

**The Diawling National Park:  
Joint Management for the Rehabilitation  
of a Degraded Coastal Wetland**

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## **INTRODUCTION**

Until the sixties the lower delta of the Senegal river (Fig. 1) was an area of extraordinary ecological richness. Consisting of a mosaic of dunes, floodplains and estuarine zones with mangroves, the area was known for its rich birdlife (Naurois 1969) and important fisheries (Reizer 1971). Several thousand people, practising a variety of activities, found a livelihood there. Since then the environmental quality has deteriorated, first by the diminishing floods and rainfall, and later by the alterations brought about by the large-scale hydraulic engineering works under the authority of the Organisation for the Economic Development of the Senegal Valley (OMVS), a trilateral organisation grouping Mali, Senegal and Mauritania. Two major dams were built in the watershed. The first is a storage dam at Manantali in Mali (completed in 1990) on the Bafing, the main tributary of the Senegal River contributing 50% of its flow. This has created a reservoir theoretically capable of stocking 11 billion m<sup>3</sup> of the strongly seasonal rainfall on the Fouta Djalon mountains in Guinea. The water can then be gradually released over a longer period than the natural flood. The second is a salt-wedge dam at Diama (completed in 1986) close to the river mouth.

The dams should permit continuous access to fresh water in the valley mainly for irrigated agriculture on hundreds of thousands of hectares of former floodplain, create hydropower (800 Gwh) and allow river navigation. So far the results have been far below expectations (Crousse *et al.* 1991). Much of the land, equipped for irrigated agriculture at great expense, has been cultivated for a few years only, often because of increased soil salinity. The infrastructures have led to greatly diminished alternative floodplain use for recession agriculture, fisheries, pastoralism, forestry and groundwater recharge and caused serious social and health problems (see Acreman & Hollis 1996). Hydropower production is only just starting and the river navigability component is still in the planning stage.

The Diama dam, located 27 km upstream from the city of St Louis (Senegal), was built to stop the dry-season intrusion of sea water along the river bed. In association with the dam, embankments were built on both sides of the river in order to create a freshwater lake, now managed at 1.75 m above sea level (ASL). This high water level allows farmers upstream to lower pumping costs for rice cultivation, but the embankments have cut the former floodplain and estuarine area from the river floods that used to occur between August and November. As a corrective measure for the impacts of the Diama dam on the lower delta, the OMVS Council of Ministers decided in 1980 that it was necessary to create an artificial estuary on the Mauritanian side of the river. In order not to compromise biodiversity in the typical estuarine and coastal deltaic ecosystems, the hydraulic infrastructure necessary for the artificial estuary should have been in place by the time the Diama dam was completed. However, the realisation was hampered by many delays and this had disastrous consequences

for the biodiversity and productivity in the lower delta. In 1994, at the request of the Mauritanian government, IUCN, through a regional wetlands programme financed by DGIS (the Dutch Development Aid Agency), started a field project to restore the ecosystem and to elaborate a management plan for the whole of the Mauritanian lower delta in collaboration with the stakeholders.

## **PHYSICAL GEOGRAPHY**

### **Geomorphology**

During the last major marine transgression (5000 BP) the lower delta was part of a large bay, some 100 km wide at the mouth and stretching more than 200 km inland. This bay was gradually filled in, mainly by fine silt and clay alluvia. In the lower delta this infilling created extensive low lying floodplains (-0.5 to +1.4 m ASL) with poorly drained halomorphic soils interspersed with inland dunes (<+6 m ASL) of unclear origin (Tricart 1961, Monteillet 1988), and separated from the ocean by a recent coastal dune. The position of the river mouth has shifted depending on the balance between river flows and longitudinal coastal drift. During low rainfall periods, the dominant picture over the last few hundred years, the river mouth moves progressively southward (Gac *et al.* 1982), during high rainfall periods the river can break through the coastal dune at more northerly locations. The shifting river bed created a complex network of tidal creeks, lagoonal areas, sebkhas (salt-crusted depressions) and temporary lakes interspersed with alluvial terraces.

### **Climate**

The lower delta belongs to the low rainfall subsahelian zone. The long-term average rainfall is about 300 mm per year but the average from 1970 to 1990 has been about 150 mm per year. Rain tends to fall in a few intense storms in August and September. Evaporation is estimated at 2250 mm a year. Over the year three seasons can be distinguished: the rainy season from mid-June to mid-October, the cool dry season from mid-October to mid-February and the hot dry season from mid-February to mid-June. Average temperature is about 26 °C.

During the rainy season dominant winds are westerly, with west-south-westerly intervals. During the dry season dominant winds are north-north-westerly, with north-easterly intervals (the hot 'Harmattan' wind blowing from the desert). Average wind speeds in the delta are over  $6 \text{ ms}^{-1}$  and seem to have increased during 1980 to 1990, possibly because of deforestation and the drying out of the floodplain (Michael *et al.* 1993). Air humidity is relatively high thanks to the proximity of the ocean. Morning dew is a frequent phenomenon.

### **Pre-dam hydrology**

In the past, the annual flood reached the delta around mid-August, gradually pushing out saline waters and inundating the floodplains. The pattern of flooding was highly complex with the initial movement mostly south to north through the Ntialakh, and, depending on which spillway would be dominant in any one year, reversals of current in the main channels. Maximum water height would be reached around mid-October, covering anything between 3,000 ha (1974) and 100,000 ha (in 1950 when the Aftout es Saheli, a coastal depression north of the lower delta was filled all the way to Nouakchott). Depending on the flood

strength water levels would lower rapidly or, during floods reaching 2 m ASL, remain high for a maximum of two months. As river flows decreased, sea water would progressively move upstream in the river bed (in 1982 reaching Podor, 300 km from the river mouth) and the main tidal channels. Fresh water, stored in the isolated depressions, would gradually become saline through contact with the saline soils. Evaporation would cause the seasonal lakes to dry out between January and March and create hypersaline conditions in the tidal creeks (creating a so-called inverse estuary) and lagoonal areas. Strong tides at the end of the dry season (May to July) could flood the low lying plains and occasionally even fill some of the depressions, creating salt crusts. At the beginning of the flood the highly saline water in the Ntiallakh would be pushed north into the depressions, thus contributing to their salt reserve and the formation of sebkhas.

Ground water in the lower delta is generally hypersaline and close to the surface (-1m ASL). Under the dunes pockets of fresh water of variable extent, resting on the more saline deeper layers, exist. These were probably primarily recharged during floods (>1.5m ASL) high enough to reach the sandy soils of the dune edges.

### **Post-dam hydrology**

The salinisation tendency of the lower delta, already evident with the weaker floods of the seventies, was exacerbated during and after the construction of the Diama dam and the associated embankments, finished in 1990. With the exception of the flood of 1987 there was a very low input of fresh water into the floodplains. Eolian deposits in the channels have severely disturbed the flow patterns. Wells tapping the freshwater lenses in the dunes have progressively become more saline in a south to north sequence.

At the start of the IUCN project in 1994, of all the hydraulic infrastructure needed to restore the flooding and create the artificial estuary, and that should therefore have been in place at the Diama dam closure in 1986, only the sluicegate at Lemer was fully operational by 1994. Though calculations had shown a flow of at least  $18 \text{ m}^3 \text{s}^{-1}$  was necessary to push out the saline waters to the mouth of the Ntiallakh (Gannet Fleming 1986), budget constraints limited the intake from the river into the Bell basin at the Lemer sluice to  $15 \text{ m}^3 \text{s}^{-1}$  and the outflow from the Bell to the Ntiallakh basin to only  $5 \text{ m}^3 \text{s}^{-1}$  (see Figure 1).

## **THE ECOSYSTEM**

### **Vegetation**

Except for Baillargeat (1964) and Adam (1965) very few data existed on the vegetation of the Mauritanian lower delta, but a careful reconstruction of the pre-dam situation and a comparison with the post-dam situation has been carried out on the basis of unpublished reports and in depth interviews with the local population (Diawara 1997). In the sequence of recent vegetational changes in the lower delta it is quite difficult to distinguish between those caused by the prolonged drought, by human action (for example the cutting down of trees to feed cattle in 1972-73 and 1982-83) or by the effects of the engineering works, as all three have had similar effects. Still, the presence in areas of difficult access of dead standing trees are proof of adverse environmental conditions. The result is a strongly diminished vegetational cover by trees, by annual and perennial herbs and by grasses, leading to vast

desertified plains with windblown salt and moving sand dunes. Most key species in the floodplains and estuarine area have been severely hit.

Thus it is estimated that mangrove cover (*Avicennia germinans* and *Rhizophora racemosa*) was reduced to less than 10% of its 1960 extent, that of the hundreds of hectares of *Acacia nilotica* (very important for the women as a source of tannins for the leather used in handicrafts) only a few specimens survived. *Sporobolus robustus* a perennial grass (used to make the traditional fishing gear and mats) that used to cover thousands of hectares of floodplain was reduced to a few pockets on the dune edges. *Echinochloa colona* a grass of high pastoral value (in the sixties the dried hay gave a higher return per hectare than groundnuts) only just survived, *Oryza barthii* a wild rice was eliminated, and *Nymphaea lotus* a water lily (whose seeds are used as a staple food, replacing cereal) virtually disappeared. The only increase observed was in the halophile pastures of *Salsola* and *Arthrocnemum*, species eaten by the camels when there is little else. The freshwater lake behind the dam was quickly colonised by reed-mace (*Typha domingensis*) and the exotic *Pistia stratiotes*, that caused many ecological problems in the Djoudj National Park, also made its appearance. On the inland dunes of Ziré, Brette and Ebden and on the coastal dune completely deforested sandy areas without any vegetational cover were increasing, while stands of *Acacia* were declining.

## **Wildlife**

The lower delta was especially famous for its rich birdlife. Important breeding colonies of herons, egrets and cormorants (over 10,000 nests in the early sixties) used to exist in the mangrove and *Acacia nilotica* forests (Naurois 1969). The local population used to collect large numbers of eggs and young from the colonies. Only a very small remnant of this former richness remains in the single large *Rhizophora* tree at the mouth of the Ntialakh. Other notable species were pink and lesser flamingo (*Phoenicopterus ruber* and *P. minor*), white pelican (*Pelecanus onocrotalus*) and crowned crane (*Balearica pavonina*), the first three species breeding mainly in the southern Aftout in years of major floods. The absence of floods facilitated access to the delta and poaching by city dwellers, operating from four wheel drive vehicles, virtually eliminated the Arabian bustard (*Ardeotis arabs*), a species still common in the late eighties.

Drought and excessive hunting caused the demise of the larger mammals. The last lion *Panthera leo* was shot in 1970, the red-fronted gazelle (*Gazella rufifrons*) was last observed in 1991. There remained only jackals (*Canis aureus*), some warthogs (*Phacochoerus aethiopicus*), wild cats (*Felis sylvestris*), hares (*Lepus capensis*) and patas monkeys (*Erythrocebus patas*). There have been no observations of the manatee (*Trichechus senegalensis*) or crocodiles (*Crocodylus niloticus*) since the closing of the dam, the hippopotamus (*Hippopotamus amphibius*) was last observed in the early sixties.

## **SOCIAL ASPECTS**

A historical account of the lower delta since the XVIIth century is given in Barry (1981). Originally a Wolof stronghold, Moors of Haratin descent are now the dominant ethnic group. Most of these Moors used to come to the area with the herds during the dry season only, but have progressively become sedentary since the sixties (Cheikh & Diop 1997). Minorities of white Moors and Halpularen also occur in the area, the Halpularen tending the herds of the

other ethnic groups. Before the drought the economy depended on fishing, small-scale recession agriculture and livestock. It was essentially a subsistence economy, except for the fishery products and dried grass sold mainly at St. Louis. The drought caused an important rural exodus. The Moorish population mostly became small shop keepers in Senegal until 1989 (when a conflict between Mauritania and Senegal caused massive repatriation; the subsequent militarisation of the delta was linked to the demise of the gazelle). Subsequently the Moors moved to Nouakchott, predominantly becoming construction workers. The Wolof left for the industrial and artisanal fishery in Nouadhibou and Nouakchott. In 1994 the permanent inhabitants of the area were virtually exclusively women, children and old people. At that time it was estimated that there were less than 6,000 permanent residents, though some 20,000 people would consider themselves as being 'inhabitants' of the lower delta. A sociological study (Tall 1994) showed that the main income of the permanent residents came from selling mats made from *Sporobolus robustus* stalks interwoven with leather. For the confection of a large mat the women form temporary co-operative associations called 'Tweez' that, for example, have an elaborate system of fines for unexplained absences from work. Vegetable gardens on the edge of the reservoir supplemented the income.

## THE DIAWLING NATIONAL PARK AND THE RESTORATION PROJECT

After more than ten years of controversy the Diawling National Park was finally established in 1991. It covers about 16,000 ha of former floodplain and is separated only by the Senegal river from the similar sized Djoudj National Park, in existence since 1971 and situated on the left bank in the Republic of Senegal. In fact, a lot of the opposition against the creation of the Diawling Park came from the local inhabitants that thought they would be subjected to a similar experience as their counterparts on the other bank. Most villages on the Mauritanian side have close tribal and family links with groups on the other bank and were perfectly in the know on the successive stages of the establishment of the Djoudj National Park, with the forced removal of villages and repressive measures against grazing and fishing within its boundaries. However, from the outset the concept was different as can be seen from the objectives of the Diawling National Park, as stated in the presidential decree of 1991:

- the conservation and sustainable use of the natural resources of a sample of the lower delta ecosystem;
- the permanent and harmonious development of the range of activities of the local population;
- the co-ordination of the pastoral and fishing activities within its boundaries.

The Park's objectives provide a clear mandate to integrate conservation and development and to include all stakeholder groups of the lower delta, not only those whose traditional rangelands are inside the protected area. To support this decidedly modern approach by the Mauritanian Government, IUCN and its local and foreign partners started in 1994 by organising a visit by a multi-disciplinary team, composed of sociologists, hydrologists, agronomists, ichthyologists, protected area specialists, a botanist and an estuarine ecologist. In order to integrate the views of the local population a participatory approach was favoured. It was immediately clear that local knowledge of the former functioning of the system was highly developed and that it would be indispensable for the drafting of the management plan. The main conclusions of the study were that the first condition would be to restore the pre-dam flood cycle. The return of productivity would allow the local population to take up their traditional activities (in the central Bell basin of the Park and the peripheral zone) and to develop or extend new ones, notably ecotourism and market gardening. This should be

accompanied by measures to facilitate transport (access roads, embankments) and to provide an adequate drinking water supply. Over 1994 and 1995 in-depth interviews were conducted with most of the stakeholder groups and additional scientific investigations were carried out. The first draft of the management plan (Hamerlynck 1996) was then circulated amongst the local partner institutions (Faculty of Sciences of Nouakchott University, Banc d'Arguin National Park, Direction de l'Environnement et de l'Aménagement Rural). The second draft was presented to a wide audience of stakeholders and government institutions in December 1996 and, after amendments, approved by the Ministry of Rural Development and the Environment in early 1997.

In the meantime a first phase of ecosystem restoration, training and equipment of the Park authority and some small scale pilot projects with the local population were started, financed primarily by the Dutch government (DGIS) through the IUCN Wetlands Programme. Additional funds were obtained from the Government of Catalonia (woodless construction of the Park Headquarters), from the Ramsar fund (hydrological equipment, meteorological station, local consultants) and from the Fondation Internationale du Banc d'Arguin (stage boards, topography). To restore the flooding, sluices and additional embankments (Figure 2) were built (Hamerlynck & Cazottes in press). The implementation of the rest of the major objectives of the management plan (1997-2000) will be jointly financed by the Caisse Française de Développement (infrastructures for road access, water supply, market gardening, fishing and tourism), the Fonds Français pour l'Environnement Mondial (research, capacity building, biodiversity enhancement) and IUCN-DGIS (technical assistance, community development, boat building, handicrafts, environmental education).

## FIRST RESULTS

### **Institutional setting**

All the villages in the lower delta are part of the commune of Ndiago, which has an elected mayor and a council (Mauritania initiated a democratisation and decentralisation process in 1992). Initially these were extremely hostile to the Park and demanded on all occasions (such as during visits by government ministers and by addressing petitions even to the head of state) that the decision to create a Park should be revoked, that a dam should be built on the Ntiallakh (thus annihilating the artificial estuary concept) to create a fresh water lake (for drinking water) and 20,000 hectares of irrigated rice. From the interminable discussions with the municipal council and various stakeholder groups it soon became clear that the teachers were among the fiercest opponents of the Park (they will therefore be a prime target group for the environmental education programme to be developed in the next phase). As they had been the best students in the local primary schools, they left the area at twelve years of age to the secondary school in Rosso and then moved on to Nouakchott for teacher training. Having lost contact with the ecosystem and imbued with a concept of development as something measured in terms of large-scale infrastructure, they were convinced that the proposed management plan was a trick to keep the delta backwards. They argued that by starving the population of drinking water, this would force people to migrate, and that finally the birds would have the place to themselves and would propagate in peace. They had also been influenced by OMVS missions in the eighties that had made them believe that the Diamma dam would bring the solution to all their problems, instead of becoming the primary cause of the lower delta's demise. In contrast, most of the stakeholder groups that had to make a living

from the natural productivity, could see the logic of what the Park was trying to do, even if they firmly believed that they would eventually be asked to leave ‘once the birds took over’.

After having explained the major axes of the management plan and having implemented some pilot projects of integrated rural development, a proposal was made to the commune to constitute a management committee which would assure the liaison between the Park and the local population for the joint management. It was proposed by the Park that this committee would have representatives from the most important stakeholder groups (i.e., one for freshwater fishing, one for estuarine fishing, one for grazing, one for market gardening, one for handicrafts, etc.). The commune, in return, proposed to create a committee almost identical to the municipal council, a body essentially composed of village chiefs. However, some of the stakeholders communities feel they are not at all represented by this council and some council members have very little knowledge of the functioning of the ecosystem. It has therefore not been a very useful structure for input to the management decisions. As a compromise the Park has been continuously providing the municipal council with the key technical documents and has made sure that members of the council were aware of, and could participate in, visits of local and foreign experts. The day to day contact and exchange of management advice is done on a village by village, stakeholder group and *ad hoc* basis. Finding an acceptable institutional arrangement to formalise these exchanges and to implement the management decisions that ensue will remain a difficult issue, especially as the extension of water management impacts to the Ntiallakh basin will considerably expand the stakeholder group number and diversity.

Although discussions with stakeholder communities covered the entire lower delta, detailed studies and activities were initially concentrated on Burette, Ziré Takhredient and Ziré Sbeikha, the three villages in closest contact with the Park and whose traditional rangelands would be most directly and immediately affected by the new management (see Table 1). The approach was greatly helped by the fact that, at the Park’s creation in 1991, some respected elders from various villages were recruited as ‘guards’ and that the Park’s head of surveillance is a respected local ‘cherif’. For surveillance clear instructions had been given not to take a repressive approach. For example, the gun of a local ‘poacher’ (or traditional hunter according to your point of view) that shot a pelican was confiscated by the cherif, telling him to come and fetch it the next week (so as to let him cool down a little). Before handing him back the gun he got quite a sermon on the Park and conservation in general, on the fact that pelicans, flamingoes and spoonbills are rare and that it is better to hunt ducks, that it is not good to hunt when the birds are concentrated in the last lakes as they then have no other place to go and feed, etc. The same tolerant and awareness oriented approach was used towards the people collecting eggs and young of cormorants, explaining that their strategy of completely emptying the colony was a dead end street, that they should not collect at all inside the Park and practice restraint in the buffer zone for at least a few years until the populations have returned to full strength. That even then we will need to do research to jointly establish the sustainable exploitation quota. As it happens, the best measure for the reduction of hunting and poaching pressure has been the return of the floods, which have made the colonies and the floodplains much less accessible and have allowed birds to spread out more thinly.

The procedure for stakeholder meetings was highly diverse and was left at the discretion of the village chief. In some villages Park staff would only get to meet the chief, in others a group of wise men would be gathered. Meetings with women’s groups were often attended

by two or three men, that normally stayed in the background. In the freshwater fishermen's village all adult men would participate in the meeting, with the women listening in, and sometimes very vocally participating, from behind a veil screen.

**Table 1. Main stakeholder groups exploiting the Bell basin and the immediate surroundings of the Park.**

Village	Group	Resource interest (in order of importance)	Management input
Zire Takhredient	Tahredient men	freshwater fishing	hydrological and ichtyological knowledge, surveillance, monitoring rain gauge
Zire Takredient	Takhredient women	collecting of grasses for artisanal mats, Acacia seedpods for tanning, water lily seeds, animal husbandry (goats), market gardening	knowledge of ecological requirements of target species, surveillance
Zire Sbeikha	Boukhous Boynie men	brackish water and shrimp fishing, collecting of eggs and young of piscivorous birds, hunting	hydrological and ichtyological knowledge
Zire Sbeikha	Boukhous Boynie women	collecting of grasses for artisanal mats, Acacia seedpods for tanning, animal husbandry (goats)	knowledge of ecological requirements of target species
Zire Sbeikha	Tendgha, Trarza, Oulad Bousbaa, Chorfa men	Pastoralism (cows, camels)	hydrological and agrostological knowledge, surveillance, monitoring rain gauge
Zire Sbeikha	Tendgha, Trarza, Oulad Bousbaa, Chorfa women	production of high quality mats, animal husbandry (sheep, goats), market gardening	providing accomodation and food for consultants and ecotourists
Brette	Tendgha, Djawadj men	transport, shopkeepers (dependent on overall activity and purchase power), market gardening	transport and marketing of produce, managing nurseries for key tree species
Brette	Tendgha, Djawadj women	market gardening, collecting of grasses for artisanal mats, Acacia seedpods for tanning,	managing nurseries for key tree species

		animal husbandry (goats)	
Brette	Halpularen men	Pastoralism (cows), animal husbandry (sheep, goats)	agrostological knowledge
Brette	Halpularen women	market gardening	managing nurseries for key tree species

### **Ecological restoration through joint management**

For the village of Brette, whose rangelands have mostly disappeared into the Dama reservoir, the immediate development alternative was market gardening. The main activity used to be pastoralism over a limited range within the delta. They were one of the first groups to become sedentary. Subsequently they were shopkeepers in Senegal. The women of this village organised themselves into a co-operative group with each member contributing US\$2 to the joint fund. The group, and a number of women groups from other villages that had expressed interest in this activity, then received some wire fencing, agricultural equipment and seeds in accordance with the number of members and the extent of the land cultivated by the co-operative. The needs of each group were assessed and the support could take different forms. Thus one village was provided with cement for a well, the women contributing for the iron and the professional diggers. For the initial six months technical advice was provided by a ‘vulgarisateur agricole’, recruited from a sedentary agricultural community in the middle valley of the Senegal river.

The results of the first campaign were below expectations as the new techniques required adaptation to the generally more sandy and salty soils of the dune margin of the reservoir. In the second season, when the women were on their own, except for some follow-up visits to check on bottlenecks, the area around Brette became a major exporter of vegetables to Nouakchott. The collective aspect quickly watered down as some women individually developed new gardens and started employing foreign workers to water the gardens. These are paid with a fifty percent share of the profits. A lot of land was also developed by entrepreneurs with traditional links to the local community and by members of the different government administrations present in the delta. The Park’s main task will be to make sure access to land with market gardening potential is also made available to the least powerful in the community. In the other villages, especially on the coastal dune, the market gardening project was less successful, mostly because of the limited freshwater supply.

For the village of Ziré Takhredient the main interest expressed was for fresh water fishing. This community, from a warrior tribe that traces its roots to the island of Tidra in the Banc d’Arguin National Park, is generally recognised as being the first group, among those still present (numerous archeological sites point to earlier occupants), to settle the lower delta. They were present already before the arrival of the Wolof, who came shortly before the first trading post was established in St. Louis in 1633. The Takhredient have a disdain for farmers, whom they consider as poor and miserable. As the one of them said ‘as long as there is one fish in the water we will not work the land’. Each fisherman traditionally ‘owns’ one or more stretches along the main creeks in the Bell basin. If the owner is absent others may exploit the patch but have to give part of the catch to the owner’s family. Normally the fishermen do not exploit the fish during their spawning migration but in exceptional circumstances such as a famine or if a woman has recently become a widow one or a few schools of pre-spawners may be taken. In spite of all these sustainability measures, the lack of water in their

traditional rangelands brought fishing to an almost complete standstill. Most of the men moved to Nouakchott and even the women were forced to move away for several weeks to work as labourers on the rice farms near Rosso. The Park helped to partially solve this crisis by employing primarily Takhredient as workers on the woodless construction of the Park's headquarters.

With the Takhredient community interactions have been most intense and productive but also the most conflictual. They have always maintained that they found our proposals for restoration interesting but that they did not trust project staff. So the project agreed that they would be informed and consulted about any Park activity occurring in their rangeland. This sometimes went wrong. For example the consultant who installed the stage boards to measure water height in the creek closest to the village did this without prior notice. Every morning when he returned to the site he had to recommence as all his topographical markers had been systematically removed. When he finally succeeded to do the topography and the installation in one day, the stage boards were removed twice. The problem was quickly solved when Park staff admitted its mistake, explaining to the villagers that the consultant was not aware of the agreement with them.

As the fishermen have an extremely detailed knowledge of pre-dam hydrology and fish migration and spawning patterns (Diagana 1997), technical collaboration was very productive. Thus the Berbar sluicegate was added to the original scheme in order to allow for fish migration to and from the spawning grounds in the Diawling -Tichilit basin (Boissezon 1994). In their typical approach to things the Takhredient told us that if we would not add a sluice they would simply destroy the embankment. The extra expense on this sluice, and a second one (the Lekser sluicegate) for shrimp migration added on the advice of the brackish water fishermen of Zire Sbeikha, prevented the project from completing the embankment that should have been delimiting the Park's northern edge (Figure 2). A point of disagreement with the Takhredient community was the fact that the 5 km long Ziré embankment, connecting the village to the main road, would not be suited for use by cars. During the inundation the village is easily accessible from the main road by the Bell embankment. During the dry season, a track through the Diawling basin can be used.

From the Park's point of view creating a road through the middle of the Park would be ecologically unsound, it would also complicate surveillance and the extra cost of an embankment four instead of one metre wide at the top would be huge. Moreover, maintenance costs would be prohibitive for a village of some 200 people. In spite of all these arguments a major conflict arose when a member of the Park staff with political ambitions, when questioned, assured the villagers that a road would be built on the embankment (and that the village would be supplied with electricity, drinking water, a mosque, etc.). The villagers removed the fencing of a 4 hectare plot of dune fixation and pasture restoration experiment, established with their help, to the north of the village and fenced off the sluicegate in the embankment during the flooding season. Signboards, threatening anyone who would try to open the sluicegate, were posted all along the fence. It took more than a month of apologies, the removal of the staff member and lots of meetings with notables and high level administrators to dissipate the distrust and to be allowed to open the sluicegate.

With the hydraulic infrastructure completed in 1996 the water in the Bell basin could be completely controlled. The fishermen proposed an early flooding as they knew *Tilapia* wrasses are ready to spawn as early as July. The women insisted that the *Sporobolus* and

other grasses needed rain before flooding to achieve optimal production. Waiting for the rain would delay flooding to early or mid-August, which would considerably shorten the growth season of the fish. It was therefore decided to simulate rainfall by allowing only a thin layer of water to cover the crucial parts of the floodplain in July. This compromise scheme, early flooding to 1 m ASL with a pause in water rise until early August, and then raising to 1.1 m ASL (the target flood level of 1.3 m ASL will only be reached a few years from now in order not to endanger the new embankments not yet protected from wave action by a vegetational cover) was tested in 1996. The test was highly successful with women collecting grass stems of over 2.5 m. In case of failure the Park would have proposed an alternate flooding scheme, one year favouring *Sporobolus*, the next year favouring the fish.

The fishermen were provided with a fund for the purchase of fishing gear and they commercialised at least 15 tons of fish at US\$0.30-0.40 per kg. They quickly abandoned their traditional individual fishing zones to concentrate effort at the Park's hydraulic infrastructure where fish tend to concentrate. The 1997 season, with higher water levels (1.25 m ASL) and more exchange with the Diawling basin, was even better with catches of up to 400 kg per day.

The regeneration of the *Sporobolus* allowed us to start another pilot project for the artisanal production of mats made of grass and leather, a speciality of the Moorish women. As there had been virtually no raw material available for over a decade most of the skills had been lost. Only very basic mats, bringing in US\$50 a piece (about two weeks work for 5 women), were still being made. A local consultant visited all the interested women groups, copied patterns from old mats in private collections in Nouakchott and improved design and execution (selection of stems, better tanning of the leather, use of finer strips of leather, creating smaller mats easier to transport by tourists), which increased added value. She was also a great awareness trainer on the Park's objectives and on hygiene and child care.

Obviously, the return of productivity was a boon also for wildlife. During the African Waterfowl Census of January 1993 the sad state of the Park, containing only 2000 waterbirds in rainfed depressions and a few cows, was lamented (Taylor 1993). The 1994 count found only 2 birds in the Park (Triplet & Yésou 1994), but in 1995 this shot up to nearly 50,000 (Triplet *et al.* 1995), with the rest of the Mauritanian lower delta showing similar changes. Subsequent counts show a very clear relation to the maximum water levels reached during flooding (Yésou *et al.* 1996, Triplet *et al.* 1997, Triplet & Yésou in press). The Park now regularly contains numbers of international significance of pelican, cormorant (*Phalacrocorax lucidus*), black stork (*Ciconia nigra*), spoonbill (*Platalea leucorodia*), flamingo and lesser flamingo, shoveler (*Anas clypeata*), pintail (*Anas acuta*), garganey (*Anas querquedula*) and avocets (*Recurvirostra avosetta*) and is listed as Mauritania's second Ramsar site. Anhinga (*Anhinga rufa*), cormorant, several species of herons and egrets, African spoonbill (*Platalea alba*), Egyptian goose (*Alopochen Aegyptiacus*), gull-billed tern (*Gelochelidon nilotica*) and crowned crane now regularly breed again in the lower delta (Hamerlynck *et al.* 1997). Other groups of wildlife have also profited.

## CLOUDS AND OPPORTUNITIES ON THE HORIZON

Paradoxically, when the project began in 1994 it had the comparative advantage of finding an almost completely destroyed ecosystem with very little exploitation pressure. Therefore, the gradual restoration of the hydrological cycle over the years 1994-1996 was immediately

perceived by the local population as a positive action and the spectacular recovery of fisheries, pasture and *Sporobolus* led to a boom in local income. In the meantime the news has spread and the lower delta is attracting outside attention. Thus in early 1997 there was a potential conflict when women from villages up to 50 km away came to collect *Sporobolus*. Park staff was alerted by the local population that some of these women were using a technique that might compromise the regeneration of the plants. In collaboration with the local women an information campaign was launched to demonstrate the correct technique and the conflict was resolved. Still, in the near future a management system may have to be imposed allowing the exploitation only of 50 % of the *Sporobolus* meadows in any one year. This idea has already been put forward to the local population and is under consideration.

Also, as there was very little grass elsewhere in the dry season of 1997, the Bell basin, that normally accommodates a few hundred local cows, was 'invaded' by some 1,200 bovines from further north. There seems not to have been any clear overgrazing damage at the time and when the rains started in late August the herds were moved north by their owners. However, immediately after the rains some 800 bovines (probably all non-lactating cows and the bulls of the group that visited before the rains) came back and started grazing the early growth pastures. This may have prevented these from reaching maximal biomass and from flowering and setting seed. An evaluation of carrying capacity and a round of talks with all local and outside stakeholders to figure out who (with how many animals and when) will be allowed to graze in the lower delta seems necessary. Otherwise, in a true drought year, the results may be catastrophic.

Another novelty of 1997 is the appearance of an intensive shrimp fishery. Shrimp used to be collected small scale, dried and sold to St. Louis by the local population. In 1997 an entrepreneurial businessman obtained a shrimp fishing license from the ministry of fisheries. Very efficiently he has put into place several cool stores. He visits the fishing camps every day to collect the last night's catch (up to 300 kg) and to bring fresh ice. He pays the fishermen about 25% of the final retail price of US\$7 per kg, which is reasonable. The local population has mixed feelings about this new situation: on the one hand it is a good source of extra income but it has also brought a lot of 'foreign' fishermen to the area. These are not using the traditional nets made of grass, but use fine mesh nylon and the scale of exploitation has increased considerably. The Park staff will work towards an understanding with the stakeholders and the ministry of fisheries on a limited number of licences and on restrictions with regard to season and mesh size (which should be 4 cm). It should also be made clear that preference should be given to employing the local fishermen and that none of the tidal creeks (especially at the sluice gates where this is quite easy) can be closed off completely. This is necessary to allow part of the stock to return to the ocean for next year's production. The shrimp boom has been used as an entry point for a discussion with the local fishermen on the link between mangrove and shrimp. To allow them to visualise the link, the complex roots of the mangrove are compared to a cage or a net where the juveniles are safe from predators. When this comparison was made for the first time, the mayor of the commune of Ndiago, who had accompanied Park staff on many 'guided tours' for foreign visitors and had thus heard many quite sophisticated explanations on the importance of mangrove, said, while looking at the roots, that this was the first time he really could make sense of what we had always been stating.

The presence of water in the Park basins has also attracted entrepreneurial businessmen who want to develop hundreds of hectares of vegetable gardens in the regenerating *Acacia* forest

on the edges of the dunes, just to the west of the Park's borders. To reduce pumping costs these gardens tend to be extended in a north-south direction and quite narrow in an east-west direction, thus blocking access to the water in the basins for herds and wildlife. Therefore, instead of having a functional buffer zone, the Park may in the near future be surrounded by a strip of agricultural land. The Diawling Park would then become an oasis, a green fleck with lots of touristically attractive birds in the middle of a wasteland. All of its interactions with, and functions complementary to, the surrounding drylands would be severely reduced. The development of market gardening may also increase pressure to modify the water management system: the main market gardening season is January to March, when the Park is normally progressively drying out and its waters becoming brackish. Putting more fresh water in that season may irrevocably modify the diverse pastures of the basins into the reed-mace monoculture observed in the Diama reservoir. Similar claims, for as much fresh water as possible for as long as possible, has caused severe degradation and loss of multifunctional floodplains in the upper delta.

## CONCLUSIONS

All these potential sources of conflict and risks of environmental degradation centre round the issue of land ownership and access to the resource. The traditional systems, usually some form of collective ownership, have no legal status. In principle the law states that the land belongs to the person exploiting it, but only intensive forms of exploitation qualify (i.e., with visible infrastructure such as embankments, enclosures, and houses). It is relatively easy for influential city dwellers to obtain a 'temporary' licence to exploit the 'wastelands' that are part of the traditional multifunctional resource space, the commons, and turn them into areas of intensive agriculture. The notion that the person or group that exploits a plot becomes its owner has been one of the major brakes on the success of the reforestation and set aside policy advocated by the Park. Many groups still think that this is part of the Park's strategy to be able to claim the temporarily fenced land afterwards.

When it is the local population itself that progressively moves into more intensive exploitation (i.e., the shrimp fishery, the gathering of *Sporobolus* and of *Acacia nilotica* seedpods or the development of market gardening), the Park managers have always a knowledge base and understanding of the ecosystem to fall back on in discussions on how to limit potentially negative impacts or over-exploitation. When the risks are explained, very quickly people in the assembly pick up the point and relate back to past events or bad seasons or make links between the different components of the ecosystem. Once the discussion amongst themselves starts it is relatively easy to kindle it with technical arguments and scientific explanations of what they themselves perceive as the way the ecosystem functions and how its productivity can be exploited and maintained at the same time. In contrast, outside investors motivated by short-term profits are rarely persuaded to alter behaviour on the basis of ecosystem considerations.

The modernisation of the land ownership laws has had beneficial effects in allowing some individuals from the landless classes to accede to ownership and to develop 'unused' (if such land exists at all in Sahelian West Africa) or underused space. The development of intensive irrigated agriculture on vast tracts of land has allowed production per cultivated hectare to increase but has reduced the productivity of the surrounding multifunctional space. Still, it has somewhat released the countries from the climatic fluctuations, though at a high cost as long as world grain prices remain low. The traditional land 'ownership' system, with

different groups exploiting the same area in different seasons (for example fishermen - nomadic herders) is difficult to capture in modern legalistic terms. Intermediate solutions, guaranteeing a minimal living space based on the ‘terroir’ (the space traditionally used by every community be it sedentary or nomadic) may be a solution. However, defining the terroir is very difficult as ‘any place where any of my ancestors has ever pitched his tent’ is often considered to be their property by the (former) nomads, who in general have more political clout than the sedentary locals. In the actual context only the protected area can guarantee to the local population that they will be allowed to continue exercising their traditional rights. Still, the 11,000 hectares of the Park outside of the Diamma reservoir will soon appear to be insufficient to sustain all of the local sedentary population and all of the nomads that traditionally made use of these pastures. It will most certainly be unsustainable if outsiders, ecological refugees that are unable to find a livelihood in the rest of the valley, will migrate to the lower delta.

Integrating the Diawling National Park into a vast biosphere reserve, covering the entire lower and the part of the upper delta where irrigated agriculture has little or no future, might be a good strategy to avoid swamping by outside operators. It should also be noted that, in spite of increased local support for the Park this would have been insufficient in itself to block plans to convert 8,000 ha of the Park to irrigated rice (in an orchestrated press campaign the Park and its foreign partners were accused of preventing Mauritania from feeding its population) or to stop the building of a dam on the Ntialakh, a decision which required an interministerial conference. These threats could only be defused through lobbying by powerful local and foreign partners, supported by sound research data provided by Nouakchott University and other partner institutions.

Human and animal health, the productivity of the drowned areas in the Diamma reservoir and of the artificial estuary would greatly benefit from a change in the OMVS management of the Diamma dam (Baba & Hamerlynck 1997). The extension of the integrated management model favoured by the Park to other areas (see for example El Hacen *et al.* 1997), now subjected to the strictly sectoral (irrigated rice) approach of OMVS, might prevent further biodiversity and productivity losses. This may also defuse some sources of potential conflict and social strife in the valley. The fact that the Diawling National Park, in contrast to the agricultural users, is not a member of the OMVS water management board and the difficulties the Park has each year to obtain enough water at the right time, are proof that the use of water for integrated development and nature conservation is still considered to be of secondary importance.

## RECOMMENDATIONS

The major recommendations coming out of the approach adopted by the Diawling Ecosystem Rehabilitation Project include:

- Adopt an open-minded and respectful ‘listening’ attitude towards traditional knowledge, concentrating on finding scientific explanations of the stakeholders’ understanding of ecosystem functioning rather than disqualifying the sometimes strange contentions as folklore. An observant local always knows more than a visiting consultant.
- Take development issues at least as seriously as environmental issues; take a broad ecosystem-based approach and do not consider the protected area as a separate zone for most issues;

- Be honest about what can and cannot be achieved with the restoration; modesty in the claims can only turn out favourably;
- Do not make false promises. If confronted with an expectation that cannot be fulfilled, do your best to identify a partner (e.g, development aid agency) who could address those needs;
- Take enough time to identify key actors, win confidence, to prove ones assertions by field actions, to move slowly and carefully; mistakes are not corrected easily; creating a new National Park and a functioning joint management system takes at least one generation;
- Ensure that those dealing with stakeholders have adequate communication skills; where necessary, get input from sociologists;
- Build a constituency also at decision maker level and in the national scientific community; point out the innovative nature of the approach and that the country can be proud of this;
- Maintain a continuous presence in the field to ‘feel’ the signals of both the ecosystem and the stakeholders. Show high plasticity and follow an opportunistic strategy (with flexible funds) in response to the signals;
- Promote by demonstration a more egalitarian society and seek a true empowerment of local stakeholders.

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