palm inter cropping; , palm monoculture; , salt mining; ①, Hamraia; ②, Sif El Menadi; ③, Dendouga; ④, Nessigha; ⑤, Oum El Thiour

Table 1 Summarized averages and standard deviation of the age, size of the family and incomes by activity sectors (US\$ 1 = DA 74.17 Algerian dinars, December 2010)

Users	Age	Family size	Income/DA/month		
			Medium	Minimum	Maximum
Farmers	50.26 ± 11.65	8.18 ± 3.23	37 618 ± 40 105	7000	140 000
Livestock producers	42.61 ± 13.45	7.92 ± 1.60	8338 ± 1146	7000	37 500
Farmers–livestock producers	37.34 ± 15.32	7.92 ± 3.65	50 752 ± 47 850	9160	233 000
Salt mining	44.00 ± 13.03	7.40 ± 1.14	1 444 444 ± 634 775	40 000	2 166 666

Deglet Nour cultivar is the most cultivated date variety (80.7%) followed by *Ghars* cultivar (13.2%) and *Degla Beidha* (6.1%). The same trend is noticed with the farmer–livestock producers (75% *Deglet Nour*, 19% *Ghars* and 6% *Degla Beidha*) whose farm sizes average 4.58 ha. 60% of the farmers and 50% of the farmer–livestock producers intercrop their palm plantations. The main crop plants are either perennial (fig tree and pomegranate) or annual (barley and clover). Although the *Deglet Nour* is by far the most predominant palm species, the area also hosts many other date varieties which hold a significant genetic value.

The irrigation schemes of the palm plantations are based on canalized line irrigation where water arrives consecutively through the various plots of land. The drainage water surplus is important to decrease soil salinity. The majority of the farmers (66%) and farmer–livestock producers (65%) claim not to use chemical fertilizers, while organic manure is employed by the majority (82%). However, pesticides against the crop pests (date mite *Oligonychus afrasiaticus* McGregore and Carob Moth *Ectomyelois ceratoniae* Zell.) are practically employed by all the farmers, while 25% also admit the use of herbicides. The totality (100%) of the farmers claims to have little knowledge of the effects of chemical pesticides on their health and on the wetlands. All the farmers use specialized labor for pollination of palm trees and date harvesting; however, the farmers often complain of a lack of qualified labor for this crop.

Livestock Production

The wetlands and their surrounding areas constitute a grazing area for the local and regional livestock producers, as well as for the farmer–livestock producers. All the livestock producers or farmer–livestock producers use the grazing area except during dry years. The livestock in the study area is made up primarily of sheep followed by goats *Capra aegagrus hircus* L. and dromedary *Camelus dromedarius* L. There are two types of livestock producers observed in this area, the farmer–livestock producers (livestock producers-owners) and the livestock producers (nomad livestock producers). The livestock of the farmer–livestock

producers is herded by a shepherd or a nomad livestock producer. This practice is common in the area involving an amount of money paid to the shepherd per capita and per month. The livestock size held by the nomad livestock producers is significant (74%), with an average of 190 ± 86 heads compared to that of the farmer–livestock producers, which is 62 ± 65.5 heads with a proportion of 65%. Their livestock is made up primarily of sheep (65.48%), followed by goats (21.38%) and dromedary (13.14%). The totality of the livestock producers has recorded a decrease in vegetative cover; in contrast, the farmer–livestock producers claim to be satisfied with the situation.

The itinerant livestock breeding way of life is becoming less attractive to the population, causing a decrease in nomad livestock producers.

Salt Mining

Approximately 75% of the governmental salt companies are found in this area, and among these, ENASEL (Entreprise National de Sel) is the prominent firm. ENASEL produces two types of salt, alimentary, and industrial salts, with more than 100 000 tons produced per year. In the area, salt mining is represented by two different legal forms: 22% are owned by governmental salt mining and 78% by private owners.

The average surface area for salt mines in the chott is 180 ± 142 ha. The mines employ between 7 and 90 permanent salaried staff. Salt extraction is based on obligatory saline tables, all drilling is prohibited, and the water of the saline tables must be extracted from the chott. It appears from our research that 22.2% of the mines use saline tables (one public salt mine and the others are private mines). However, the remainder of the companies makes direct salt extractions due to lack of water.

Attitude of the Users Toward the Chott

All of the salt miners recognize that the chott has a great economic impact, whereas only 56% of the farmers agree with the previous statement; representing a highly significant difference ($\chi^2 = 58.35$, $p < 0.001$).

Concerning the perception about the wetland status, the results reveal that all the interviewed livestock producers ignore that their zone is protected, and that only 56 % of the farmers are aware of the protected status. 60 % of the salt miners and 50 % of the farmer–livestock producers are well-informed of the protected status.

The lack of water is stated as a problem for all the different user groups; 61 % of farmers followed by 58 % of farmer–livestock producers deplore the lack of water. In contrast, only 40 % of the salt users state that the lack of water is a constraint. Thus, the difference between the respondents is highly significant ($\chi^2=137.28$, $p<0.001$).

In addition, all of the livestock producers and 58 % of the farmer–livestock producers perceive the chott to be threatened, while 80 % of the salt miners do not perceive this threat. The difference between the respondents is highly significant ($\chi^2=88.98$, $p<0.001$).

Focus Group Discussions

The first focus group site (Hamraia) highlights that the method in which salt is exploited by the private owners represents a particular threat for the wetlands. The other focus groups do not share this point of view. All the groups agree that salt extraction from the chott constitutes a significant richness for the region but most estimate that the local population does not benefit directly. All of the focus groups (with the exception of Sif El Menadi) are concerned about the flow of the water discharges into the wetlands. The Sif El Menadi group is the only agglomeration which is not connected to the waste water evacuation system.

Through the five focus groups carried out in the study area, we found that only the population in Nessigha is aware that the area is protected; however, all groups are aware that their zone has a significant flora and fauna diversity. The group (Nessigha) is well-informed that the wetland is protected but they do not agree with the new status of the area (Ramsar status). It is noteworthy that these people are located in a zone which contains the large governmental salt mining plant (ENASEL) which forbids access to its land.

The local vegetation plays a major role in the daily livelihood of residents with many plants providing fodder for the various livestock; some plant species are used as building material or in cooking, heating and traditional medicines. All the groups agree that their zone could be a tourist asset because it hosts several historical vestiges. Some residents find that there is a perceptible yearly increase of the number of birds which frequent the zone; whereas they note that the gazelle and the Houbara bustard are sharply declining. The focus groups see a potential for hunting and tourism as alternative sources of income.

The focus groups carried out in the study area emphasize the important economic (agriculture, breeding, salt production and its derivatives) and ecological stakes for the region. In addition, most groups note that the wetlands are threatened by pollution from the discharges of the degraded waste water systems and see a possible future for ecotourism in the area.

DISCUSSION

Agricultural extension and intensification have had an impact on the chott, leading to an overuse of the ground water due to deep water pumping (Taïbi et al. 2003). Water constitutes the economic capital of the area; the increase in the average surface cultivated by the farmers and farmer–livestock producers has put more strain on this capital. All of the socio-economic sectors have deplored the lack of water, with farmers highlighting insufficient quantities of water. This lack of water has prompted certain farmers to re-use the drainage water with the risk of accentuating soil salinity. The irrational use of water and the weaknesses of hydraulic infrastructures are judged to place the oases of the whole region in a state of water deficit (Benzouche and Chehat 2010). A further aggravation of the problem is the overuse of the Albian groundwater (fossil) and the pumping out of hot water in an arid area requiring new and specific installations, posing serious problems of economic costs and leading to potential ecological impacts (Sahli 1997). Zammouri et al. (2007) stated that in the Tunisian Saharan zones, an increase in groundwater salinity was the result of agricultural intensification. Climate change is likely to exacerbate the water shortage in the region thus disrupting ecosystem services. Thus, the percolation risk of the salted chott water could cause a salinization of the ground water (OSS 2008). The surveyed population clearly perceives the pollution caused by the waste water discharges to be very harmful to the environment and in particular for salt production. With regards to water pollution, the farming and livestock groups representing distinct socio-economic entities differ from the salt miners. Our results confirm Tessema et al. (2010)'s conclusions that the positive attitude of a population toward conservation is much related to the services and benefits obtained.

Another matter of concern is the widespread use of pesticide which can be the source of environmental damage with considerable economic losses. Rinaudo et al. (2006) indicate that the presence of pesticides in streams and their impact on fish life and biodiversity could be partly due to the contamination of groundwater. Given the lack of precise evaluation on the quantity and the nature of chemical inputs used in Chott Merouane, we cannot quantify their effects on the environment. However, it is important to

underline the danger which they represent for the natural environment over the long-term, highlighting the need for future studies of water quality.

The importance of the size of the livestock kept by the two types of livestock producers in the region shows that the zone constitutes a significant grazing area. The increase in the animal charge in the grazing area affects at the same time the pastoral value of these ecosystems and their specific diversity (Corre et al. 1979). Ozenda (1992) has also demonstrated that overgrazing increases the regeneration time, making plants more fragile and less productive. This trend leads to a rapid vegetative degradation of the meadows and greatly reduces fodder value. The degradation of the vegetative cover is accentuated due to the grazing species encountered in this arid region (sheep, goat and dromedary) (Chaieb and Zaâfour 2000). Certain policies like land reclamation have had an additional impact on the grazing lands (Kanoun et al. 2007).

Salt constitutes the second most exported product from Algeria toward Niger (Grégoire 2002). The production is very significant at national and international levels. Nevertheless, the method employed to collect salt can generate serious consequences for the region. The current salt mining practices (non use of tables and direct salt extraction with trucks) is not sustainable in the long run and it can reduce the salt production capacity in the future. Likewise, the harvest of salt in the same area for several years can cause pollution of the site by secondary elements (in particular magnesium salt). This phenomenon is observed in the smaller chotts which are relatively dry, like El Magtâa (Générale des Mines, unpubl.).

The majority of people surveyed are not aware of the protected status of the area and they believe that the chott can protect itself. Those individuals who are well-informed of the protected wetland status display possibly some resentment and equate the protection status with hunting prohibition. This indicates that the local population is not currently involved in the site protection and that awareness campaigns could be beneficial in this area to promote a more integrated approach. The absence of protection and management body organizations in the site and the lack of access to some areas may be responsible for this behavior. Local populations and traditions are directly related to the environmental conditions; thus the populations need to be involved in environmental actions and decisions (Rwelmira 1999). This is a valid point for our study zone, especially considering that the traditional activities have intensified over the years. However, it must be noted that the participative approach is not easy to implement (Stoll-Kleemann 2004) because of certain constraints related to specific cultural contexts (including women's participation, ethnic minorities, power struggles, etc.) (Barton et al. 1997).

It appears that the majority of the surveyed population has a positive vision concerning the chott, its local and national economic value, its touristic potential and the need of the various actors to preserve it. As to be expected, all the salt mining owners estimate that the chott value is very significant compared to the other social-economic sectors that do not have a vested interest in the wetlands. Given the overwhelming interest in developing eco-tourism, it seems important to develop other alternative economic activities that could reduce resource use. Several authors recommend promoting ecotourism projects to decrease the pressure on wetlands (Mironga 2005; Ambastha et al. 2007; Nyakaana 2008), but extreme care should be taken because ecotourism development could have significant drawbacks in a fragile environment.

The education level and incomes of livestock producers are considerably lower than that of the other social-economic sectors. Although they are unaware that their zone is protected, these people represent the sector that faces the greatest threat concerning water availability and quality. Baral and Heinen (2007a) note that education, age and income are not significant indicators of a conservation attitude. This suggests that raising public awareness is important for all socio-economic sectors; however, awareness campaigns must target each group differently. In this case the message can be the same, while the approach is different between the various population types (Vicker 1994). Environmental conservation can be carried out only if the population is informed and integrated into the environmental decisions and management.

All of the socio-economic sectors use natural resources in some manner, sharing the same limited resources. The livestock producers contest agricultural extension on grazing areas as well as the use of livestock water points for irrigation. The lack of saline tables also complicates the sharing of water between the different sectors as the water quality begins to suffer. This situation confirms our hypothesis that economic stakes in this area can be a probable source of conflict between multiple users and can result in heightened pressure on the wetlands. It is important to encourage inter-sectorial dialogue and evaluate the impact of each sector to develop an integrated management plan.

The results of this study reject our first hypothesis, indicating that the current economic activities are having a negative impact on the protected area. Our second hypothesis was confirmed. The biological quality (flora and fauna), the economic stakes of the wetlands, and the local population's attitude demonstrate a clear conflict of use between the different socio-economic sectors. In this context, these aspects are critical to evaluate the extent of the damage and the need for creating a conservation framework for the wetlands. As Ambastha et al. (2007) reported population prosperity and their incomes are dependent on

both land availability and access to water. This study enabled us to determine the perception of the economic stakes of a chott; providing information on the various economic activities in the wetland and especially on the relative importance of these activities for local population (Schuyt 2005). This information could help initiate a participative integrated management approach for improving the management of these valuable, yet vulnerable wetlands.

CONCLUSION

The data analysis showed that wetlands in arid environments have a socio-economic importance and the economic stakes are significant on the local, national and even international level. The different socio-economic sectors are conscious of the importance of the wetlands and the threats that degraded infrastructures and inadequate management could have. For better conservation of the site, all socio-economic sectors must be integrated into the environmental decisions and management. Baral and Heinen (2007b) suggest that the success probability of conservation programs increase if marginalized people (such as women, minorities, and poor, etc.) are introduced into the process. In the context of global changes, successful conservation of salt pans requires a better collaboration between socio-economic groups with a joint vision to reduce the negative impact and to promote sustainable use.

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