CHAPTER 6

WATER AND LAND

"My way is every way of my people, and I drink, every time I drink, only the water that I can hold in the hollow of my hand."

[Peul proverb]

WATER AND LAND

by
the **authors** and
Olivier Berney [1]

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BOL, CHAD

LAKE CHAD IS A PRECIOUS SOURCE OF FRESHWATER SURROUNDED BY AN EXTREMELY DRY ENVIRONMENT

INTRODUCTION

Worldwide, attention has been focused on the vital importance of water by the declaration of 2003 as the International Year of Freshwater. However, in spite of the growing recognition of the key role that water plays in development, more needs to be understood about the links between how it is used and the effects on the environment. Water is a precious and finite resource, crucial to the development of agriculture, but also fundamental to a whole range of other ecosystem services, including wildlife, fishing and livestock [6.1], [6.2].

In an area of virtual desert, the Lake Chad Basin offers a source of freshwater for the people who live on the shores of the lake and rivers and well into the hinterland. Farmers and pastoralists are keenly aware of the fluctuations in water availability and its effects on their lives, a fact which is reflected in the language that they use. They do not simply call the seasons "dry" or "wet". Instead, they refer specifically to the effect of rain on vegetation, using descriptions such as "necessary rainfall", "effective rainfall" and "useful rainfall".

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NEAR DANOUWANE VILLAGE (N'GUIGMI), THE NIGER

WATER IS A FINITE RESOURCE — ITS WISE MANAGEMENT PROMOTES FOOD PRODUCTION AND ECOSYSTEM CONSERVATION

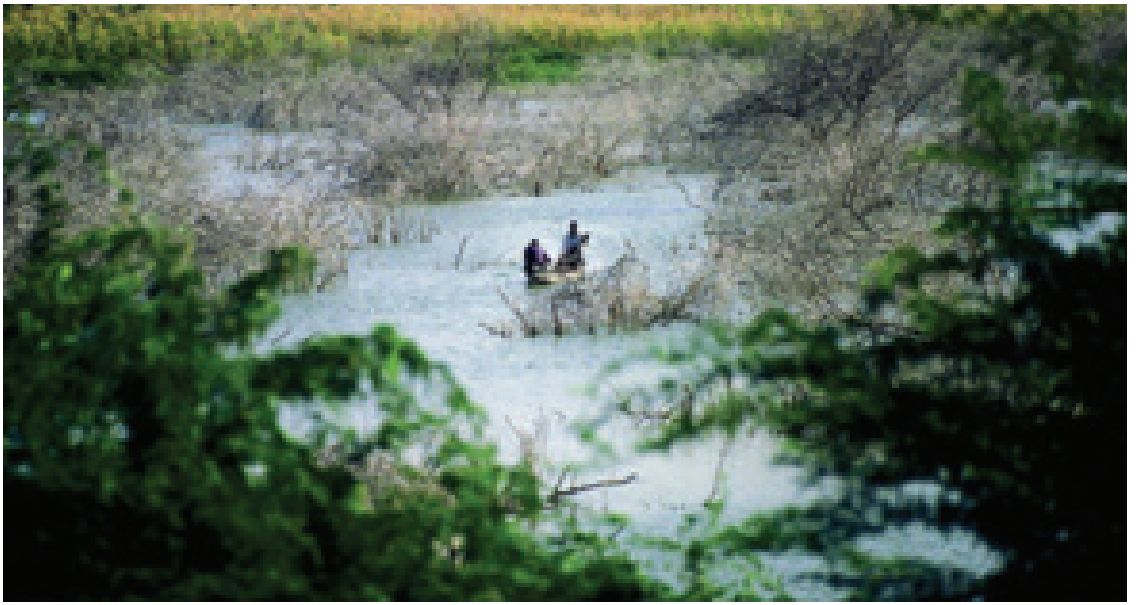
Local farmers have learned to adapt their agricultural systems to monthly, seasonal and yearly variations in rainfall. They can even predict the movements of the lake, since high and low water levels are a direct consequence of rainfall.

As a result, farmers and pastoralists have developed specific techniques in order to take advantage of the unique characteristics of this ecosystem without damaging it. These include the use of recessional land and natural wadis and ponds, the creation of polders and the construction of wells.

All efforts to increase food production should focus on enhancing these techniques, rather than replacing them with new intensive irrigation schemes, for example through the use of new water-saving or harvesting methods combined with improved agronomic practices, such as the following.

- The selection of drought-resistant seed.
- Integrated pest management.
- Introduction of legumes (*Vigna unguiculata* and others) intercropped with cereals.
- Rehabilitation of degraded soils using pioneer local cereal varieties combined with networks of water retention structures.
- Adequate maintenance of ground cover.
- Treatment of acid soils.
- Enhancing fish production from ponds and polders.

PORT OF DORO LELEWA (N'GUIGMI), THE NIGER



LARGE AREAS OF LAND ARE PERIODICALLY FLOODED. WHEN THE WATER RECEDES, THE SOIL STORES MOISTURE THAT CAN BE EXPLOITED FOR AGRICULTURAL PRODUCTION

RECESSIONAL LAND

The seasonal fluctuations in lake and river levels create large areas of land that are periodically covered and uncovered by water. As the water recedes, this land stores moisture that can be exploited for agricultural production.

Farming systems around the lake use both traditional and improved technologies to adapt to the changing lake levels. A first crop, generally a cereal, is obtained by cultivating during the rainy season. A second crop, for example, transplanted sorghum, *gombo* or vegetables, is produced from residual moisture that becomes available at the end of the rainy season, as lakewaters recede and large areas of fertile alluvial soils become available for direct planting [6.3]. A third crop can be obtained if small dams and pumps are available to provide irrigation water during the dry season. Lamentably, dykes and gates around the existing irrigated areas are often in poor condition, and the producers do not have the capital to improve them because of the low returns from farming. In old irrigated areas, bad irrigation management often leads to accumulation of salt on the soils and their consequent abandonment. High costs of fertilizers and difficult access to agricultural credit are behind the poor adoption of improved technologies that could increase the production in recessional land.

Recessional lands are also of particular importance for other reasons.

- **Preservation of biological diversity.** For many species of fish and waterfowl floodplains are of vital importance as breeding grounds as well as staging areas on their migration routes. All types of wetlands may harbour unique plants and animals.
- **Production of goods.** These lands are among the most productive ecosystems in Africa. Floodplains are important grazing areas for cattle and wildlife and a source of wild fruits, vegetables and medicines. Forests may yield valuable timber.
- **Production of services.** The lands can be an efficient, low-cost water purification system (herbaceous swamps), a recreation area (hunting, fishing and boating), and a buffer against uncontrolled floods.

Without these lands, the drylands of the West African Sahel would be both less productive and more hazardous as a place for people to live [6.4].

The Hadejia–Nguru wetlands

Extract from FAO Land and Water Bulletin No. 4 [6.4]**.**

The Hadejia–Nguru wetlands [6.5] concern a part of the floodplain of the Komadugu–Yobé river basin in the Lake Chad Basin in the northeast of Nigeria and are home to probably about a million people. The wetlands have formed where the waters of the Hadejia and Jama'are rivers meet the lines of ancient sand dunes aligned northeast–southwest. An area of confused drainage has formed here, with multiple river channels and a complex pattern of permanently and seasonally flooded land and dryland. The wetlands are nationally and internationally important for migratory waterfowl. They support extensive wet-season rice farming, flood-recession agriculture and dry-season irrigation. The floodplain also supports large numbers of fishing people, most of whom also farm, and is grazed by very substantial numbers of Fulani livestock, particularly cattle, which are brought in from both north and south in the dry season. There is also an important dispatch from the wetlands of fuelwood and fodder for horses. In the past, much of the rice, as well as fish and birds, was traded out of the area. This has changed, but there is now a strong export of other agricultural products, for example, peppers, wheat and fuelwood. The economic value of production from the wetlands is very large, many times greater than that of all the irrigation schemes for which the inflowing rivers are dammed, diverted and their waters used.

There are natural changes, for example, the impacts of drought that have serious implications for the future of the wetlands and the sustainability of their production systems. There are also major economic changes within the wetlands themselves.

N'GUIGMI MARKET, THE NIGER

WETLANDS PRODUCE RICE AND VEGETABLES FOR BOTH HOUSEHOLD CONSUMPTION AND TRADING

The extent of irrigation greatly increased over the 1980s, largely as a result of the advent of small petrol-powered pumps and the ban on the importation of wheat in 1988. As the use of small pumps spreads, conflicts are beginning to emerge between farmers and pastoralists, and between small and large farmers for access to land.

The wetlands have also been affected by developments elsewhere in the river basin. The construction of the Tiga Dam on a tributary of the Hadejia River in the early years of the 1970s has exacerbated the effects of the low rainfall of the two following decades. The result has been a reduction in the extent of flooding in the wetland. Most of the dams,

irrigation schemes and water resources plans for the Yobé basin were prepared in the 1970s and early 1980s, using data for the relatively wet period up to 1973. The post-1972 drought has reduced the proportion of rainfall that runs off to the rivers. The 1988 flood at Hadejia was probably one of the largest for some years and it was augmented by the failure of the dam at Bagauda.

The Hadejia–Nguru wetlands have long been known as a centre of fish production. Upstream hydrological developments induced by irrigation projects threaten to degrade this important resource. Studies of floodplain fisheries have shown that fish production is closely related to flood extent. The existing and planned dams upstream of the Hadejia–Nguru wetlands are likely to have a serious impact on fisheries. Despite the lack of information specific to the Hadejia–Nguru wetlands, there are enough studies from other floodplains affected by hydraulic works to show that the effects of dams on fish communities are likely to be serious. The dams are likely to bring changes in river flow, loss of habitat, blocking of channels, changes in silt loading, plankton abundance and temperature, which are likely to affect fish communities.

The economic value of fish production from the floodplains adds weight to the argument in favour of maintaining the annual flooding of the wetlands. Moreover, the significance of fishing goes beyond its value in monetary terms. Fishing plays an important role in the flexibility and adaptability of the rural economy in the floodplains. A reduction in this flexibility through degradation of the fishery resource may have serious repercussions on the ability of communities to adapt to fluctuations in their environment. Many people are involved in fisheries and so the social consequences of any appreciable reduction in productivity will be felt throughout the area. Degradation of fisheries may also affect other sectors of the rural economy. Most people who fish also pursue other activities – such as farming, livestock rearing, manufacturing of crafts or trading – and the loss of, or reduction in one component of, the household economy is likely to affect activities in other sectors. There will also be "downline" effects on fish processors, fish dealers, customers and consumers.

In addition to producing fuelwood, the forest reserves and bushland of the floodplains yield important non-timber forest products that are significant to the livelihoods and subsistence of local communities. Some, including leaves, are important marketed commodities that generate substantial income. *Baobab* leaves are used widely as an ingredient for soups and stews and are especially important as a "drought food". Honey, produced by local beekeepers, is a highly valued commodity.

Since 1985, the area has been the focus of the Hadejia–Nguru Wetlands Conservation Project. This project has been run jointly by the Nigerian Conservation Foundation, IUCN (World Conservation Union), the Royal Society for the Protection of Birds and the International Council for Bird Preservation (now renamed BirdLife International). In 1990 a major development project was started by the European Community that included the eastern part of the area. The Northeast Arid Zone Development Programme (NEAZDP) has a very substantial budget to generate village-based development initiatives. Attention has tended to be directed in particular to the potential resources of the wetlands.

The economic importance of the floodplains suggests that benefits they provide cannot be excluded as an opportunity cost of any scheme that diverts water away from the floodplain system. Policy-makers should be aware of this problem when designing water development projects in the river system. Further analysis is also required of the type of "regulated flood projects" regime, which could maintain much of the floodplain system intact while still allowing some upstream water developments. Further investigation of all the economic benefits provided by the wetlands is also needed, and the sustainability of production within a floodplain area should be more thoroughly examined.

PORT OF BLANGOUA, (KOUSSERI) CAMEROON

FORESTS AND BUSHLAND IN FLOODPLAINS PRODUCE FUELWOOD AND OTHER IMPORTANT NON-TIMBER PRODUCTS

POLDERS

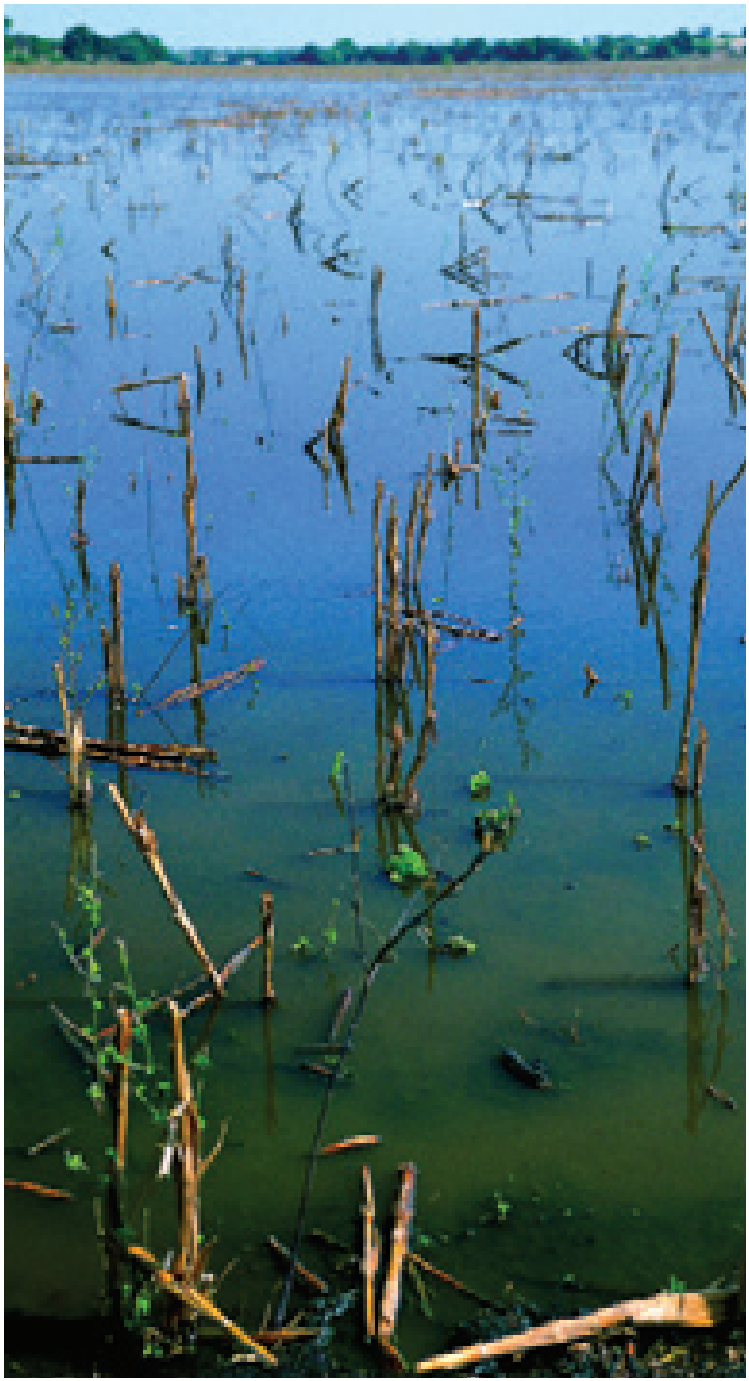
During annual spates, the long, narrow depressions located along the northern and eastern coast of the lake are flooded by lakewater, which normally recedes during the dry season. By closing these off at the inlets with a rudimentary dam, lake dwellers found they could produce a remarkably fertile plot of irrigated land, suitable for growing crops. Such a dammed wadi is currently called a "polder" [6.6].

Strictly speaking, the Dutch term "polder" represents an area where the water table can be regulated and controlled independently of the water level in the surrounding area. In this respect, a polder in Lake Chad can hardly be considered a true polder. However, a polder is also often considered as a low-lying area reclaimed from the sea or a lake and artificially protected against the risk of flooding. In Lake Chad, the term "polder" is used in this sense.

It is quite difficult to determine when polders started to be established. A dam appears on a map of the Kouri region dated 1913, but dams were most probably introduced long before then. More evidence of their use is available for later years, and they were already widespread along the northern shore of the lake in the 1950s.

Polder dams are traditionally built by embedding two rows of acacia tree trunks vertically at the narrowest point of the inlet. Palisades are fashioned using ropes made of *Calotropis* fibre and dum palm leaves, and the intervening space is filled in with sand. Dams can reach 100 m in length and are generally between 2 and 3 m thick [1.5].

As the waters are gradually absorbed into the soil, crops are planted. To begin with, the outer edges of the polder are cultivated, since this is where the water first recedes.



KLA AOUDOU POLDER (BOL), CHAD

POLDERS ARE NARROW INLETS FLOODED BY LAKEWATER. A SMALL DAM AT THE INLET MOUTH PREVENTS WATER FROM RECEDING, THUS ENABLING AGRICULTURAL PRODUCTION DURING THE DRY SEASON

The central areas are reserved for later cropping. If the higher reaches dry out too quickly, shallow wells are dug to irrigate them. In this way polders can boost crop output from one harvest to three harvests per year.

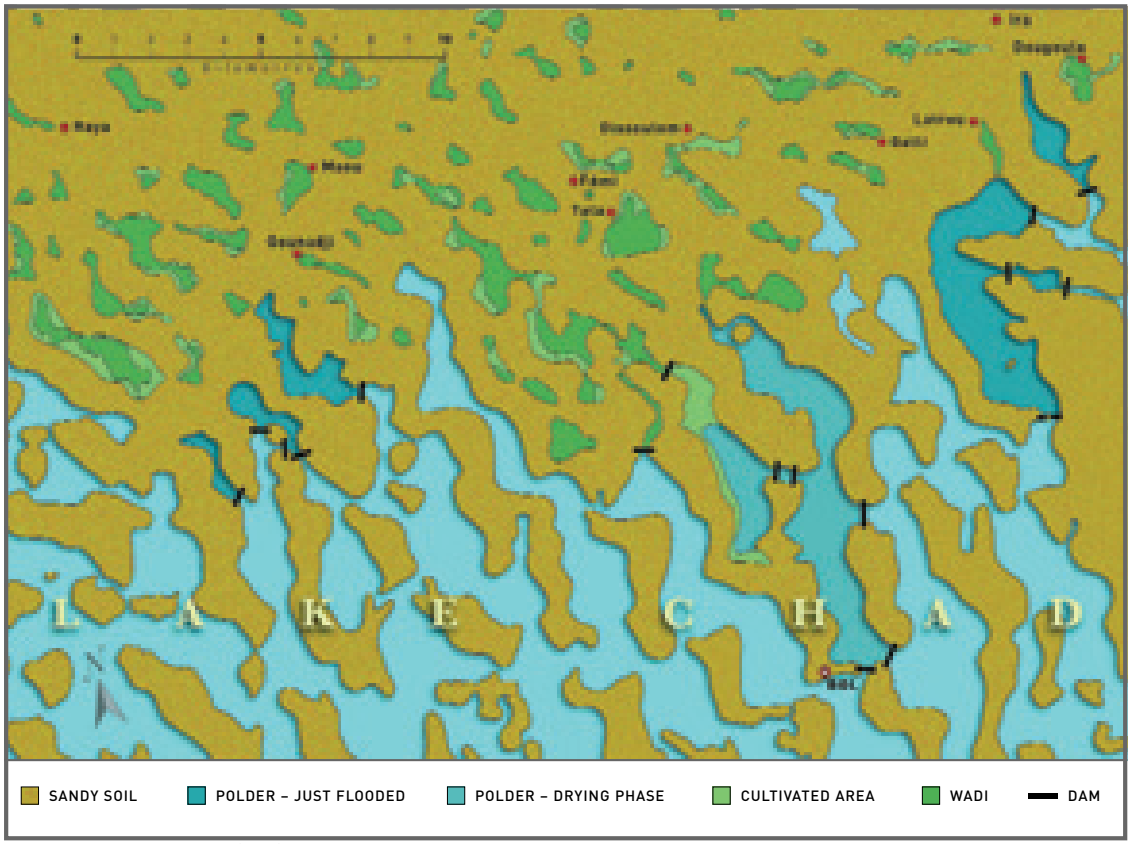
The dams normally last for six to ten years, provided that the passage of cattle over the top of the dyke is not too heavy. In any case, polders are designed as a temporary structure. Every six to ten years, the dams are deliberately breached to allow in fresh lakewater to wash out the accumulated salt from the soil and deposit new layers of silt. Generally, the polder is then left to allow the original vegetation to re-establish, in order to restore the balance of the soil. Animals are let in to graze, and their dung contributes to the recycling of the organic material of the land. Since this is a nomadic society, the farmers move on to build new polders elsewhere, or to reactivate ones that have been allowed to lie fallow.

Lands irrigated using this system need no input of fertilizer. They are naturally rich in nutrients left by the lakewaters as they recede, and they are maintained by the system of cropping and fallow. The soils are generally hydromorphous and medium in terms of organic matter content, consisting of damp gley with calcareous alluvial deposits, which are developed to a greater or lesser degree after being submerged or saturated with water. These soils are rich in minerals and, initially, rarely saline. Today, sorghum, millet, rice, wheat, maize and vegetables are grown on polders.

It should be stressed that the farming practised in these polders is essentially subsistence cropping and not commercial. Only part of the available land is actually cultivated, because of the immense task of clearing spontaneous vegetation which, after just a few months of neglect, can reach a height of 2 m.

KLA AOUDDU POLDER (BOL), CHAD

THE DAMS USED TO BE BREACHED EVERY FEW YEARS TO LET FRESHWATER INTO THE POLDER. RECENTLY, PVC PIPES HAVE BEEN INSTALLED IN SOME POLDERS TO AVOID THE NEED FOR BREACHING THE DAM



MAP OF POLDER AREA AROUND BOL (CHAD) IN 1956
DATA ELABORATED FROM ORSTOM/FAO [6.7]

In recent years, modifications have been made to the traditional method of building polders, with varying degrees of success. In some cases, polyvinyl chloride (PVC) pipes have been placed across the dam at the lowest point. When the polder is flooded, the pipes are closed off by jamming them with small sandbags. When the land becomes too dry, generally after two to three years, the sandbags are removed so that the polder can become flooded again. The process is repeated as the need arises. Sandbags can be replaced by installing valves on the pipes (for example, in the Kindjiria polder, a SODELAC (Societé de développement du lac) project with international funding, which covers a surface of 800 ha [6.8]). This system allows water to be let in without breaching the dam – a saving in cost and labour – and can work well provided that the principle of letting the polder rest and recuperate is respected.

KLA AOUDOU POLDER (BOL), CHAD

SANDBAGS ARE USED TO CLOSE OFF THE PVC PIPES

PERMANENT POLDERS: IS THIS THE WAY FORWARD?

Another adaptation of the polder introduces a more permanent structure, which is alien to the notion of versatility on which this system of irrigation is based. In this case, the dam is built from reinforced concrete, and motorized pumps are used to inject more lakewater as required. The water is directed along a network of channels, also built of concrete, so that land further afield can be irrigated. By its very nature, a concrete dam is likely to be more permanent: it is clearly much harder and more expensive to remove or abandon a dyke built of cement than one made of tree trunks and dum fibre. The intention is evidently to build a structure designed to remain in place on a permanent rather than a temporary basis.

Projects and plans aimed at intensifying polder irrigation, and at making it a continuous process, are moving forwards, although progress has been slowed by lack of tools and human resources. Intensification of irrigation would undoubtedly increase food production. However, gains in output must be offset against higher production costs and, perhaps more important, the invisible costs to the environment, which will only become evident much further down the line.

Flexible and cheap irrigation methods favour mobility: if a dam is inexpensive and easy to remove, farmers can move on when the time is right. These methods also promote cultivation rights based on consensus and tacit customary agreements, which in turn sustain mixed agropastoral production systems. Continuous polder use does not foresee access by animals, since its sole aim is to intensify agricultural output. Yet livestock have a valuable role to play in a production system. Animals provide meat, milk and

TER BOLET POLDER (BOU.), CHAD

AS THE POLDER DRIES OUT, SHALLOW WELLS ARE EXCAVATED TO EXTRACT WATER

KLA AOUDOU POLDER (BOL), CHAD

TRADITIONAL SMALL-SCALE POLDERS ARE QUITE EASY TO MANAGE. RECENTLY, LARGER POLDERS COVERING HUNDREDS OF HECTARES HAVE BEEN CREATED TO INTENSIFY PRODUCTION BUT THEIR ENVIRONMENTAL AND SOCIAL IMPACT SHOULD BE CAREFULLY EVALUATED

manure and also offer a degree of income generation and food security. If an area under polder irrigation is hit by drought, crops will fail no matter how sophisticated the structure, but animals can always be moved to better grazing pastures.

By their very nature, permanent polders encourage communities to become sedentary, a tendency that goes against traditional practice in the region and that deprives people of the flexibility that has enabled them to survive in the past. The new polders are much bigger than their forerunners. A traditional polder covers an average of 20 ha. By contrast, the polder that has been recently developed near Bol covers a massive 800 ha, attracting a huge increase in population in the process and putting an unsustainable strain on the land. Increasing yields mean that other issues have to be addressed, such as access to markets. Indeed, once new crops have been introduced, and production has been intensified beyond subsistence needs, the entire system and infrastructure will have to be overhauled. Additional roads will need to be built. Services will have to be provided for the new populations.

Less obviously, at least in the short term, continuous polder use will take its toll on the environment. Permanent polder use can cause salt buildup in soil and groundwater, making the land less fertile. The overuse of water in one area can lead to inadequate supplies in another, a factor that can lead to the disruption of the delicate wetland system on which the Lake Chad Basin relies. The result will be losses in wildlife, fish stocks and vegetation. Already, the effects of intensification plans have begun to make themselves felt. In some parts of the lake, wetland areas are drying out, a process that is leading to changes in the migration patterns of birds, feeding and breeding grounds for fish and wildlife, and grazing for livestock. As part of the ripple effect, pastoralists are also having to alter their seasonal pattern of movement between arid and wetland environments.

The sustainability of traditional systems related to irrigation and use of freshwater must be studied and evaluated both from the environmental and from the production point of view.

There is still a lot to do to ensure a more rational and sustainable use of the limited surface water, starting with a complete inventory and the establishment of reliable regulations concerning existing installations and their exploitation [6.8].

BOUDOU ANDJA WADI (DUM DUM), CHAD

WADIS ARE DEPRESSIONS THAT COLLECT RAINWATER. SOME OF THE MOST ANCIENT WADIS ARE SOURCES OF SALT AND EDIBLE ALGAE USED BY HUMANS AND LIVESTOCK (SEE ALSO CHAPTER 9)

WADIS

A useful natural source of water in the Lake Chad Basin comes from the wadis. In arid countries the Arabic term wadi (French *oued*) means "a temporary watercourse", which is most often dry but which carries huge quantities of water and mud during flood events. Around Lake Chad wadi has a different meaning and refers to the ancient depressions on the edges of the lake bed and low-lying floodplains near the rivers that collect rainwater. As a result, they may be full at certain times of the year and dry at others. The depressions vary greatly in size and shape. Some are round, but often they are long and narrow, resembling small rivers when water is plentiful. Wadis with steeper banks tend to collect more water and more organic matter.

Wadis are made up of stratified lacustrine alluvial soils, which are rich in organic matter, with swelling calcium and montmorillonite clay formations. For centuries, local communities have used wadis for a variety of purposes, depending on their needs and on the particular type of wadi. Some of the most ancient wadis are sources of natron or salt to supplement the diet of livestock. Others are set aside to provide drinking–water for animals. Wadis with a good supply of water may serve as a breeding ground for a valuable alga (*dihé*: see chapter 9). Many are used cultivated and cropped, and farmers have developed traditional skills to get the most out of these naturally fertile areas, which often allow them to produce a second harvest [1.5].

The crops planted will depend on the season – a wadi may be farmed with cotton or vegetables in the dry season and wheat, sorghum or maize in the rainy season.

NEAR GUITTE (NDJAMENA), CHAD

SOME WADIS PROVIDE FRESHWATER FOR AGRICULTURE AND LIVESTOCK

Periodically, the wadi will be left fallow to allow the spontaneous regeneration of *Acacia*, *Boscia senegalensis*, *Salvadora persica* or *Capparis decidua*, which provide good fodder for cattle. Often, the edges of wadis are planted with date palms (*Phoenix dactylifera*) or are used for grazing. Wadis are frequently rich in the wild grasses known as *kreb*, which are highly prized by pastoralists for whom they provide food security in the dry season.

NEAR LIWA, CHAD

PALM TREES ARE OFTEN PLANTED AROUND THE EDGES OF WADIS