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State Secretariat to the Minister of Energy, Mining, **Water** and **Environment**, in charge of **Water** and **Environment**

Department for Environment

Evaluation of the oasis ecosystem Tafilalet by the approach of Millennium Ecosystem Assessment

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PNUE

Millennium Ecosystem Assessment

SUMMARY

Introduction

Protecting the ecosystem of the oasis of Tafilalet was identified as a priority within the framework of the implementation of the action plan relative to the regional study of Meknes-Tafilalet. This study was developed by the Environment Department of the Ministry of Land Use, Water and Environment (MATEE) through the Moroccan National Observatory of the Environment (ONEM).

Several activities, related to the issue of global fight against desertification, rational water management and the preservation of the oases, are implemented in the region. The Specific needs were also determined and budgeted according to the type of action to be taken. The amount needed for the achievement of the project is estimated at about US $ 5 million. A project carried out by the European Commission (EC) related to the establishment of a system to attend and evaluate the National Action Plan to Combat Desertification in Morocco (NPA / CD Morocco), contributes in finding a solution to this issue.

In addition, the Ministry of Land Use, Water and Environment through the Planning Administration, conducted a national study entitled "Moroccan Oasis Planning and Development Strategy - 2003). Several other studies and actions, mainly on the fight against desertification, were completed or are still on the process by the Regional Office of Agricultural Exploitation of Tafilalet.

The Hydraulic Regional Administration of Ghéris, Guir, Maeder and Ziz has also initiated several measures aiming to rationalize the exploitation of water resources. The Japan International Cooperation Agency JICA) supports, by a project to rehabilitate ‘Khettarats’, a traditional system of underground water supply, the rational management of water resources in the region.

Synergy between different initiatives should be promoted in order to capitalize on the efforts and optimize the use of resources. Involving civil society in the decision-making process and strengthening capacities, especially in terms of the future planning, will serve as a guarantee of the acceptability and sustainability of the actions taken to preserve and protect the oases.

This study, which aims to evaluate the oasis ecosystem on the basis of a holistic approach, adopted this perspective, with a partnership and participatory spirit. It used the already existing information and involved various important parties in a spirit of cooperation and collaboration in the process of primary data collection. It was also concerned by the future of the oases and the actions to be taken to ensure a desirable future.

The evaluation of the oasis ecosystem of Tafilalet is part of the Millennium Ecosystem Assessment (www.millenniumassessment.org). This leading project in Morocco, intended as a sub-regional study, along with those of Assir in Saudi Arabia and Sina in Egypt, represents the Ecosystem Assessment for the Arab region Millennium.

1. Introduction to the Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MEA) is an initiative through which the UN Secretary General called, in 2000, the international community to support and restore the "health" of our planet. This project aims at an integrated evaluation of the ecosystems and the consequences of their progress on human well-being. The site of Tafilalet in Morocco which is located in the region of Meknès-Tafilalet (Fig. 1), along with that of Assir in Saudi Arabia and Sina in Egypt, are the subject of a sub-regional study representing the MEA arid ecosystems.

The oases are defined as an area intensively cultivated in a desert or heavily characterized by the dry climate (Mainguet et al. 2007; Lacoste, 1987). They have many environmental functions. They may also provide social, environmental and economic services.

Characterized by their cultural and architectural diversities, the oases offer exceptionally rich and varied sceneries. They have potentials that are at the root of several human activities such as agriculture, tourism, craftsmanship, and industry. These potentials, however, are located in a difficult and a fragile environment. The severe weather conditions, low levels of resilience and water scarcity have prompted human beings to use a traditional food-producing system.

In the past, human beings had always lived in harmony with their environment. In the present, however, with the population growth and the improvement of production technical tools, these ecosystems are forced to change, which is in fact causing their dysfunction. Indeed, the Oasis Systems are facing several problems such as the abandonment of agricultural practices due to productivity loss resulted from the increase of salt in the soil, irrigation water shortage or its poor quality, desertification, migration, etc..

The desert, water and plants, including date producing palms, are the principal components of the oases of Tafilalet, classified among the main Moroccan palm areas (Harrak et al., 2001). These oases are home to an ancient civilization influenced by dryness and traditional know-how in the mobilization of water and natural resource management.

Sub-Global Assessments: Approved Assessments

Africa (southern regions), Canada, Caribbean region, Chile, China (western regions), India, Kenya, Norway, Peru, Papua New Guinea, Philippines, Portugal, Sweden, Trinidad, Vietnam

Sub-Global Assessments: Associated Assessments

Arafura and Timor Seas, Argentina, Asia (central regions), Australia, Brazil, Colombia, Costa Rica, Egypt, Fiji, India, Indonesia, Morocco, Saudi Arabia, United States

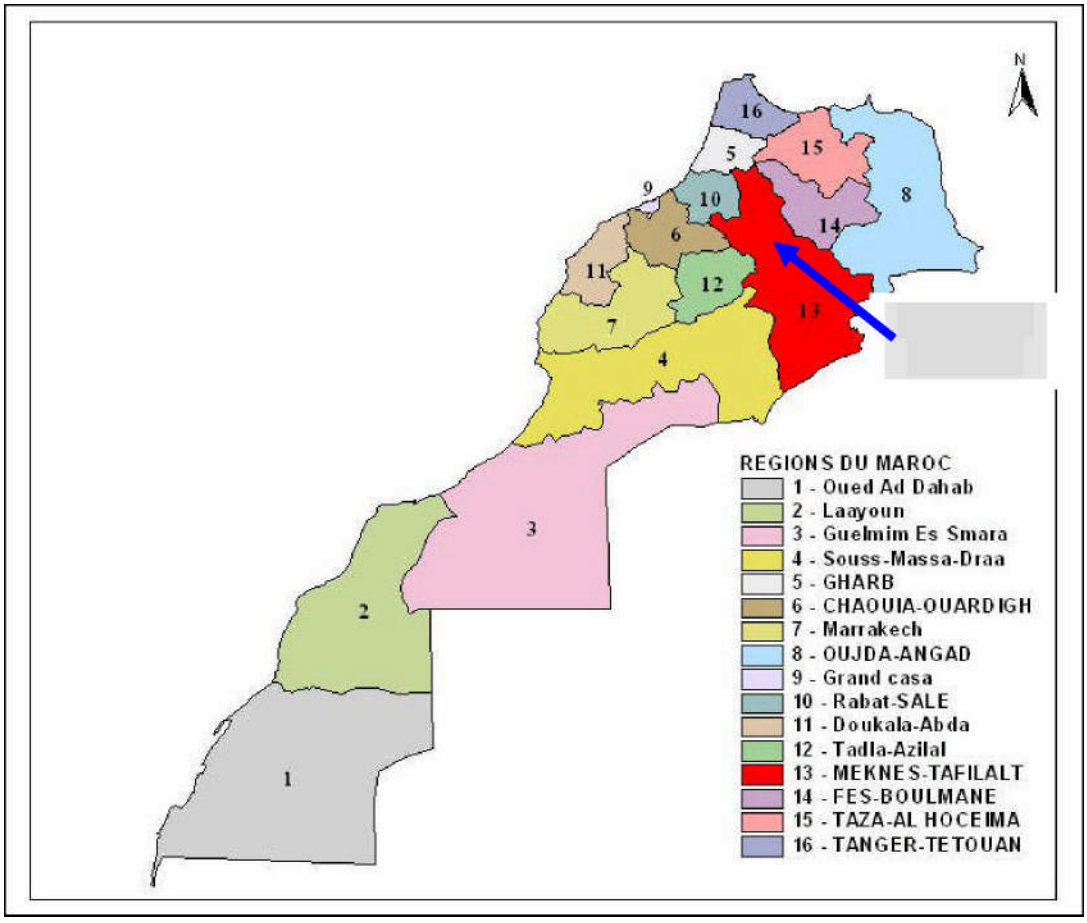


Figure 1: Evaluation sites for the millennium and location of the leading site Tafilalet

An agricultural know-how was developed in these vulnerable fragile balanced environments: the adoption of an intensive 3-storey vegetation system associated with livestock, agriculture-craftsmanship association, the practice of an agriculture oriented towards crops and varieties with high-commercial value and the diversification of extra-agricultural activities.

These oases are under increased pressure resulting from the abusive anthropic action (over-exploitation, overgrazing, water over-pumping, etc..) on the natural resources already depleted by the effects of the dryness recurrent periods, water shortages, pathogenic attacks on palm trees ('Bayoud'), etc.. This deterioration process, affecting the ecosystems integrity, can lead to the decline of the services that are considered as the locals' basic resources and to welfare loss and to a destabilization of the social and cultural human communities.

Facing this situation, which never ceased deteriorating, correction sectional policies were undertaken via the projects of preservation restoration and rehabilitation of the agro-ecological systems: protection of productive heritage, pastoral improvement, economic development actions However, the made efforts remain limited if compared to the gravity and complexity of the situation.

This study aims to better understand the potential and constraints of these oasis ecosystems in their socio-economic context, how the goods and services of these ecosystems contribute to improving the human welfare, what are the anthropic impacts on these ecosystems, and what could be done to prompt these ecosystems to provide sustainable services for human benefit.

1.1. Background and context:

1.1.1 Description of the region Tafilalet

1.1.1.1. Biophysical characteristics

Tafilalet, which corresponds globally to the province of Errachidia, covers, among other parts, four watersheds that are, from West to East, Ghéris, Ziz, Guir and Maeder in the south (Figure 2). These four watersheds cover a total area of 60,000 sq. km, or 9% of the national territory, accommodating a population of approximately 0.81 million inhabitants, or 2.7% of the national population. These four watersheds cover three economic regions (Bouanane_Bouarafa, Sous Massa-Draa and Meknes Tafilalet) and four provinces (Errachidia, Zagora, Ouarzazate and Figuig).

The Watersheds of Ghéris, Maeder and Ziz, which are situated in the area concerned by this evaluation, are located in the province of Errachidia. This province comes within the region of Meknès-Tafilalt which covers an area of 77,250 km ², roughly 20% of Moroccan oasis zones and 11% of the national territory, 97% of which consists of uncultivated land and pastures (N ' Ait M'barek, 1999). The province of Errachidia covers a total area of 59,585 km² and represents about three-quarters of the region of Meknès-Tafilalet and homes about a quarter of its population.

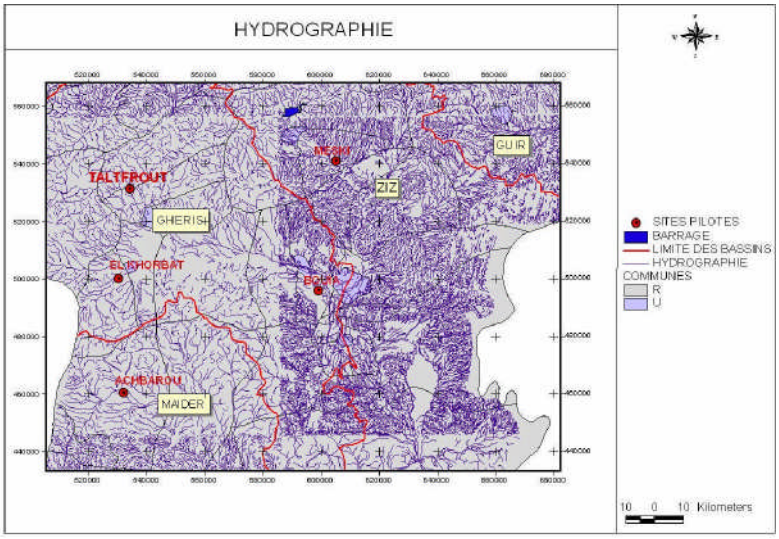


Figure 2: Watersheds of Tafilalet and hydrographic network.

The watersheds of Ghéris, Ziz and Maeder are surrounded by the basin of Guire in the East, Bouanani in the North, Moulouya and Oued El Abid in the North-West, the pond of Dades in the West and the Sahara in the South. The hydrographic network is formed mainly by the river of Ghéris, Ziz and Gaiz, respectively. The first two originate at the top of the High Atlas and the third at the summit of Jbel Saghro in the oriental Anti-Atlas. From the relief (Figure 3), we distinguish, from North to South, three morphological units:

- The High Atlas mountains in the North;
- The plain of Tafilalet in the center; and
- Semi-desert high plateaus in the South (Hamada).
- The altitude ranges from about 3500 m in the North to 800 m in the South

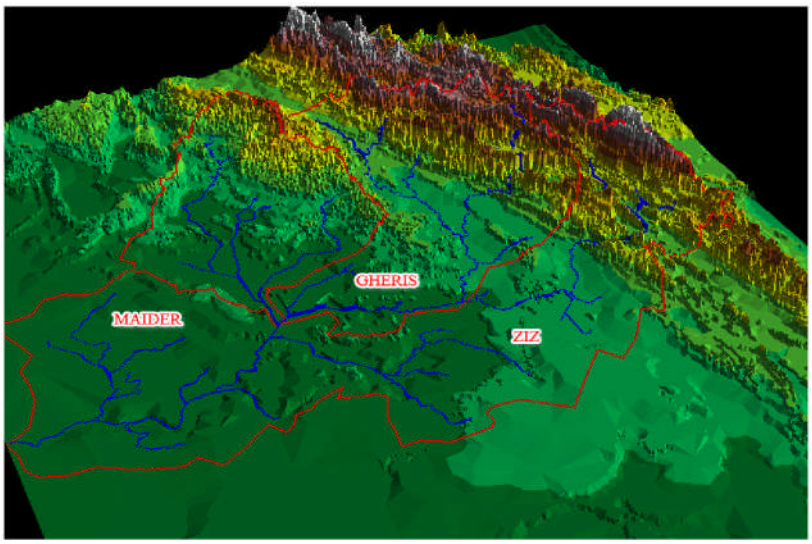


Figure 3: Relief of the area of study

From a geological point of view, Tafilalet is located in the structural area of the Anti-Atlas and the Southern part of the Oriental High Atlas. It is characterized by the diversity of its formations and features. Its Northern part dates back to the Jurassic age, the middle part to Cretaceous period

and its Southern part to Paleozoic and Precambrian ages. The fossil and mining heritage of the region depict an exemplary richness.

The soil cover is not organized in the same way everywhere in Tafilalet. It is characterized by a sedimentary partitioning (Kabiri 2003, 2005, 2004, 2006; Boudad and Kabir 2002; Abiotic Report 2000, MRMT, 2001, Kabir et al. 2003). This sedimentary heritage is organized in pedologic areas, whose differentiation methods were initiated by two particle transport agents: one is essential and frequent which is the wind, and the other is secondary and periodic, river floods.

The soils are of two types: raw mineral soils and slightly developed soils. Some soil marks, more or less advanced, can be found in different locations (Abiotic Report 2000, DAT, 2005, JICA, 2005, Kabiri, 2006, 2005, 2004, 2003; Kabiri et al. 2003). The cultivated soils have an argillaceous character of alluvial origin. They are rich in organic matter, which participates in their good fertility. The deposit of salts due to the effect of evaporation leads to a higher accumulation of salt on the surface and a tendency to alkalization in depth. Agricultural soils do not exceed 1% of the total surface located along the Ziz and Ghéris valleys. 99% of the lands consists either of range lands or are uncultivated.

The soils of the oases of Tafilalet are vulnerable and characterized by the limitation of pedogenesis processes and the formation of saline crusts on their surface. They are degraded and affected mainly by wind erosion, which leads to an increased desertification activity, constituting, therefore, of a constant threat of sand expansion and conglomeration in the infrastructure and agricultural production areas. Furthermore, water erosion is more intensified upstream.

The water resources of this region are dependent on climatic conditions and geological structure. Indeed, this resource is qualitatively and quantitatively influenced by time and space changes. Surface water is characterized by the high inter-annual change and by differences between the periods of low and high water levels.

Surface waters come from some sources, and from Hassan Addakhil dam, but mainly, from the wadis which are the main hydraulic network in the region of the study: Ghéris _ Ziz 375 Mm3 (RDH, 2007) [Ziz (250 mm3) and Ghéris (125 Mm3)] and Maeder (40 Mm3).

The dam of Hassan Addakhil, built on the wadi of Ziz in 1971, is the first high water dam in the East Atlas (photograph 10). It supplies the Ziz valley by a main 166-km-canal and another secondary one of 251 km. The agricultural area covers an area of 27 500 ha. The agricultural perimeters of the top watersheds are irrigated by the Small and Medium Hydraulics(SMH) for an area of 4970 ha and a mobilized volume of 35 Mm3.

The water exploitation and allocation results during the thirty-four years of service of the dam revealed that the average total per season is 100 Mm3 (62% of the volume expected in the study harnessing), evaporation and infiltration (16%), restitution to the area of recasement (8%), restitution of the Ziz valley (28%) and the releases towards Tafilalet (48%). The pond of Ziz recorded accordingly a water deficit, the more intensified in comparison with the other ponds.

Water floods allow, in addition to the occasional irrigation, the recharging of the groundwater and the nutrition of the dam of Hassan Addakhil. These floods, which resulted from heavy rains falling on the High Atlas watersheds (Ghéris, Ziz) are often violent. The flood occurred between May 25 and 27, 2006 at Ziz generated substantial numbers at the dam of Hassan Addakhil. This additional supply is estimated at about 34 Mm3. The volume of the reservoir is 54 Mm3, a filling rate of 17% (against 9% for the same period in the previous year) (DRH GRZ, 2006). The filling rate of the dam is measured currently at 75% (DRH 2007). According to the Regional Agency for Irrigation and Agriculture Development of Tafilalet (ORMVA / TF), it can operate three agricultural seasons.

Photo 1: View of the dam of Hassan Addakhil in 2007

Waters regulated by the dam of Hassan Addakhil are intended to irrigate three zones (Bousfoul et al. 2005) :

- the valley of Ziz, covering an area of 4,500 ha, is served by two modern canals, on the left and right banks, with a capacity, respectively, of 1.800l / s and 300 l / s;
- The recasement perimeter , covering an area of 1,000 ha and located to the west of Errachidia, is powered by a modern canal with a capacity of 840 l / s. The perimeters of the Ziz and the recasement are irrigated from up to downstream;
- The Plain of Tafilalet, covering an area of 16,000 ha, benefits from 3 to 4 releases from the dam per agricultural season. These releases head directly to the river of Ziz's bank, to change the direction towards the dam of El Brouj through the P0 canal, which has a capacity of 12 l / s.

Groundwater is divided into four deep layers (Figure 4): Jurassic, Infra-Cenomanian, Turonian and Senonian, plus the (Quaternary) groundwater upstream and fracture layers in the Paleozoic and Precambrian and Quaternary downstream.

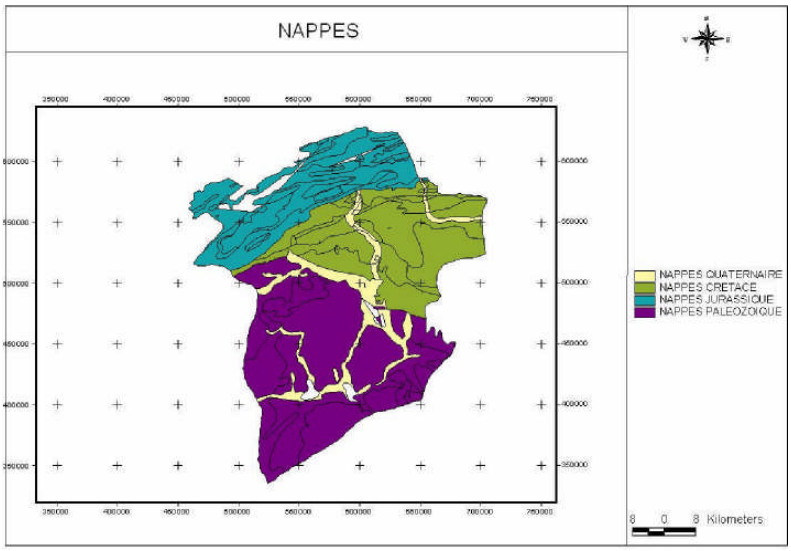


Figure 4: Aquifers of Tafilalet

Three principal agro-climatic zones exists in the region: mountain, middle and plain zones. This diversity has allowed Tafilalet throughout its history to be a biodiversity exceptional place in the world. The region is home to several plant and animal species some of which are endemic or rare.

Tafilalet is an area of old agricultural traditions where people have developed through centuries mobilization systems and water management. Indeed, agricultural practice, a result of the settling process, is allowed only through the development of irrigation in relation to the severity of the climate.

1.1.1.2. Climatic characteristics

Tafilalet's climate is continental, dry in the North (mountain zone) and desert in the South (Sahara). It is characterized by large differences in both seasonal and daily temperatures, which may reach 5% in winter. Extreme temperatures range from frosts in winter to an average of 41 ° C in July. The annual average of temperature is 20 ° C; it ranges from 16 ° C to 23 ° C. During the summer, however, the temperature can reach 50 ° C in some places (eg Rissani and Alnif) .

The annual average of rainfall is very low: 250 mm in the North and less than 60 mm in South of Tafilalet (DRH, 2007). The annual rainfall is characterized by the existence of two rainy seasons, autumn and spring, separated by two dry periods. The number of rainy days is on average 25 days per year.

Rainfall in the region reflects a wide variability with relatively large levels during the sixties and relatively low levels during the seventies and the eighties (80-87). The late 20th and early 21st centuries also witnessed periods of great shortage and thus drought increased. According to the DRH (GRZ), the average of rainfall for the period 1945 - 2006 reached 150 mm in the ponds of Ghéris and Ziz and 120 mm in Maeder.

The area was characterized by periods of prolonged droughts during the last century and the beginning of this century: 1913 - 1918; 1927 - 1931; 1933 - 1939; 1945 - 1947; 1955 - 1957; 1973 - 1976; 1979 - 1984 1987 -- 1988; 1993-1995; 1997 - 2004 (Benmohammadi et al. 2000; Kabiri et al. 2003).

However, 2006 witnessed important and very violent rainfall. We should also indicate that the region has experienced quite significant falls of snow in several places during January 2005 and February 2006 (Errachidia Tinjdad, Alnif, etc.).

The average of evaporation varies between 2678 mm upstream and 5342 mm in the South of Tafilalaet, with a weighted average over the entire Atlas watershed of 3460 mm. It reaches 2900 mm at the dam of Hassan Addakhil with an annual potential evapotranspiration of 1200 (DRH 2007).

The prevailing winds are 'Chergui' (North-East) and' Saheli '(South-West). Wind speeds are between 1.1 and 15 m / s, with important values recorded during January, February, March and June.

1.1.1.3. General socio-economic characteristics

a) Socio-demographic characteristics

The socio-demographic characteristics of the population living in the watersheds of Tafilalet were estimated according to the results of the General Population and Housing Census (GPHC, 2004).

The total number of urban and rural population was estimated at 514 190 inhabitants (34.5% urban and 65.5% rural). It is divided into seven municipalities and 35 rural communes all affiliated to the province of Errachidia (Figure 5). This population is spread into several tribes including Ait Marghad, Ait Atta, Ait Hdidou, Imazighen, Chourfa, Ikbleïn, Baali or Aït Ahmed, etc.

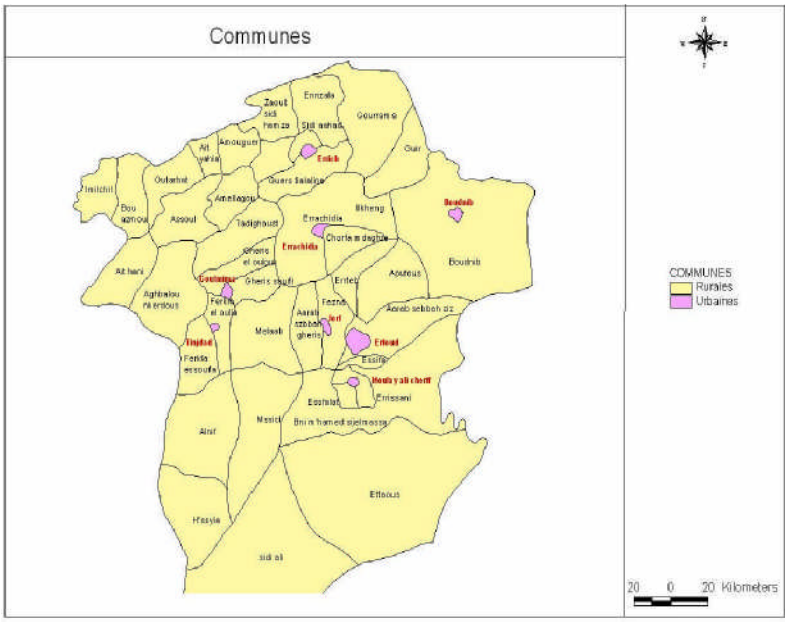


Figure 5: urban and rural Communes of Tafilalet

The active population, i.e. those aged between 15 and 59 years, is about 57% of the total population and35% is the percentage of those aged between 0 and 14 years. Women constitute 52% of the population while male population rate observed for the whole watersheds is 49%.

The analysis of marital status of the total population with 15 years or more, shows that 36% are unmarried, 54% married, and 9% other (widowed or divorced). Age at first marriage is 27 years for the whole population, 30 years for men and 25 years for women, which is considered by local standards to be a late age.

The illiteracy rate, calculated for persons aged 10 and over is 41%. It is higher among women (55%) than men (26%). Many rural municipalities have a rate of illiteracy, both sexes included, which exceeds 50%.

Concerning education, 41% of the total population is not educated. Among the educated category, 54% have a primary, secondary or high school level of education, 4% have a higher educational level and less than 1% have a preschool level.

There are only few informal literacy programs and the initiatives to raise awareness regarding the protection of the environment, apart from a few occasional and sporadic actions undertaken by certain groups, are almost absent. This state, characterized by illiteracy and a significant lack of awareness and mobilization of players for the rational management of natural resources, creates a sub optimization of the resources' allocation.

The area suffers from lack of employment opportunities and the performed activities are low paid. The unemployment rate is quite important and women are the most affected.

31% is the overall rate of activity in the three watersheds, 47% among men and 15% among women. The inactive population is around 69%, of which women represent 85%. The employed or

active population is 32% of independents, 46% of employees, 21% of caregivers, and 2% of apprentices and employers.

'Family support' category is important among women with a ratio of 50%. The activities carried out by women are composed of reproductive work (housework, care of children and the elderly, etc.) and productive work (agriculture, farming, etc.). The reproductive work is unpaid, and in this category, even the productive work is not paid.

The rural population of Tafilalet lives in housing urban areas known by the name of 'Ksar', characterized by the coexistence of various ethnic groups who live in solidarity and experiences' mutual exchange. The rural housing units and the Moroccan houses are the two main types of habitation existing in the area concerned by this study, with respective proportions of 48% and 45%. The rest is divided among other categories, namely apartments, villas, small and other housing units.

The rate of rural housing supply with drinking water and electricity is, respectively, 38% and 70%. The drainage system of these units is made up of 1% of the public, 25% of septic tanks (or cesspits) and 74% of other systems.

Cooperatives and associations are the only formal social organizations known in the region. For example, the Agricultural Chamber, agricultural cooperatives (pumping, D'man breeding, pastures management, dairy, oil, date, apiculture, poultry farming, etc, cooperatives) and the Associations of Agricultural Water Users, date producers and some local associations working in both rural development and environmental protection.

In the province of Errachidia, however, the number of development associations is over 1200. Some of them were able to conclude partnerships with national or international institutions to implement various activities (literacy, piped drinking water, income generating activities, capacity building, environmental awareness of hygiene, and support of development activities). These projects are designed either by a sectional approach (valuation of date producing palm, rural tourism, etc.) or a wider integrated and geographical approach (the fight against desertification, etc.).

b) Economic activities

The population living in the oases largely depends on the exploitation of natural resources. Civilization developed over time could grow and sustain itself in these hostile places thanks to Man's vigilance, who managed these natural resources, including water and soil, in a very clever way.

b.1) Agriculture

Agriculture, which is the core of the oasis identity, represents 68% of the economic activity, constituting, thus, the backbone of the local economy (Monograph on the Province Errachidia, 2006). It is practiced by the majority of the rural population, although its output is low due to the unfavorable weather conditions and the limitedness of useful agricultural land. In general, it is traditional, shortly mechanized, subsistence and practiced near the water sources and on river banks.

According to the General Agricultural Census of 1996 (GAC, 1996), The total Useful Agricultural Area (UAA) in the watersheds of Maeder, Ghéris and Ziz is around 48,845 hectares divided into

228,567 plots, cultivated by 35 581 farmers. 78% of water reserved to irrigate this area comes from the dam or groundwater.

According to the GAC (1996), the agricultural speculations practiced in the region are 49% of cereal, 19% of fruits, 16% of fallowing land, 11% of fodder crops and the rest is devoted to the industrial, vegetable and market gardening cultivations.

Date producing palms, the backbone of the oasis agriculture with all its varieties ('Méjhoul', 'Bouffegous',' Bouslikhen 'and others), olives, especially the Moroccan pickled olive, apples, cereals, henna, cumin, market gardening cultivations, fodder crops (alfalfa), etc, are the main agricultural cultivations.

The production of dates is intended for consumption, marketing and animal feeding (waste of dates and dates of low commercial value). The average annual production is around 26,000 tons. The main varieties are: Méjhoul (1%); Bouffegous (3%); Bouslikhen (49%) and others (47%).

Olive trees are the second arboricultural species after date producing palms. They are located mainly in the plateaus of the region between Errachidia and Goulmima (56%) and in the foothills of the mountains of Rich and Beni Tadji (44%). The production annual average is around 13,000 tones.

However, olive industry in the region is characterized by low productivity and relatively low oil quality, if compared to the international standards. The causes, among others, are linked to the plants' advanced age, the non-mastery of the optimal period of olive harvesting, the traditional process of oil extraction, low olive recovering, etc.

There are also other fruit trees planted in grove. The main species of these trees are: almond (local and improved varieties (Marcona almonds, fornat, ultra), Grape, fig, quince, pear, apple (mainly Hanna variety), orange, apricot and pomegranate.

Fall cereals are the main fallow cultures. Every year, throughout all watersheds and according to the amount of water supply of the year, 20 to 32,000 ha are sown. Wheat occupies over 70% of the cultivated area. The soft wheat and the barley fodder are grown in all sites because of their relatively short cycles. Maize, generally cultivated in secret, is grown mainly in the mountain areas and foothills, where water is available in the summer. The water highly demanding Alfalfa crop, occupies an area of approximately 7,000 ha in all watersheds.

All vegetable and market gardening species are cultivated in home vegetable gardens: onion, tomato, turnip, carrot, peppers, squash, zucchini, potatoes, lettuce, melon, watermelon, beans, peas, etc. Hanna and cumin are exclusively found in the region of Alnif with an area of 640 ha.

The farmlands are very limited in the oasis of Tafilalet. They are marked by the division of plots. Today, the oasis agricultural area is reduced to an average of 0.86 ha per farmer with an average of 5 fragmented plots. Agricultural soils do not exceed 1% of the total area located along the valleys of Ziz Ghéris. 99% of the land consists of pastures or are uncultivated (Figure 6).

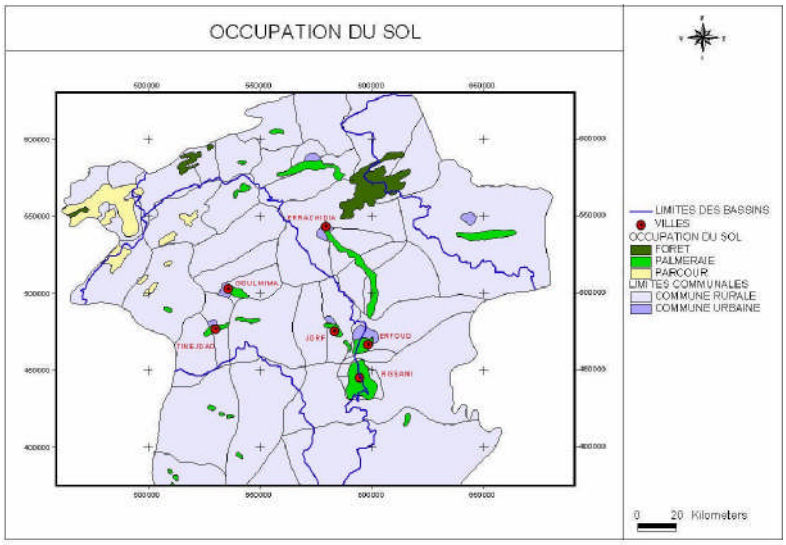


Figure 6: Soil occupation illustrious map

There are two farming types in the oases of Tafilalet: the extensive and the intensive. The extensive farming type is practiced by nomads and transhumant leading their herds, sheep and goats in the mountains and the plains in search of pasture. However, because the climate of the region is marked by long periods of drought and a high dryness, pastures are characterized by a predominance of spontaneous and thin vegetation.

The Intensive farming, on the other hand, is primarily concerned by cattle and sheep. Alfalfa is the main source of food. The 'D' man' local sheep breed, known for its high prolificacy and its ability to double lambing, is the most requested. The size of this breed is 120,000 heads (19% of the sheep total size in Tafilalet).

The size of cattle is estimated at about 30,000 heads, consisting mostly of the local breed, hardy and less productive. The improved breeds are also spread mainly around the urban zone of Errachidia and Rich. It represents less than 10% of the total size.

Goats milk (450 000 heads) is mostly represented by the local goat called 'Beldia' that coexists with the Canary Spanish milk goat introduced to Morocco two decades ago.

In Tafilalet we find two types of traditional hives (wall cavities and reed hives) in addition to a modern type (Langstroth). The traditional hives are dominant (70%) and represented mainly by the “wall cavity” type. Apis melliffica var. sahariensis is the bee that populates the region (7000 hives). This breed comes from Gharb (Northwest of Morocco). It was introduced into the region more than a decade ago.

b.2) Tourism

The geographical position the Province of Errachidia enjoys, its history and its human, cultural natural diversities are all assets that provide the province with a tourist and attractive character. It is the historic crossroad between the imperial cities and the South. Its oases stretch along the main water arteries: the rivers of Ziz, Guir and Ghéris. The region's nature is blessed with exceptional, rich and varied landscapes, consisting of valleys, gorges, oasis, mountains, springs and desert (Figure 7).

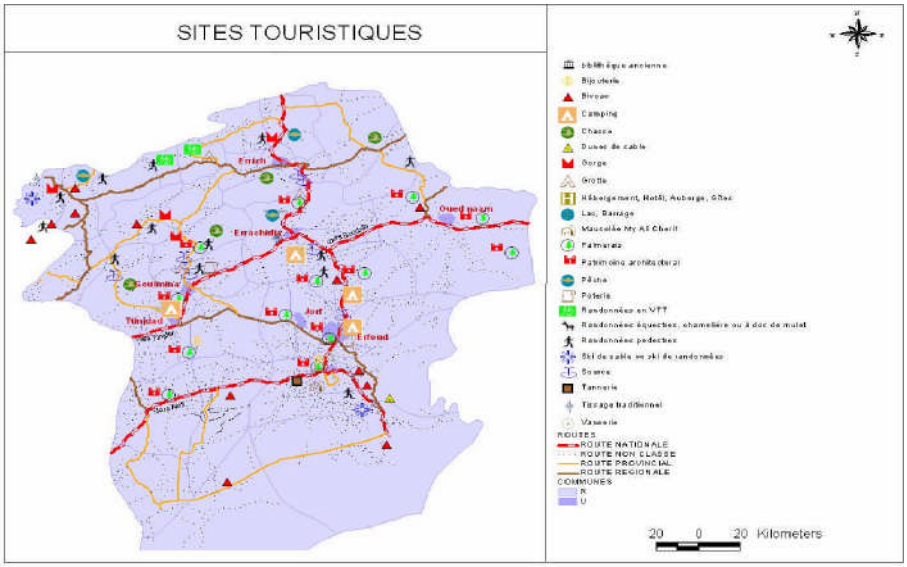


Figure 7: Map of tourism-relative sites in Tafilalet

(Source: Delegation of Tourism, Errachidia)

This richness and diversity allow the development of nature-based tourism activities such as hiking or riding, sportive fishing, nature exploring (fauna, flora and landmarks are still intact and virgin).

According to the delegation of tourism in Errachidia, reception infrastructure consists of classified and unclassified hotels, inns, cottages, guest house and campsites ordered (36 units, 1299 rooms and 2726 beds; 96 units, 919 rooms and 2817 beds, respectively). The sector has 6 tourism couriers, 25 guides, 3 travel agencies, 40 carriers and 7 vocational associations.

Oasis tourism provides tourists with specific characteristics to meet the needs and tendencies of tourism demands: individuality, seeking quiet and open air, authenticity and simplicity, a desire for adventure and freedom, discovery of local traditions, etc.

b.3) Craftsmanship

The oasis region is famous for its traditional, rich and diverse craftsmanship, which is a cultural heritage of a secular culture and various influences. There are several types of crafts. Among them, making carpet, pottery, basketry, ceramics, sculpture, lace, embroidery, leatherworks, jewelry and weaving is the most important (Monograph of the Province of Errachidia, 2006).

The province of Errachidia has thirteen cooperatives with 326 members and 14 vocational associations. Craftsmanship is as important as tourism through the economic role it plays and its cultural patrimonial centrality. It plays an important role in the socio-economic promotion of the oasis population from the creation of income-additional sources to the agricultural activity.

1.1.2 Key issues in the region

In Tafilalet, degradation of natural resources is reflected in the different types of existing ecosystems. It is driven both by natural factors and anthropogenic actions exacerbated by a socio-economic context marked by poverty. The successive droughts witnessed in the recent years have also significantly limited the production of the region. They have promoted wind and water soil erosion, scarcity of water resources and environment fragility.

The rapid population increase in the recent years and the radical change in the population's lifestyle, in addition to the precarious economic situation, generated a strong pressure on natural resources. This pressure affected agriculture through the excessive water pumping from groundwater. Wasting this already scarce resource is even more serious because it is often used to irrigate agricultural speculation with very low economic productivity, using traditional irrigation methods which significantly help wasting water resources.

This results a degradation of soil, dryness of palms, drying up of 'Khettarat' and overexploitation of water resources, with consequent loss of agricultural productivity and agro-biodiversity. In addition to water scarcity, viruses, such as' Bayoud', seriously threatens the future of the entire ecosystem oasis of Tafilalet.

This oasis faces three problems: pressure on limited agricultural lands, overexploitation of forests and pastures and land degradation due to water and wind erosion and sand encroachment. The land is at the root of many conflicts of uses and users. Deforestation and overgrazing have led to the degradation of the vegetation cover.

Despite this very difficult situation relative to the old palm groves, we currently notice that there is an agricultural investment race "lands of extensions" outside the traditional groves, with an inordinate water withdrawal. This agricultural expansion led to a perceptible decline of the piezometric levels of layers'. Salt outcrops, almost everywhere in Tafilalet, rendered dozens of hectares barren, due to capillary rise and irrigation with salted water.

Erosion and sand encroachment seriously threatens the oasis ecosystem. Water and wind erode and transport large quantities of sand and silt and drop them around the oasis, in basic or hydroagriculture infrastructure. Frequent winds take soil particles and accelerate desertification by carrying sand to the irrigated areas, particularly in the lowest areas of the plain of Tafilalet.

So far, the annual land losses in the Oases of Tafilalet and the rate of progression of the dunes remain almost unknown. The available data are scattered, fragmentary and sometimes very localized. The study of aerial photographs of the years 1959 -1961 and 1964 and some geomorphologic criteria allowed us to draw a map of the wind dynamics in entire center of the Southern Morocco in general and the region of Jorf in particular (Mainguet & Chemin, 1979). This map shows a general shift to the North-East of 320 m between 1951 and 1964 in the region of Hanabou (24.5 m / year) (Chemin 1984).

Urbanization within the oasis of Tafilalet is characterized by the abandonment of the 'Ksours', the old traditional houses, for small houses inconsistent with the natural landscape. The traditional construction style of the oasis is threatened with extinction because it is more and more replaced by concrete construction. Money remitted by immigrants originating from the region is partly responsible for this, so-called habitation modernization.

The global result is an increasing phenomenon of desertification whose most visible character is sand encroachment. Global world environmental changes and their impacts on the ecosystem are little- unknown. They may dramatize the situation and endanger the future of these ecosystems and also that of humans.

1.1.2 Need for evaluation

The region of Tafilalet is characterized, in addition to the very difficult climatic conditions, with a very serious social situation which requires integrated and collective huge efforts and strategies to fight against it. Poverty is widespread as demonstrated by its ranking to third position at the national level (RGPH, 2004).

Rapid increase in population in the recent years, combined with other endogenous and exogenous factors, caused great pressure on natural resources. This deepens the phenomenon of desertification whose most visible illustration is sand encroachment on agricultural lands, infrastructures and habitations. Global environmental changes and their impacts on this ecosystem are not known and may dramatize the situation and endanger the future of the ecosystems and human communities that depend on them.

Tafilalet oasis ecosystems are seriously threatened by desertification, caused mainly by anthropogenic activities and climate changes. The fragile balance, long maintained by human vigilance, suffers today from various forms of pressure. The causes of this degradation are not yet fully defined and the evaluations made so far are usually sectional, partial and non-participatory.

This study, which is concerned by the evaluation of the oasis ecosystems in accordance with the DPSIR model (Driving forces of change - Pressures - State - Impact - Response), recommended by the MEE, is justified by the need for a holistic understanding of the relation human beings/ecosystems and how to manage this relation as to ensure the durability of the benefits and services provided by these ecosystems on the one hand and contribute to the evaluation of the ecosystems on a global scale, on the other.

1.2. Objectives of the evaluation

The global objective is the integrated evaluation of the oasis ecosystem of Tafilalet and how it contributes to the well-being of humans, in order to provide the decision-makers with scientific information that can help them design a plan for sustainable management of these environments.

The ecosystem integrated evaluation aims specifically to:

- evaluate the oasis ecosystem of Tafilalet in an integrated manner;
- strengthen the capacity of the participants, directly and indirectly concerned by the project;
- educate those involved in the oasis system or those who are generally concerned by desertification about new tools for the integrated environmental evaluation;
- produce and disseminate information useful to decision-making regarding the protection of the oasis ecosystem; and
- seek funding for the achievement of the Management Plan of the recommended actions.

The analysis of this study will help a better understanding of the following points :

- Oases' biophysical, institutional and socio-economic elements;
- The management of natural resources and the services provided by this ecosystem;
- The various transformations undergone by the oasis system;
- Threats and pressures on these ecosystems and what are the impacts on the services;
- Probable scenarios and possible solutions.

1.3. Commitment of the stakeholders:

1.3.1. EME group Users

The stakeholders are any person, body or organization that may be affected directly or indirectly, positively or negatively by the results of this study, namely local people, institutions representing the different departments at the regional level, communities and local authorities, NGOs, the private sector, civil society (associations, vocational groups, individuals, etc.). The concerned parties were identified by inquiry and investigation through:

- startup workshop of the project in which we explained the goals and the consistency of the study and its importance at international and national level;
- information and awareness meetings on the objectives of the project;
- thematic meetings with particular emphasis on the local initiative of human development;
- direct contact and / or through representatives of other development players in the region; and
- involvement of the stakeholders in data collection.

There are two categories of concerned parties, key parties who are directly affected by the project, usually the local population whose welfare depends on the resources and ecosystem services, and the secondary parties who represent any other persons and institutions with an interest in the resources of the oasis of Tafilalet.

The identification of these players was made with a view to have different potentialities and constraints in the region and the actions to be made to ensure sustainable goods and services provided by the ecosystems of the oasis. It also helps distinguishing the concerned parties that should be encouraged to participate in the evaluation to identify useful alliances and relationships that could be exploited for the benefit of the evaluation and reduce risks by identifying existing or potential conflicts that might hamper the development of the study.

The main components or structures identified as concerned parties are:

- National institutions: the Ministry of Energy, Water and Environment, the Ministry of Agriculture and Fisheries, the High Commission for Water, Forests and Desertification Control, the National Office of Drinking Water (ONEP).
- Regional, provincial and local institutions: Wilaya and the region of Meknes- Tafilalet, the Province of Errachidia, the Regional Agency for Irrigation and Agriculture Development of Tafilalet (ORMVA/TF), its Subdivisions and Centers of Agricultural Development (CMV, Regional Directorate and Provincial Service of Water and Forests, Directorate of the Hydraulic Region of Guir-Ghéris- Ziz-Maeder, Regional and Provincial Directorate of ONEP, Provincial Delegation of Tourism, National Education of Health, Youth and Sport and National Support, Social Development Agency, Regional Fund of Crédit Agricole (Agricultural Bank).
- Institutions specialized in scientific research: Moulay Ismail University, Faculty of Sciences and Techniques of Errachidia, Regional Center for Agricultural Research of Errachidia.
- International agencies: PNUE, UNESCO, UNDP, FAO, WB, MM, FEM, FFM, etc.
- International Cooperation: JICA, AFD, USAID, etc.

- Regional, national and international non-governmental organizations.
- Socio-professional structures: agricultural and craftsmanship cooperatives
- The local population and the private sector

The analysis of the stakeholders was carried out according to the following steps:

- The identification of stakeholders groups: this step allowed the identification of the players who may have direct or indirect relations with the project, positively or negatively influence theproject;
- The identification of interests for the project: that is to say, the identification of the role or roles the player may play.
- The evaluation of its importance and influence, that is to say, determine whether the concerned player is important or not for the success of the project and whether it has an influence or the development of the various phases of the project. The degree of importance and influence was determined by combining a qualitative weight factor.

The important players in the area which have a direct influence through their interventions in the project, in addition to the local population and the Ministry of Development, Territory, Water and Environment, are the Regional Center for Agricultural Research of Errachidia, the Regional Office of Agricultural Exploitation of Tafilalet, the Province of Errachidia, the local authorities, local authorities of the studied sites, the Chamber of Agriculture, cooperatives and some local associations.

The Regional Office of Agricultural Exploitation of Tafilalet is a key player in all achieved projects, or those in progress, in the various studied sites. In addition to the role it plays in the supervision and development of the rural world, the office achieved several programs in consultation with the local authorities and the local players who are involved in the different phases of the project.

The activities cover several fields such as the development of hydro-agricultural equipment (diversion dams, irrigation channels ...), the rational management of irrigation water by encouraging the local irrigation system and the creation of collective pump stations operated by the Associations of Water Users in Agriculture, the promotion of women in rural world through the creation of small income generating projects (craftsmanship, small scale farming, weaving and embroidery ....).

Other players are equally important and influential. These are the institutions that provide agricultural credit to ensure projects' funding by granting loans to the farmers, the Hydraulic Regional Directorate which carries out studies and research for the mobilization of water resources , the Regional Center for Agricultural Research of Errachidia, which conducts research in the field of agriculture in general and in the fight against the disease of 'Bayoud' in paticular, the Faculty of Sciences and Techniques of Errachidia by its scientific research and supervision of different studies in various fields related to science and technology. Some local associations active in the field of environmental development or protection are also considered important for the success of the evaluation project's objectives.

1.3.2. Key Questions

- How have the oases of Tafilalet changed over time?
- How have the services of these oases changed?
- What are the most important critical factors that have introduced change in the oases?

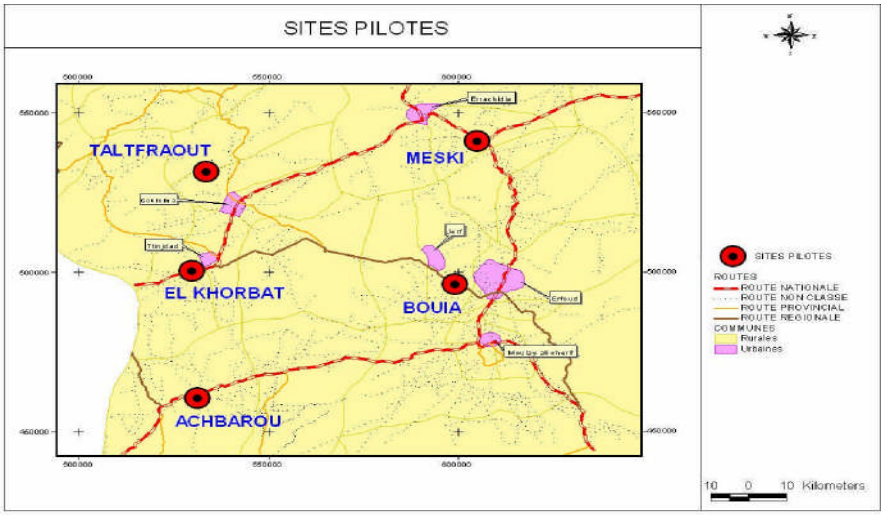
- How have changes in the oases of Tafilalet affected human well-being and poverty alleviation?
- What are the major uncertainties that will affect decision-making concerning the oases ecosystems?
- How will the oases and their services change in the future under different scenarios?
- What are the existing options to manage the sustainability of the oases?

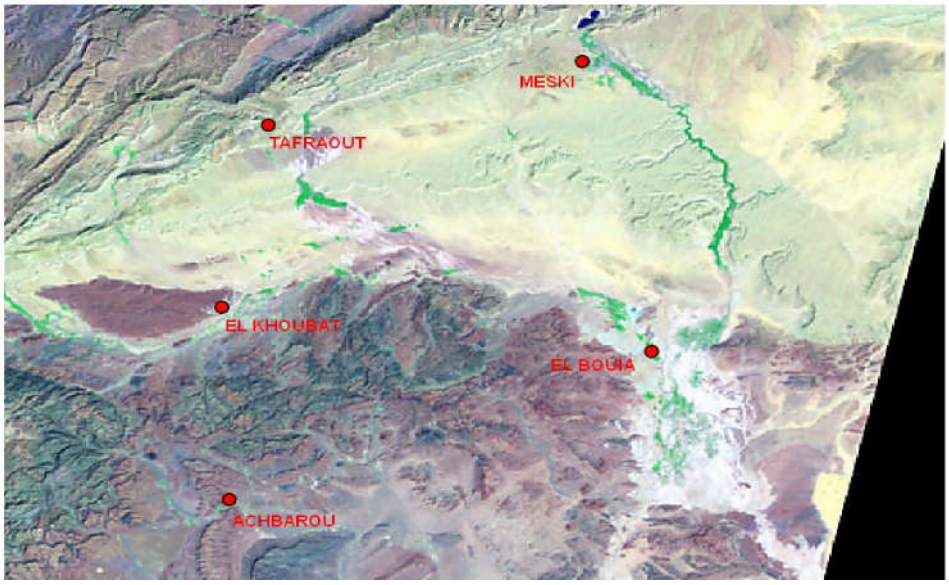
1.4. Adopted approach

1.4.1. Delimitation of the area of the study

Due to the important expanse of the oasis ecosystem of Tafilalet, it was deemed necessary to limit the area of the study at five locations (Figure 8) which reflect, however, the socio-economic and ecological diversity of the region. The choice of these sites was done with a view to cover the landscape and socio-economic diversity and variability of Tafilalet, in order to detect the eventual complementarities and interactions existing between the different ecosystems, namely:

- the area of mountain foothills represented by the sites of Taltfraout and Meski; and
- the pre-Sahara area (plain), represented by the sites of Bour El Khorbat, Bouyer and Achbarou.





Source image: Landsat

Each site has a particular specific issue. Indeed, the site of Meski owes its existence to the blue source (source of Meski) and whose future is acute.

Bour El Khourbat is an agricultural extension site where water unregulated exploitation by the pump motor has created a shortage situation. This site is an excellent example to study the impact of agricultural extension on old palms.

Bouiya is an example of a site threatened by sand invasion. It is an area well known by this phenomenon. The results obtained on wind dynamics in this area are broadly similar to those of other areas of the oasis of Tafilalet.

Taltafraout, thanks to its geographical isolation, is an ideal site (a kind of archetype) of old palm grove, grown thanks to 'Khettarat' water. This site currently witnesses the expansion of agricultural lands towards the South of the grove.

Achbarou represents an old oasis, dead by water using up and where people are always there living with the money remitted by immigrants originated from the village.

The sites where water scarcity consists of a major constraint are Achbarou and Bour El Khourbat, and Meski, to a lesser degree. In the site of Bouiya, sand is the major constraint, whose intensity never ceases aggravating.

1.4.2. Concept of evaluation - Ecosystems and Human Well-being

The method adopted within the framework of this study is the same described in the conceptual framework of the Millennium Ecosystem Assessment (Figure 9).

The used methodology is based on the DPSIR model (Driving forces of change - Pressures - State - Impact - Response), developed by the European Agency for the Environment from an initial model of the Organization of Cooperation and Economic Development (PSR model: Pressure - State - Response). It aims to describe the interactions between society and the environment through environmental indicators. This model is used in the Millennium Ecosystem Assessment and allows carrying out environmental evaluations, providing information about the elements of the analysis model.

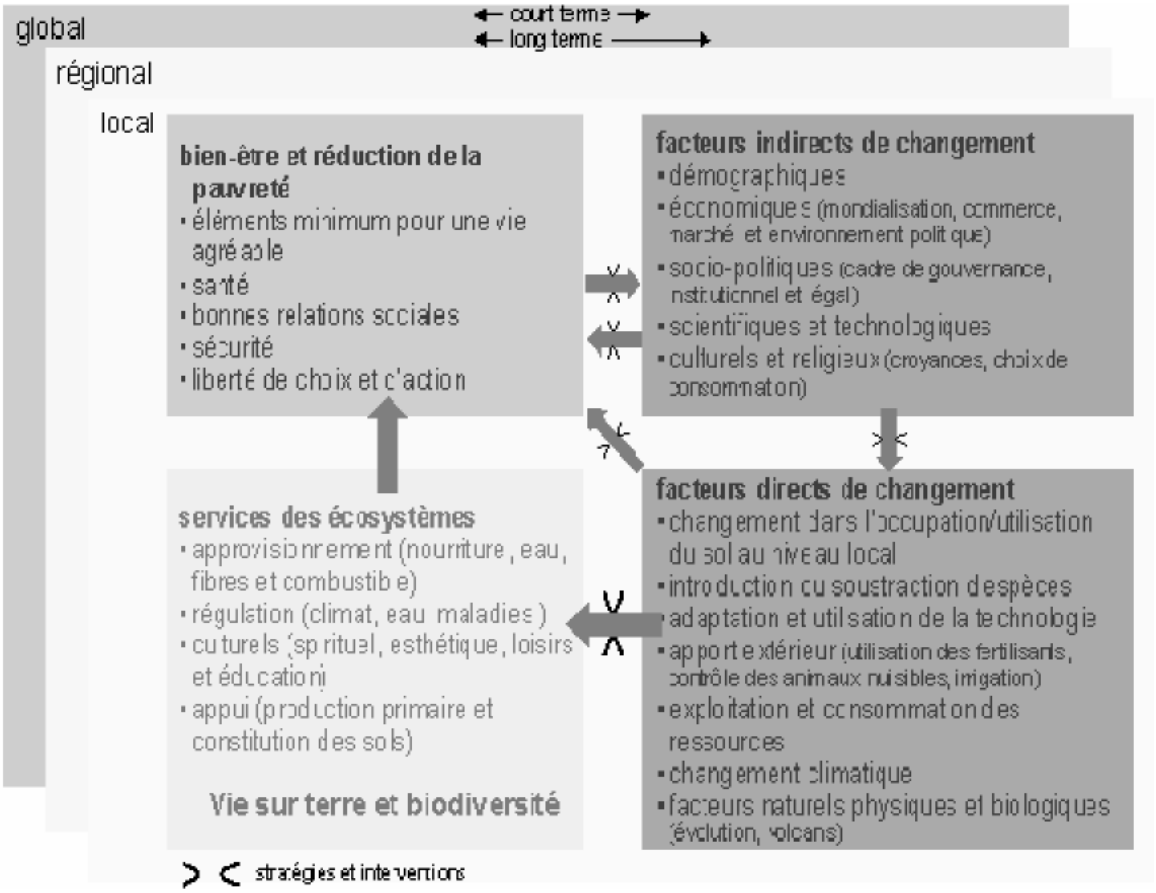


Figure 9: Framework for the Millennium Ecosystem Assessment

1.4.3. Applied specific methods:

1.4.3.1. Environment and socio-economy

Data and information used in this study come from different researches or official census, addressing the environmental and socio-economic components of the oases of Tafilalet, in addition to the direct collection of primary data to fill the identified gaps.

The primary socioeconomic data were collected using two methods, a face to face direct survey using a predetermined questionnaire and a participatory approach using semi-structured interviews completed by observation. The survey was conducted at two levels, using two types of information (Q-1, Appendix 1, and Q-2, Appendix 2).

The first survey, called 'Ksar' Survey, was conducted to identify the habitations' conglomeration, their administrative location, their demographic characteristics, the existing different basic infrastructures such as electricity, drinking water, sanitation, schools, roads ...

The second survey, called household survey, focuses on collecting information about households different socio-economic characteristics, i.e. household structure, the production and reproduction, exploitation of natural resources, water management, the risk of sand encroachment, etc.

The first phase of data collection preparation was to define the major challenges, the information we need, the time available for the collection, and the data collection methods to be used. The second step was to ensure the participation of the local population, informing them in advance of the survey's goals and involving them in the identification of the needs and planning of data collection. The third stage was concerned by the identification of the local players (the concerned

parties) in the region and by the choice of the groups and individuals involved in the activity. The targets were selected at random and proportional to the population in each site in order to cover a wide spectrum of perspectives to reflect all points of view of the studied community.

Concerning the biophysical part, several studies were already conducted in different localities in Tafilalet and in various work settings (Kabiri, 2007 and 2001; Abane et al., 2005; Bakadiri and Mehdaoui, 2005; Ouadi, 2005; Ouhejjou, 2005). A summary (Q-3, Appendix3) has tackled water management, desertification, biodiversity, irrigation techniques, maintenance and cleaning of irrigation canals, agriculture, lowering of the groundwater levels, etc.

1.4.3.2. Geographic Information System (GIS)

The implementation of a GIS is based, among other things, on a database conception and appropriate applications. Elaborated data are obtained either from the Digital Terrain Model (DTM), with a resolution of one km, such as slopes, aspects, limits of watersheds, or from topographic and geological maps published; or from documents relative to the works of specific interpretations.

To describe data, we have developed a data conceptual model (DCM). This model represents both alphanumeric and cartographic data. The basis cartographical layers are derived from the scanning and vectorization of existing maps, by processing pictures taken by Landsat or GPS on the ground. The used Landsat pictures were captured during three distinct periods with an interval of about 15 years. The visual comparison of satellite pictures recorded in 1972, 1987 and 2001, helped detecting the changes caused by the disturbances occurred between these periods.

The implementation required the achievement of the basic physical schema. The working environment of the application is based on menus and windows which intuitively guide the user during his operation. The application is divided into a setting, environmental and socio-economic parts.

A false color composition with pictures from different years allowed the observation of important changes occurring in the studied territory. The problems of shadows and the determination of information about the vegetation cover were solved by the method of vegetation indices. Despite the still very apparent influence of some factors on its performance, the NDVI (Normalized Difference Vegetation Index) remains the most frequently used.

1.4.4. Organization: Process, Planning, activities, institutional organization

To complete this work, the National Observatory of the Environment-Morocco called for nominations for the recruitment of three consultants. The choice focused on three Moroccan academics: an environmentalist, a social economist and a GIS specialist by a multi institutional committee of evaluation.

After signing the contracts with the consultants, there was a meeting with the National Observatory of the Environment-Morocco to discuss the methodology and planning of work and other logistical arrangements. This stage was marked by the presentation of an establishing report which was subsequently the subject of rigorous evaluation and approved by the committee of evaluation.

A visit to the field was organized by (NOEM) in collaboration with the Directorate of Land Use and the consultants in charge of the missions, aiming to better understand and appreciate the issue of the project in its real context. Local associations, farmers, cooperatives, etc. were contacted during this mission, in which the pillars of the study were identified. These were the localities of Meski,

Bouiya, Bour El Khourbat, Talatraoute and Achabrou, spread over the three watersheds of Tafilalet.

The startup workshop of the project was organized in the town of Errachidia, on June 29th, 2006, to which the local players (regional and provincial administrations, development offices and research and education institutions, local authorities, press, civil society of the region, etc.) were invited.

This workshop was presided over by the Director of ORMVA / TF and witnessed the presence of the Dean of the Faculty of Sciences and Techniques of Errachidia, the Director of the Hydraulic Regional Directorate and the Head of NOEM Division, representing the Ministry of Land Use, Water and Environment. An in the field visit was organized on the margin of the workshop on June 30th, 2006.

The consultants then prepared a detailed work planning, and the study began to take shape, paying an exploration visit to the field, collecting and using secondary data, contacting key stakeholders, participatory collection of primary data, analysis and drafting of thematic reports. A first version of the summary report was developed after approval of the committee of evaluation of thematic reports.

A workshop on the development of different scenarios was held on May 14 and 15 2007. This workshop aims to introduce the diagnosis results to the local players to be validated and to reflect on the development of possible scenarios for the ecosystem of Tafilalet too.

To involve civil society, including local associations, NOEM, in consultation with the consultants of the project, opted for the choice of a local association to address the facilitation of the work on the ground and also mobilize the local players, in order to better understand the issue of the evaluation and involve them in the global reflection on the future of the oasis. The mission entrusted to the chosen association is to prepare a documentary on the project and contribute to the logistic organization when workshops are held and during data collection. This association was given a computer, digital camera, a camcorder and a video projector.

2. Evaluation of the oasis ecosystem and its services

2.1. Supplying services

2.1.1. Agricultural production:

2.1.1.1. Service

a) Vegetal production

Oasis agriculture (photograph 2) is generally traditional and subsistence. It is practiced around water resources and rivers. It is characterized by a fairly significant biodiversity, with local varieties adapted to the natural conditions of the place.

It is practiced according to three deferent models: a three-stage model (date producing palms, olive trees and other fruit producing trees, and vegetables or cereals), a two-stage model (date producing palms and vegetables or cereals) or a one-stage model (date producing palms). The photograph 2 illustrates the three-stage cultivation method and photography 3 the three-stage cultivation method

2 photographs: Typical fields of traditional agriculture

Photo 3: A three-stage cultivation field

It offers a vast number of agricultural products including fruit production (date producing palms, olive, apple and almond trees, etc.), cereals, fodder (alfalfa), market garden productions and the date palms production which constitute the most dominant speculation. These crops are often combined on the same plot. They consist of an income source for the farmers through the marketing of dates, olives and the other products (potato, bean, haricots ...).

In the five 'Ksour' surveys, only 3% of the agricultural area is used for a single-stage system, the rest is used for mixed production systems characterized by the coexistence of different tree and grass strata.

The mixed system represents 100% of crops in the 'Ksar' of Meski and Taltafraout, 95.24% in Bour El Khorbat, 93.33% in Bouya and 96.43% in Achbarou. In these last three 'Ksours' the cultivation method supporting the mixed production is the tree system with proportions of 4.76%, 6.67% and 3.57%, respectively.

In the five 'Ksours', the practiced agricultural speculations are mainly date production of different varieties (' Majhoul ',' Faggous' and 'Khalete') used for self-consumption, marketing or for livestock feeding. The sale of agricultural products is most often carried out through intermediaries.

Photo 4: dates and other date derivatives

92% of the agricultural area is used for traditional agriculture, 1% for modern agriculture and 7% for mixed agriculture. The proportion of farmers who used fertilizers reached 94% on average. The farmers are grouped into three categories depending on manure type: those who make use of organic fertilizers constitute 59%, 1% of those who provide the fertilizer and those using mixture of organic and chemical fertilizers represent 38%.

The gross income of the agricultural production is about 20 000 DH / house / year, 72% of which consists of dates, 10% of wheat, 7% of olive, 5% of barley, 4% of maize and 1% of alfalfa (Fig. 10). Production costs represent 11% of the gross income. The average of 34% of this production is destined towards self-consumption, the rest is sold.

Agricultural products are most often sold through intermediaries, who often buy the harvest in the fields. The lack of rapid transportation and financial resources among local farmers encourages such speculation.

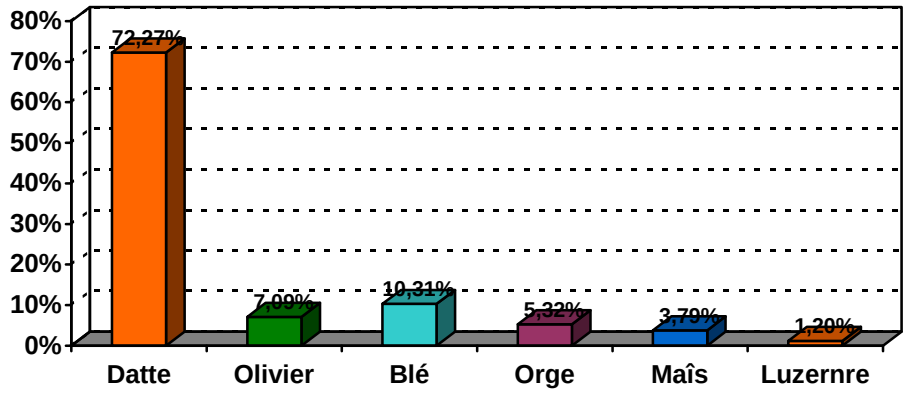


Figure 10: Composition of agricultural value in the five 'Ksours'

Date current production is often of poor quality. It is often destined for animal feeding. Palms have suffered from a growing detrimental over-exploitation to satisfy a growing demand of the Moroccan urban centers, which affect the ecology of sites and the farmers too.

Not only does the date producing palms produce dates, their trunks and leaves can also be used different operations (doors manufacturing, beams, etc.., their leaves are used to make baskets, ropes, mats and roof coverings). Palms also create a microclimate for other fruit trees, vegetables,

etc, and used for sand dune fixation. They are, therefore, the main frame and structuring element of the landscape and social life in the oasis.

b) Animal Production

In the five studied 'Ksours', the prevailing breeding system is often of a type characterized by intensive housing herd management. Animal feeding is based mainly on alfalfa and other additional foods such as the crushed waste of poor-quality dates; beet dried pulp, bran, barley, corn, crushed beans, straw and hay as well as dried alfalfa.

Indeed, 88.5% of people surveyed in five different locations provide food for their cattle in a barn, 3.4% lead them to pastures throughout the year and 8.1% in both practice both extensive and intensive farming (pastures and supplement fodder in barns). The herds constitute mainly of D'man breed sheep and local breed cattle. In these sites, the average herd size per house is estimated at two heads of cattle, 13 heads of sheep and one goat.

It was in the sites of Meski and Bour El Khourbat where there is a significant number of the pure breed cattle. The oases of Tafilalet are characterized by the existence of a 'Ksar''s bull which serves as the breeding herd for the local cows. However, this tradition has disappeared in all studied sites, except site of Taltfraout.

The site of Taltfraout has the biggest number of goat heads. In the studied oases, we also find donkeys, mules and camels. Donkeys, however, are the most dominant. They are used for the transportation wood, water, alfalfa, wheat, etc. and the labor as well.

Net income of the products generated from livestock (milk, butter, hides, wool) is estimated on average, in the five sites, at 8100 DH / year / house, 85% of which is destined towards consumption.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>A : race caprine locale</td><td>B : race bovine locale</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>C : race ovine D'Man</td><td>D : Chameaux locaux</td></tr>
</table>

Photo 5: Extensive and intensive livestock

In addition to cattle breeding, the population of the 'Ksours' practice small breeding, consisting primarily of poultry and beekeeping. The latter is almost traditionally practiced, in general. It is concerned by desert yellow bees (Apis mellifica var. Sahariensis) known for high productivity, hardiness and softness. The number of hives per studied site varies from 4 units to a maximum of 60 units. The average value of apiarian activity per house, in the five sites, is around 1324 DH / year, 30% of which is destined towards self-consumption. Some apiarian modern breeding also exists in the region. But in general, they belong to transhumant (photograph 6), who come from elsewhere to make profit from the local honeybee vegetation.

Photo 6: Beehives

Poultry farming is traditional. Egg's production is mainly intended for sale with an insignificant income. Poultry production is mainly intended for self-consumption.

2.1.1.2. Forces of change and pressures

a) Population growth

The population of the watersheds continues to grow at a significant pace. This population was only 484 298 in 1994, giving accordingly an average total annual increase rate, compared to the population of 1994, of 0.60% (1.998% in cities and -0.06% in the rural world). The average fertility rate in the watershed equals 3%.

The difference in the population increase rate between municipalities and rural communes is mainly due to the natural growth of the population; the exodus of populations from rural to urban centers; the integration of the rural areas of the 'Ksours' to the urban area and the resettlement of the Moroccan residents living abroad, originated from the region.

The change in a population for a given period is equal to the death rate minus birth rate plus the total of migration flow during this period. The evolution of the population in the future can be estimated using a number of parameters that help determining these indicators. However, these parameters are not always available which makes this projection difficult.

The increase in population creates additional needs for food, water, housing, etc, causing therefore additional pressure on the biophysical framework already characterized by fragility and sensitivity which increase its vulnerability. Need for food generates pressure on the agricultural system and necessitates expansion into less fertile lands or over-exploitation of existing agricultural lands. Productivity loss, less income and the risk to lose local crop varieties, may oblige farmers to abandon the agricultural activity.

Agricultural lands suffer also from urbanization following the increase in population in major urban areas. This phenomenon of urbanization exists mainly in the Valley of Ziz. It causes a significant decrease of agricultural lands. The system related to land is a blocking factor which leads sometimes to the outright abandonment of agricultural activities in soil high quality places.

b) Plant and animal diseases

Bayoud is a disease that attacks date producing palms. It is caused by a fungus called Fusarium oxysporum f.sp. albedenis. Due to this fungus, more than 2 / 3 of the date palms heritage in the oasis of Tafilalet was lost in just one century. It preferentially attacks the noble varieties, and especially the 'Mejhoul' and 'Boufggous' which have good commercial quality. Its impact is greater in areas with relatively considerable water resources. Thus, the site of Meski is one of the most active places infected by this disease which threatens the vegetal biodiversity in the region.

In the five studied sites, 'Bayoud' and drought caused the drying up of 45 date palms on average per houshold, a total of 111 feet per household, a drying rate of palms of 41%. According to the ORMVA/TF, 3% of date-producing palms disappear every year due to this disease.

'Bayoud, drought and human interference have halved, during the past ten years, the number of palms in the region of Alnif located in Achbarou.

White Cochineal: Parlatoria blanchardi TARG (Homopterous, Diaspididae) binds itself to all parts of date producing palms. The white encrusting caused by the shields of the insect hampers photosynthesis and therefore hinders the growth of the tree. All palm groves in the region, without exception, are infested.

The snout moth of dates, belonging to the Pyralidae family, grows either in the stored dates or in the dates on palm trees. Because of its ubiquity and ploychromy, the insect has received several specific names. In the oases of Tafilalet, Ectomyelois ceratoniae is the main species that attacks the dates. The insect has a predilection for soft, young and thin skin varieties.

Olive trees in the area are also infested by insects, including:

•The bark beetle of olive trees (neroun) Phloetribus scarabeioides, Coleoptera. This insect causes devastating effects, especially after the weakening of trees due to the drought, by digging tunnels in the trunks.

• Olive-tree cochineal insect (Saissetia oleae olive Homopères, Coccidae). The insect, characterized by black hemispherical shells, can cover all parts of the tree.

• Olive-tree fly (Dacus olea Gmal, Diptera, Tryptidae). The fly pierces young fruit to lay its eggs. The larvae feed on the pulp of olives.

These diseases reduce the productivity of olive fields and threaten the sustainability of their production. The income of the local population as well as their well-being is, accordingly, affected by these olive pathogenic attacks.

Some diseases attack beehives. These diseases are caused by the Varroa mite or other unidentified parasites. Honey production, which contributes to the formation of the income of the local population, by was affected.

c) Sand encroachment

The phenomenon of sand encroachment (photo 7), resulting from harsh weather conditions and anthropic actions, is considered the final stage of the process of physical and biological degradation of the environment. Wind action can be classified into two main classes, a mobilized sand encroachment from outside the villages and a mobilized sand encroachment from the villages and farmland on the edge of the deserts.

Photo 7: Sand encroachment in the oases of Tafilalet

Sand encroachment in the first case results from an obstacle introduced by human developments on the trajectories of sand movement. In the second case, the deposit of particles carried by the wind out of the desert results from the wind blow or flooding by barchan dunes or linear dunes resulting from the reactivation of fixed sand mantles.

Wind exportation of thinner particles and organic matter, results in productivity loss and in a structure destruction, which can support the reactivation of fixed dunes. All along the transport axis, under the wind of the first traumatized areas, other traumas occur on bare soil, fields and pastures.

Wind exerts traumatic actions in the oases. It leads to the drying up of parts of the land, the crumbling of soil and the lifting of sand particles, rock and vegetation erosion, destruction by vegetation ablaqueation. This results in an ever-increasing mobilization, which may, downstream in the direction of the wind, lead to a degradation by a simple excessive accumulation of sand.

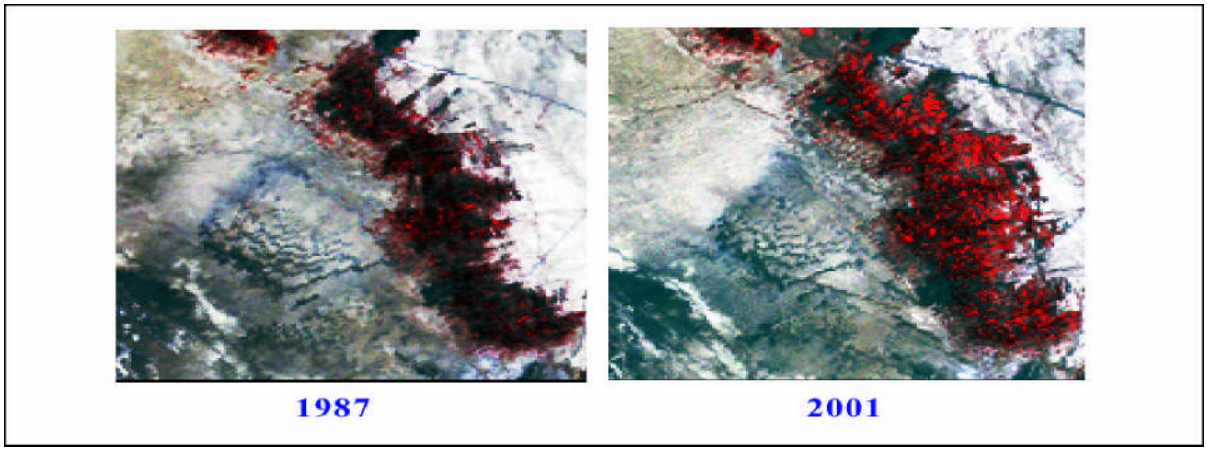


Figure 11: Speed of barchan dunes in the region of Hannabou in 1987 and 2001

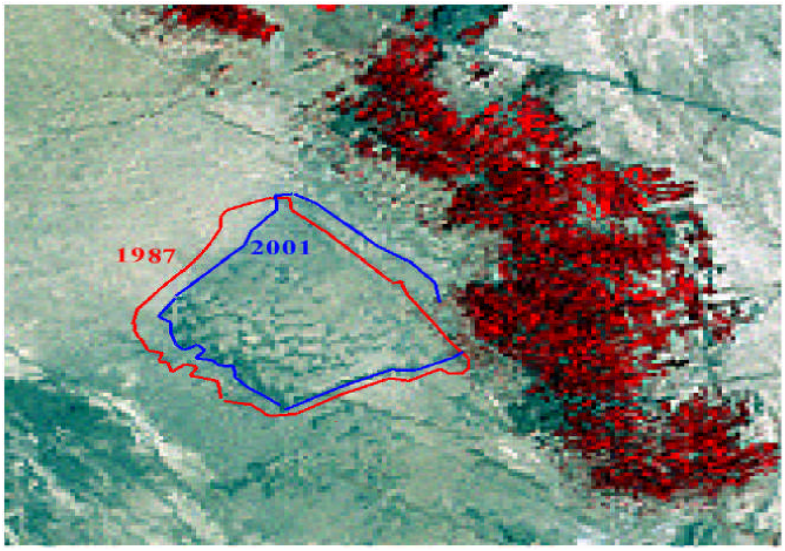


Figure 12: Movement of barchan dunes in Hannabou between 1987 and 2001

From 1979 to 1987, the invasion of the palm groves in Hanabou reached 98 hectares compared to 110 ha to Jorf in the year 1979 (Khardi 1999). The maximum movement in the region of Jorf from 1986 to 1995, is 125 m (AUPEL_UREF 1998). From 2000 to 2003, average movement is 17 m / year (Kabiri et al., 2003; Kabiri 2005, 2006).

Within the framework of this study, the measurements made on satellite pictures from 1987 to 2001 indicate a movement of about 125 m / year in the palm groves of Hanabou (Figures 11 and 12) with a shift that occurred in the South-West to North-East in the direction of the grove.

d) Drought and low mobilization of surface water

In addition to the occasional irrigation, floods supply the dam of Hassan Addakhil. However, floods, resulting from heavy rain falling in the watersheds of the High Atlas (Ghéris, Ziz), are often violent. They cause the collapse of several houses, cuts and overflowing in several structures and diversion dams (photograph 8). They affect agricultural lands as they invade the hydro-agricultural infrastructure (dams and irrigation channels 'seguias') after the fall. The damage caused by floods in 2006 was the worst in the history of the region after that of 1965.

The mobilization rate of these waters is 98% in the watershed of Ziz, but it is much lower in other watersheds. It represents a loss to be gained to increase resource availability, and also to save the material and human damages caused by uncontrolled floods, which are often violent and cause extensive material damage without being used for palm irrigation due to the lack of hydro-agricultural infrastructures that should mobilize or reduce their impact. Even if they supply the dam of Hassan Addakhil, such floods provide an annual output of nearly one million m3 which endangers the sustainability of this dam.

In Maeder, only two or three floods occur per year in this watershed in the fall and spring. The average flood does not usually reach Dayat Maidère. These floods allow the seasonal refill alluvial basins in the upstream valleys of Fezzou (Regg), of Ait Saadane (Hssia) or Oumejrane (Taghbalt).

Although floods are sometimes at low or medium speed, they cannot irrigate the palm groves for three main reasons (Kabiri, 2007):

• the main canal that draws water from the wadi is blocked by sand;

• the stream bed of the wadi is getting deeper compared with the derivation threshold that is supposed to drain water to the palm grove:

• the level of parcels of land is higher than the irrigation canal, causing an enormous waste of water.

Photo 8: Floods caused by heavy rains

Water erosion threatens agricultural lands. Indeed, the flood water undermines the banks and removes agricultural lands but also deposits large quantities of sand at the time of fall and causes siltation of irrigation canals. The result is that these agricultural lands are becoming higher and higher (enhanced) compared with the level of the river which allows their irrigation and, therefore, they cannot benefit from the flood waters if the owner does not maintain his parcel of land (Kabiri 2007).

What complicates the situation is that the collective traditional system of the cleaning out and the maintenance of irrigation canals by collective interventions ('Had essaim', 'Twiza', etc.) are no longer practical in the region. The observed localities of windblown sand accumulation cover different shapes and sizes and cover very large areas of agricultural or non-agricultural lands. The average speed of flooding is about 17 m / year toward the palm groves in the period of 2000-2003.

A weak mobilization of flood waters causes a shortfall in terms of irrigation water but also in terms of avoidance of damage to agricultural fields, to water infrastructures, basic infrastructures, etc.

Recurrent droughts are also a cause of loss of agricultural productivity and encourage the desertion of agricultural practices due to the lack of sufficient irrigation water. The area has experienced prolonged drought during the past century and the beginning of this one: 1913 - 1918; 1927 - 1931; 1933 - 1939; 1945 - 1947; 1955 - 1957; 1973 - 1976; 1979 - 1984 1987 -- 1988; 1993-1995; 1997 - 2004 (Benmohammadi et al. 2000; Kabiri et al. 2003). Figure 13 below shows the evolution of contributions and refunds of the dam of Hassan Addakhil and shows two droughts that happened in the area.

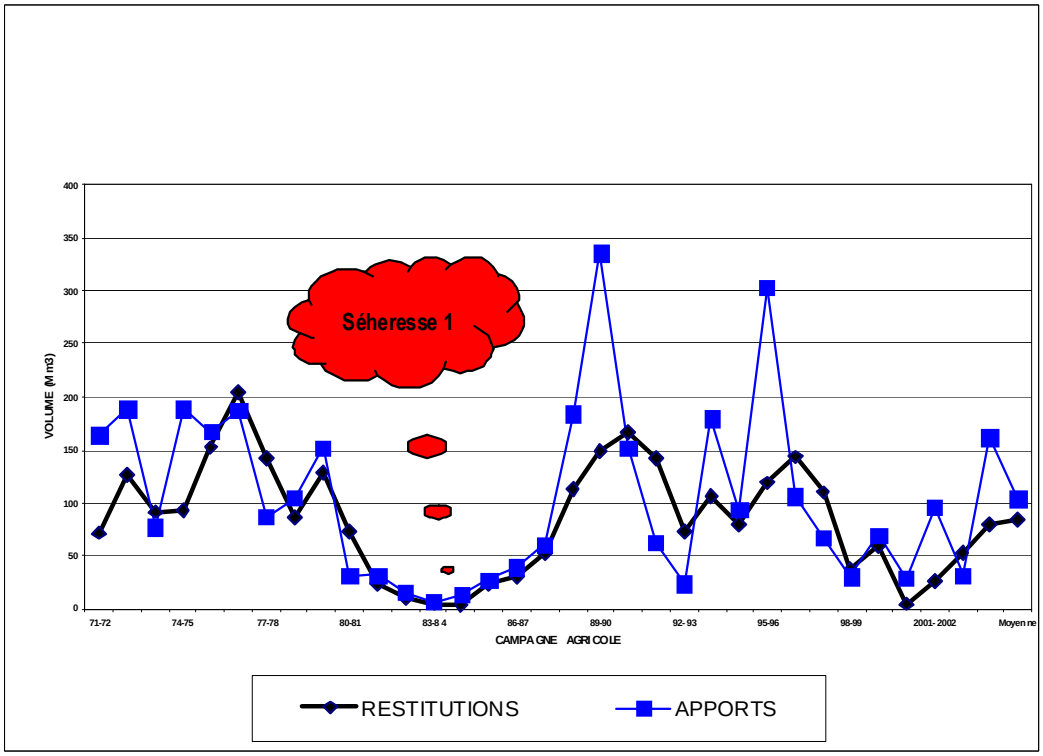


Figure 13: Evolution of contributions and refunds at the dam of Hassan Addakhil since its entry into service in 1971 / 1972 - 2003/2004 (adapted from: Bousfoul et al. 2005)

The first drought happened in the period of 1980-1989, during which there is the drop rate which has reached its minimum in 1983. For two cycles (1983-1984) and (1984-1985), there was a total disruption of the surface flow for several months. The cycle of 86-87 has recorded a very low input rate, which is about 30 Mm3. The forebay of the dam was completely empty in 1983 (personal communication of the head of management of the dam)

The second drought occurred between 2000 and 2004 when flows are less than 100 Mm3. The 2001-2002 cycle is very deficient, the contributions are less than 25 Mm3.

e) Agricultural extension and intensification:

Agricultural intensification (photograph 9) based on monoculture; seeds and plant selected varieties and on other agricultural inputs, contributes to the loss of agro-biodiversity. To become competitive in the market and to meet the demand for a given quality of products, farmers are moving towards productions of high yield and high commercial value.

The agricultural intensification and expansion have caused the multiplication of draining pumps and the overexploitation of agricultural lands of palm groves. From 1956 to 1957, three pumping stations (IRE 796/56, 798/56, 791/56) were installed at Ferkla, both of which at Bour El Khourbat. They worked with an annual pumped volume of 0.5 million m3. Agricultural cooperatives were created in 1958. The town of Bour El Khourbate has experienced an increase of intense draining pumps that are more and more modern and more powerful, since the early 70s, with rates up to 90 l / s (Margat, 1958; Kabiri, 2001, 2003, 2004 and 2005; Kabiri et al. 2001; Boudad and Kabiri, 2002, HR 2004).

Photo 9: Intensive agriculture in a field of Ferkla

Salinization of agricultural lands is a dynamic phenomenon whose speed of change seems to be accelerated mainly where irrigation comes from groundwater samples which resulted in the salinization of about 35% and the desertion of almost 20 % of the UAA.

Inquiries performed in Bour El Khourbat (Abane et al., 2005; Ouhejjou, 2005; Kabiri, 2004) indicate the existence of more than 2000 powerful and functional draining pumps during the 70 years. In 1985, the number of these stations is 573 including only 41 that have been allowed. They charged 580 l / s per day, which corresponds to about 19 Mm3 per year.

The analysis of satellite images from 1972, 1987 and 2001 (Figures 14, 15 and 16) of the study sites shows that:

In 1972, the dam did not exist yet in the Achbarou site (Figure 13) and yet, the vegetation in it was dense. Afterwards, there is a small agricultural extension due to the availability of water of 4 'Khettarats' that allow the irrigation of the oasis without any difficulty. The 80s decade is a period of drought, which led people to invest in draining pumps. Indeed, it was possible to develop agriculture on expansion lands in the vicinity of the traditional oases. This led to the almost complete exploitation of groundwater and the desertion of farmlands. In 2001, there was shrinkage of the agricultural area.

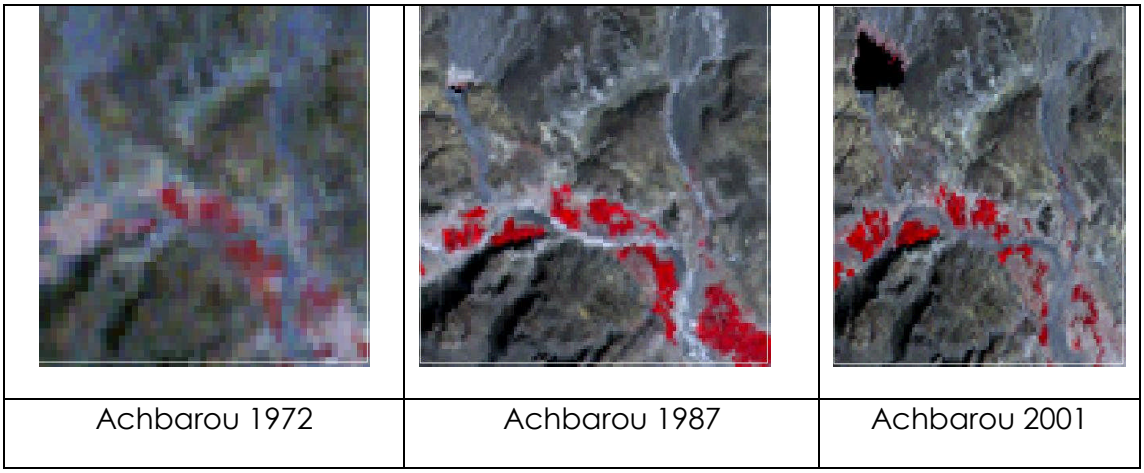
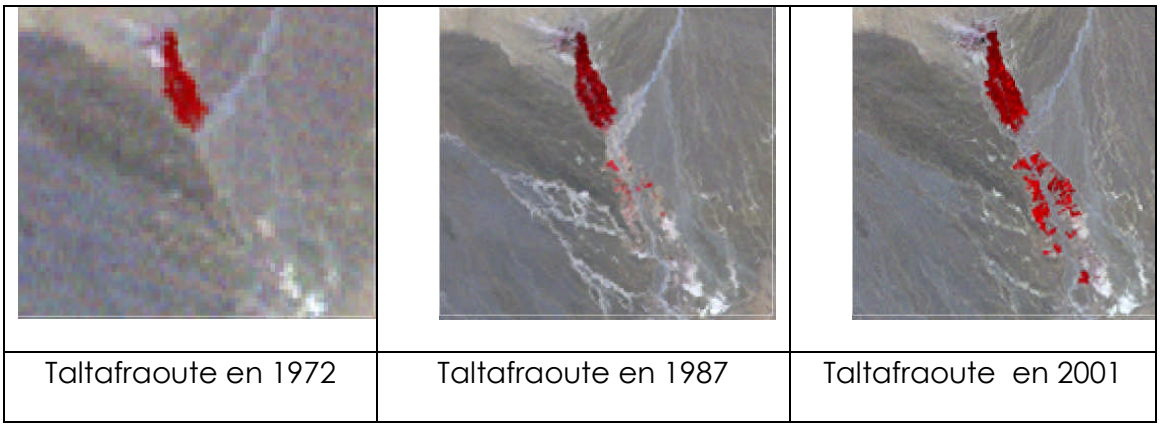


Figure 14: Agricultural expansion and the state of the palm grove of Achabrou

In the site of Taltafraoute (Figure 14), we notice that in 2001, the agricultural net expansion, has spread to the South thanks to water availability of 'khettarat' which draws on the deep water of the Infra-Cenomanian, and, in particular, motor-pumping development.



Taltafraoute en 1972	Taltafraoute en 1987	Taltafraoute en 2001

Figure 15: Agricultural expansion and the state of the palm grove of Taltafraoute

In the site Bouiya (photograph 15), we notice a slight degradation of the vegetation cover because some 'Khettarats' still function even at low speed. The expansion still continues thanks to the motor-pumping.

Bouiya 1972	Bouiya 1987	Bouiya 2001

Figure 16: Agricultural expansion and the state of the palm grove of Bouiya

Changes in the studied area were visualized using a false color composition with pictures from different years. They are reflected by the modification of pixel radiometric values which have undergone a change in their surface (Figures 17 and 18).

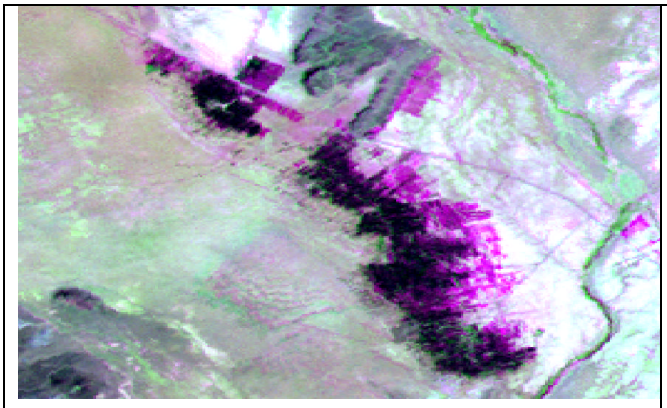


Figure 17 : Changement dans Hannabou, images 1987 et 2001

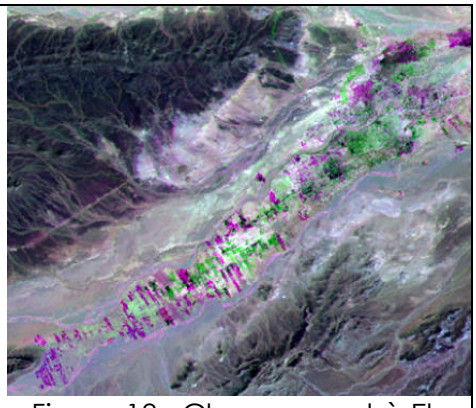


Figure 18 : Changement à El Khourbate, images 1987 et 2001

The pink color indicates a change of soil occupation between 1987 and 2001 (Figures 17 and 18) which leads to the increase of agricultural areas in magenta in the Northeastern side of the palm grove of Hannabou (region Jorf) (availability of 'Khettarats' water and motor-pumping in particular), while the pale green color in the Southwest side indicates sand encroachment at the same period.

The site of Bour El khourbate (Figure 18) is an interesting example of the expansion of agricultural lands to the Southwest (magenta) and the desertion of overused plots in the middle (green). This area has experienced an over-exploitation of groundwater which explains this evolution.

The proportion of farmers who use fertilizers in the five localities increased to the amount of 94% on average. The farmers are grouped into three categories depending on the type of fertilizers, those who use organic fertilizers consist of 59% of households using fertilizers, those who provide the fertilizer consist of 1% and those using the mixture of organic and chemical fertilizers of 38%.

At the site of Bour El Khourbat, farmers reported that 93% of their lands are arable, 7% of the lands are heavy and 2% of their agricultural lands are saline. In the other sites, respondents said that their lands are not saline and that they are 100% tillable.

However, even if one continues to practice crops on these lands, due to the lack of other alternatives, agricultural productivity is reduced and some lands are left fallow for several years. This is mainly caused by the loss of soil fertility due to salinity caused by the intense irrigation and uncontrolled use of fertilizers.

f) Expansion and intensification of rearing:

There are two types of rearing, intensive and extensive, in the studied area. The first type is developed by the sedentary and the second type is much more promoted by transhumants and nomads. Intensive farming is primarily concerned by cattle, mainly local breeds, and sheep, with very little goats. It is practiced in the oases and carried out mainly on stables.

The cultivation of alfalfa, the main used fodder, is intensively made in many agricultural fields and sometime, to the detriment of traditional food crops. The demand for fodder, to meet the needs of livestock, puts pressure on agricultural lands, either by exploiting them more or by stimulating the agricultural expansion on the other greenfields outside the traditional oases.

The oasis of Tafilalet in general and the five studied sites in particular, experiencie an increase in the number of transhumant pastoralists. These pastoralists come mainly from neighboring mountain areas (Goulmima, Ouarzazate, Rich, Zagoura etc.). They belong to several tribes such as Ait Hdiddou, Aït Marghade, Aït Atta, Aït Khlifa, Aït Chaghrouchen, etc. They exploit the pastures around the oases. The local population, however, agreed to give these pastoralists the authorization to exploit those lands in a year in two, and only during the rainy seasons (winter and spring) without admitting them in the agricultural areas.

In 2007, the region has experienced a steady flow of travelers coming from other parts of the kingdom (Laayoune, Edakhla, Agadir, Oujda, etc.). During the survey in the five sites, the number of nomads encountered is was 11 households in Meski, 6 in Achbarou, 7 in Bouya , 9 in Bour El Khourbat and 6 in Taltfraout.

The transhumants and nomads exacerbate pressure on pastures and lead to overgrazing. The incomes of local people who partially depend on the livestock are threatened with diminution. In addition to the economic loss that is likely to be generated, there is also a risk of loss of the local plant and animal biodiversity. Overgrazing and destruction of natural habitats are a threat to biodiversity.

g) Poverty and change in lifestyle:

The population of the oases depends largely on the exploitation of natural resources, especially agricultural lands. Developed oasis civilization was able to grow and to last over time in these very hostile places due to the vigilance of Man who has always lived in harmony with the natural environment. With the population growth and scarcity of natural resources, the local population witnessed the decline of their standards since the area does not offer many opportunities for employment other than farming.

The unemployment rate in the area is quite important and women are the most vulnerable and disadvantaged. Lack of income for these populations is one of the main causes of damages affecting the environment, particularly the overuse of agricultural lands.

Influenced by market forces, changes in attitudes, technological development, etc., the local population, has changed its behavior in relation to the management of natural resources. This management used to be done, not very long ago, according to the rules of the “Jmaa” of “ ksar” to which everyone in the community should submit. Currently, this regulation is abandoned and the result then is the degradation or disruption of the oasis’ ecosystem which is fragile and a bit resilient.

Destabilization of the structure and social cohesion, for instance around water, causes functional problems in the agricultural exploitation and creates many conflicts on the irrigation water. The problems caused by floods, which have always existed, but to lesser extent in the past, have been intensified in recent years probably because of climate changes and also because of the direct anthropic action which overexploits the cover.

As agricultural lands do no longer ensure a sufficient supply of goods and services to maintain the lives of local people, there was an intense immigration to Europe. Money brought by these immigrants led to a major transformation in the lifestyle of the population. Indeed, it led to the desertion of traditional houses, 'Ksours', built in adobe soil, to move into new houses built in reinforced concrete in the outskirts of 'Ksours', on agricultural lands. The desertion of farming by young people who are attracted by the urban lifestyle and other more promising horizons is another consequence of immigration.

Because of intertribal and interethnic conflicts, related to a non discharged situation and also because of the growing population, there is an invasion of individual houses of agricultural lands. This phenomenon is becoming increasingly critical in the region.

2.1.1.3. State of the agricultural ecosystem and impacts

The state of agricultural and rearing production is marked by the decline of the services they provide. The main causes are the disease of 'Bayoud’ (photograph 8), water scarcity (due to human actions and to the context of structural drought), demography, the intensification and expansion of agriculture, poverty and change in human behaviors, etc.

Agriculture is characterized by the limitation of space marked by the lack of expansion possibilities of agricultural activity outside the oases and the plots’ division. Today, the agricultural area of the oases is reduced to 0.86 ha per farmer with an average of 5 plots. This modification resulted in the reduction of the lucrative value of the Utilized Agriculture Area (UAA), generally followed by the progressive impoverishment of farmers.

Photo 10: Date producing palm destroyed by the disease of 'Bayoud'

In recent decades, the capital of date producing palms in the region of Errachidia witnessed a sharp decline due to desertion and the loss of large areas of palm groves. These damages are the result of the water crisis facing the region and which is regarded as a decisive factor in their acceleration. Moreover, the loss of date producing palm heritage is due to phytosanitary problems. 'Bayoud', appeared in 1870, caused considerable and historic damage in the palm groves of the Maghreb in general and those of Tafilalet in particular. The borer, as well, affects the quality of dates and hence their commercial value and reduces therefore the incomes of the population.

According to the studies conducted in 1997 and 1998 by the Regional Agency for Irrigation and Agriculture Development of Tafilalet (ORMVA / TF), the area of Meski is the most infested by the borer of dates (Ectomyelois ceratoniae) with an incidence of around 27%. This rate of infection is related to the increasingly growing diversity of plants associated with date producing palms, such as pomegranate, fig-tree, almond walnut, grapes, and also a certain coolness provided by the micro-climate of the area.

The incidence of this disease is high in the areas with abundance supply of water. Thus, the site of Meski is one of the most infested places. The impact on ‘Boufegous’ is very worrying (70%) because of its thinner skin in comparison to other varieties.

Agricultural lands of the oasis of Tafilalet lost their productivity by the appearance, at the end of last century, of the process of salinization, aggravated by the systems of irrigation and excessive pumping of groundwater. The agricultural lands lose, accordingly, their fertility, which has a negative effect on the income of farmers.

Due to agricultural intensification, some varieties and cultivars of local date producing palms and fruit trees disappeared from the area, to make room for other varieties introduced or selected locally. This contributes to the impoverishment of local biodiversity which, without probably being too productive from the commercial point of view, may have other virtues that we ignore or probably neglected.

The olive oil sector in the region is characterized by low productivity and relatively low quality in comparison with international standards. Olive trees are invaded or threatened to be attacked by insects such as the olive dark beetle (neroun), Phloetribus scarabeioides, olive scale (Saissetia oleae olive Homopères, Coccidae) and the olive fly (Dacus olea Gmal, Diptera, Tryptidae).

The climate is marked by long periods of drought and by its aridity. Ranges are characterized by the predominance of spontaneous and thin vegetation. According to interviewees, the load of ranges with grazing animals is low or relatively low. Indeed, 72% of respondents claimed that this number is low and 28% said it is on average. Only 2% of respondents reported that the internal pastures of the five 'Ksours' suffer from the problem of overgrazing.

However, the majority of farmers (72%) bring the commercial food supply to their livestock, due to the lack of grass in the ranges. The remaining 28% complement as well, sometimes, with alfalfa and other fodder products in the fields.

Regarding degradation of oases, 15% of interviewees said that the state of the oases area is very degraded, 29% said it is degraded, 49.4% confirmed that it is a little bit degraded, while 6.4% said it is not degraded at all.

Beekeeping witnesed a decrease in production due to the degradation of nectar plants or due to bee mortality caused mainly by the Varroa Mite, the use of pesticides in agricultural fields or during locust invasions and the succession of drought periods. The endemic yellow bee is on the way to degeneration. It is threatened with absorption from the black bee, known for its aggressiveness and low productivity, the disease of Varroa mite and the products used to fight locust.

The emaciated and loamy soils which support almond tree groves, upstream olive tree groves and downstream palm groves are subject to the phenomenon of erosion (hydric upstream and along the rivers and wind erosion downstream) (Kabiri, 2006, 2005, 2004, 2003; Kabiri et al. 2003). Downstream, wind can reach considerable speeds able to extract and transport sand before putting when its speed is reduced.

The geomorphology of land is marked by alternating reliefs and depressions; the geological structures are favorable for sand transportation over long distances through openings called “Foums” (Mainguet and Chemin, 1979; Abouaomar, 1995; Abrou, 1991; Abouchrif, 2006; Khardi 2006; Benmohammadi et al. 2000; Kabiri, 2006, 2005, 2004, 2003; Kabiri et al. 2003).

The soils are vulnerable and characterized by the limitation of pedogenesis processes and the formation of salt crusts on their surface (photograph 11). They are degraded and traumatized mainly by wind erosion. This latter leads to an increasing activity of desertification and constitutes a constant threat of silting settlements, infrastructure and areas of agricultural production. Besides, water erosion is more intensified upstream.

Regarding sand encroachment, the color, texture and traces of erosion observed everywhere in the oases of Tafilalet, confirm the autochthonous and allochtonous origin of sandy materials in the studied area. Sand accumulations observed in the oases mainly depend, first, on the geographical location of the site, then wind conditions and the nature of the obstacles. The principal forms observed are: Ripple-marks or wrinkles, sandy or windy sailing, Nebka shape, sandy shield, shield of barchans dunes, and dihedral barchans dunes and barchans dunes, sifs, etc..

Photograph 11: Soils with salt deposits in the oases of Tafilalet

In the oases of Tafilalet, a barchan dune is never alone. It is always associated with others to form a set of barchans dunes that are complex enough, called train of barchan dunes. On multiple origins, these accumulations of sand are a real danger that threatens the palm groves, hydro-agriculture, road infrastructure and settlements. Sites severely threatened by siltation are on the map in Figure 19.

To the west of the watershed of Ziz (Fig. 18), the area between the city of Errachidia and Goulmima is characterized by deflation and quicksand movements, vegetal tufts and sprinklings thickening rarely on sifs in the watersehds or on small cliffs in the North. Sails and thicker deposits exist in the Sahel and are of recent origines.

The region of Yerdi (Figures 19 and 20) is an area famous for sand encroachment. The road here is often threatened and threatening. Sand invasion of the road which may take place in one night, already cause numerous accidents and, unfortunately, human deaths as well. Three wind directions are confirmed: NE-SW (Chergui), SW-NE (Sahel) and NW-SE directions. This explains the state of gourd surface and barchan dunes building, which have a dune reverse dynamic.

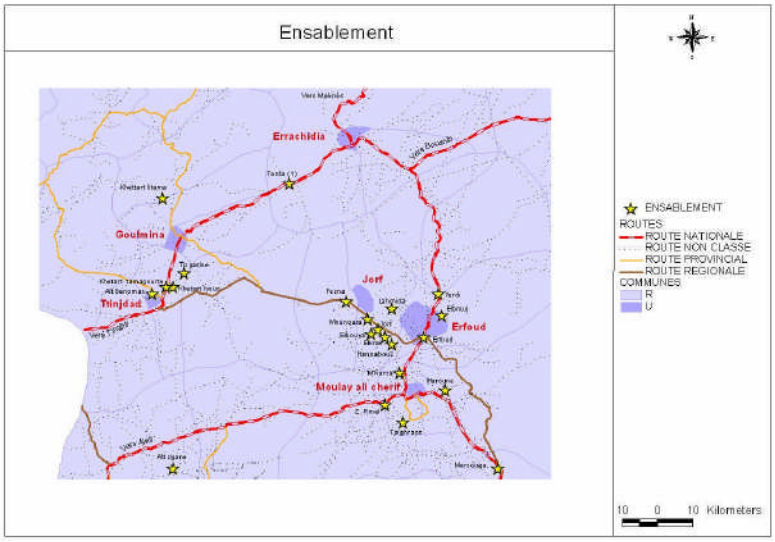


Figure 19: Location of some sites threatened by the sand encroachment

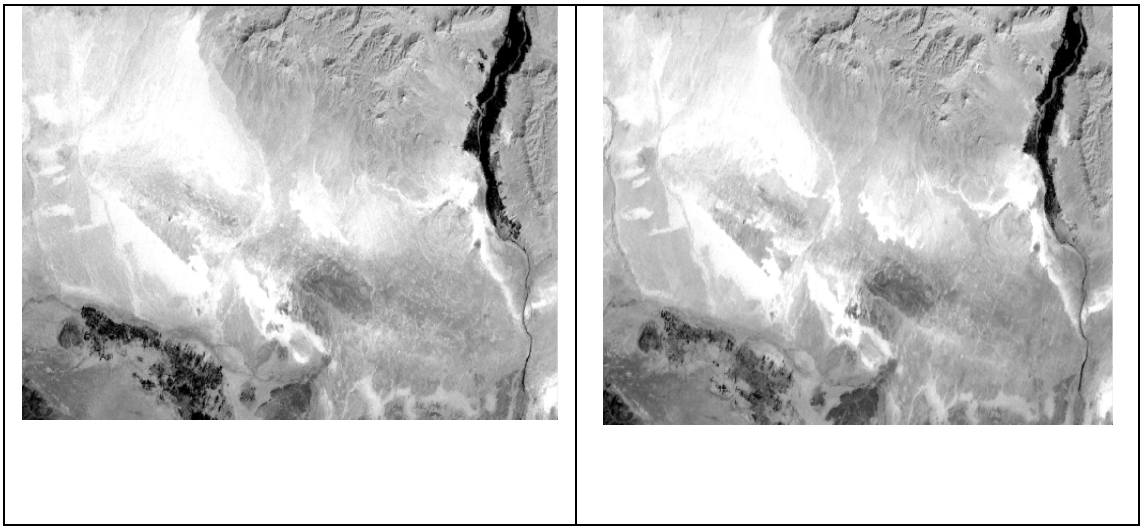


Figure 20 : Ensablement dans le site de Yerdi en 1987 et 2001

In the catchment of Ghèris (Fig. 19), the area between Goulmima and Tinjdad is considered as a dangerous wind corridor already protected by an area set aside with prohibition of thorns grubbing of 'Ksour' of Tizgaghine, Aït Moulay El Mamoune.

In the palm grove of Ait Ben Omar, sand damages the wheat plantings of the year. A few kilometers to the South of this 'Ksar ', we find the palm grove of Izelf, which endures the same things. According to a farmer, this sand encroachment began 15 years ago and affected the traditional palm grove. Site of Chtam is not far away from Izef. This site is located in an area strongly threatened by sand.

In the palm grove of Jorf, especially in its Western part, there is a complex system of 'Khettarat' whose number and length are considerable. Sand encroachment threatens these infrastructures and the entire palm grove, which justifies, in fact, the achievement of several projects aiming to mechanically and biologically fight this phenomenon, in this part of the palm grove.

2.1.1.4. Answers Regarding grazing, ORMVA / TF responded by:

• organizing the rangelands and the grazing process;

• creating 17 cooperatives comprised of 4450 farmers;

• equipping water points, raising awareness and training farmers about natural resources,

• distributing barley at the time of drought and

• planting crops

To enhance local agricultural production, Morocco, in partnership with international and national donors and the civil society, encouraged and created cooperatives of livestock (goats, sheep, cattle, camels, etc..), cooperatives of bee breeding, the creation of natural parks (such as M'cissi and PNHO) and Sites of Biological and Ecological Interest (SIBE), for example the Kheng, etc.

There was also a proliferation of date producing palms nurseries and other fruit trees, including the jujube tree. In this context, a center for specialized agricultural research (the CRRA) was created. A very encouraging law, Law #06 -01 [Decree No. 42-07-1 Law 06-01 of 17 April 2007, in force

since 03 May 2007], has been adopted by the Moroccan government to protect date-producing palms (Phoenix dactylifera).

There was other interventions concerning the date producing palms:

- distribution of more than 3000 clones;
- Weeding of 35 400 t;
- treatment against diseases of 46 100 feet of palm trees;
- sharing of releases: 31 800 types;
- Raising awareness and training of farmers and 8000 beneficiaries;
- 10 cooperatives of dates packing;
- 5 small productions of date juice;
- organization of local, regional and national fairs and exhibitions.

The ORMVA / TF is involved in the protection and enhancement of olive trees. Indeed, in 2007, it organized a cutting of trees (30,782 t), treatments against diseases (29,495 trees), raising awareness and training of farmers (6000) about the improvement of the harvest periods and modernization of 10 Oil mills 'Maassara'.

Beekeeping attracts investors and farmers more and more, and that is why ORMVA / TF :

- supervised the creation of cooperatives,
- selected queen bees and distributed them, and
- organized study tours for farmers' sons.

2.1.2. Samplings of plants and animals from the natural environment

2.1.2.1. Rendered Services

a) Aromatic and medicinal plants

Oases supply the population with wild foods of animal origin (hares, fish, whip tail, etc.) and with aromatic and medicinal plants. These are used either in the traditional medicine, or for cosmetic or culinary uses. According to the surveys of the five 'Ksours', samples of these plants are taken, in genera,l during the spring and summer with quantities of about 2 to 5 kg per year on average per household. The local population mentioned the use of mugwort, rosemary, jujube tree roots, 'Harmel' and Arabic gum.

The results obtained in some oases of Tafilalet concerning wild plants (Leslie et al., 2006; Bakali, 2006, EFP, 2006) indicate the presence of the following plant species (Table 1). These plants are mostly used by man, whether for use of cattle food, as energy for heating and cooking, in medicine or to extract flavors.

Table 1: Some medicinal plants of the oases of Tafilalet

Famille	Nom vernaculaire	Nom scientifique
APOCYNACEAE	Allili	*Nerium oleander*
ASCLEPIADACEAE	Lkarmel*	*Pergularia tomentosa*
ASTERACEAE	Izreg(m)-	*Artemisia radiata*
	Tizret(f)	
	Izreg	*Herba-alba*
	Hachir*	*Atractilis flava*
	Karzi*	*Carduncellus devoxii*
	Taskra*	*Echinops bovei*
	Ifrskl*	*Launaea arborescens*
	Ifrskl*	*Launea acanthoclada*
	Amgou*	*Pulicaria incisa*
	Chouk*	*Atractylis flava*
CAPPARIDACEAE	Toukhmijine	*Cleome arabica*
CHENOPODIACEAE	Assay*	*Anabasis articulata*
	Assay*	*Haloxylon articulatum*
	Akanoud*	*Anabasis aretoïdes*
	Laghbira	*Bassia muricata*
	Lghassal	*Salsola vermiculata*
CISTACEAE	Tazawa*	*Helianthemum sp.*
CRUCIFERACEAE	Agou*	*Matthiola livida*
	Agou*	*Maresia nana*
	Taskochtamt (rose de jericho)	*Anastatica hierochuntina*
	Tissit*	*Farsetia aegyptica*
	Traaïsme*	*Zilla spinosa*
	Traaïsme	*Zilla macroptèra*
CURBINACEAE	Afarziz	*Citrulus colocynthis*
EUPHORBIACEAE	Taynaghout*	*Euphorbia obtusifalia*
	Taynarout n rbia	*Euborbia guyoniana*
FABACEAE	Tiboukhrisine*	*Astragalus ghizensis*
	Tiboukhrisine*	*Astragalus gomo*
	Amrad*	*Acacia seyal*
LAMIACEAE	Assir*	*Rosmarinus oficianalis*
	Taslaght*	*Mentha longifalia*
	Touf lalba	*Ajuga iva*
	Aliless	*Marrubium deserti*
LABIACEAE	Tiyiyst	*Nepeta barbara*
LILIACEAE	Talamt*	*Asphodelus tenuifolius*
	Talamt*	*Asphodelus refractus*
	Azalim-n-ouchne*	*Dipcadi serotinum*
	Azalim-n-ouchne*	*Asphodelus festulosus*
OLEACEAE	Azemour /jebouge	*Olea lapirrini*
OMBELLIFERE		*Ammoducus leucotrichus*
	Atach	*Pithurantos chlorantus*
PLANTAGINACEAE	Ilivvi	*Plantago amplexicaulis*
	Tamzortntili*	*Plantago ciliata*
PLUMBAGINACEAE	Omrzgli*	*Limomium bonuelli*

POACEAE	Tizmi*	*Stipa reporta*
	Asskoune	*Avena alba*
POLYGONACEAE	Smoume*	*Rumex vesicarius*
RESEDACEAE	Imim*	*Reseda arabica*
	Irgajdi*	*Reseda villosa*
RHAMNACEAE	Azguar*	*Zizyphus lotus*
SOLANACEAE	Jijou*	*Withania adpressa*
VERBENACEAE	Angrf	*Vitex agnus castus*
ZYGOPHYLLACEAE	Tamrat	*Fagonia glutinosa*
	Ftrach*	*Fagonia zilloïde*
	Lharmal*	*Peganum harmala*
	Agoult	*Grotalaria vialatter*
	Apsasse	*Wariona saharae ?*
	Tiwinght	*Olea europaea*
	Wawrourou	*Ricinus communis*

Most of these species are endangered, mainly due to human actions. Indeed, lands supply of these plants have deteriorated mainly because of the overuse of rangelands and the disappearance of transhumance practices, given way to forms of individual and anarchic use of pastoral resources, which in the past were well managed in a collective manner according to local practices called 'Al Orf of Agdal'.

Through civilizations that succeeded in the oases of Tafilalet, Man has taken advantage of the benefits of traditional medicine and the virtues of medicinal and aromatic plants (MAP) for his welfare and that of his pets. Indeed, several aromatic and medicinal plants are used to treat some human and cattle diseases, such as headaches, stomach and bowels aches, rheumatism, enrichment of the cattle food in order to increase milk production, eyes treatment, etc.

These plants are also used directly for other purposes (Leslie et al. 2006; Bakali, 2006 biotic Report 2000; Ouadi and Kabiri, 2006; various PFE) or for the extraction of essential oils, an activity that has started growing in the region. We can cite for example:

• Aacacia seyal ('Amrade') , a shrub that was previously very well represented, especially in the mountains, but it is nowadays endangered with extinction. This shrub possesses medical virtues that could be valued. Indeed, it secretes, at the trunk leve,l a substance called ‘Arabic gum’ which has medical and culinary values. In addition, the population uses its sap as anti-asthmatic and its seed as a medicament against stomachaches.

• The Zizyphus lotus - RHAMNACEAE (jujube tree, 'Azguar'), a shrub that is clearly regarded as an excellent grazing of goats, camels and bees. Its fruits are used in human consumption and have medical uses against kidney stones, stomachache and lack of appetite, and certainly much more unknown values. The jujube tree is also a key species to fight against the sand that threatens the population. It does have the capacity to retain sand. However, its density, which was relatively large in the past, has sharply declined. It is an endangered species in the mountains and also in the plains.

• Olea eurapaea (oleaster, 'Tiwinight', 'Azemour') is a shrub whose fruits were used, until recently, as a medicament against kidney stones and injuries. This species has virtually disappeared in the region.

• Anvillea Radiata - ASTERACEAE ('Ajreg') is used as anti-diabetic and against stomachache. However, it is still toxic and is inadvisable to eat.

• Launaea arborescens - ASTERACEAE ('Ferskl') is used in the treatment of eye illnesses. This species is threatened with extinction.

b) Wood biomass:

Samples of wood biomass are performed both within or in the vicinity of the palm groves. It is a biomass which can be of wood and of woody plants (photograph 11) from agricultural lands, from range areas or from the forest.

Photo 12: Types of used wood combustibles:

The local population takes an average of 79 kg / week / household of wood biomass to meet its needs for heating, cooking and rural construction. This biomass is used either as fuel or as building material. Figure 21 illustrates the different uses of this biomass and proportions associated with each use.

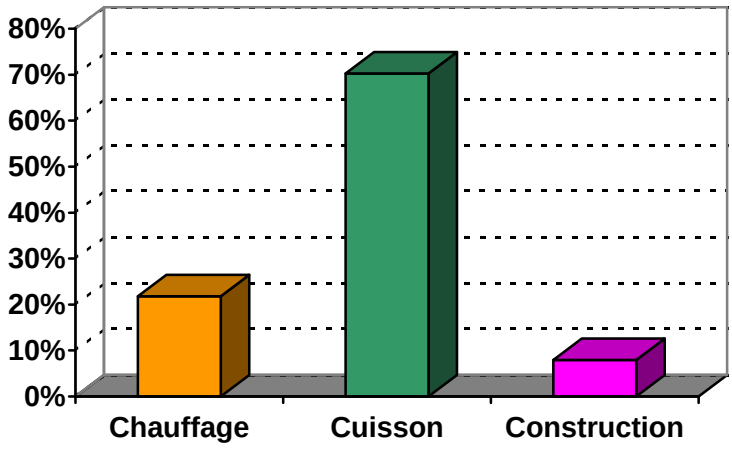


Figure 21: Use of wood biomass in the five 'Ksours'

About 81% of this amount is collected at the palm groves level, 18% is derived from range areas and 1% is used in the surrounding forests. The sampling sites of the consumed biomass are shown in the following Figure 22:

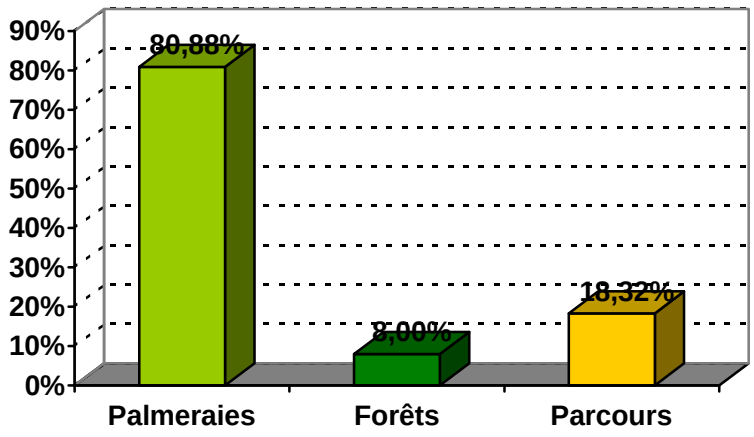


Figure 22: Location of sampling of wood biomass

The quantity of biomass consumed by the population of the five 'Ksours' is composed of 41% dry palms, 37% of dead branches, to 16% of stipes, 6% of jujube tree (' Sedra ') and other types of biomass that are less than 1% (Figure 23). This biomass is transported either on the back a donkeys (45%) or on the back of women or girls (55%).

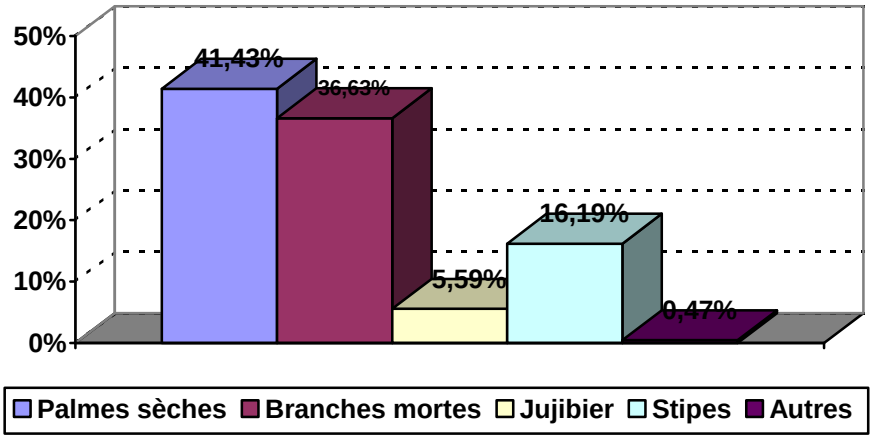


Figure 23: Types of biomass used by households

c) Wildlife:

The wildlife of the region is not well known. It is composed as an example (Table 2) of Dorcas gazelle, Cuvier's gazelle, barbary sheep, cheetah, fox, houbara bustard and many rare and endemic reptiles and amphibians [Abiotic report, 2000; CBTHA; Doglio et al . 2006; Kabiri, 2004], etc.

Tableau 2 : Faune de la région

Nom français	***Nom scientifique***
Mammifères	
Gazelle dorcas	*Gazella dorcas*
Lièvre de Cap	*Lepus capensis*
Chacal	*Canis aureus*
Renard roux	*Vulpes vulpes*
Hérisson	*Erinaceus algirus*
Souris domestique	*Mus musculus*
Reptiles	
Serpent des sables	*Psammophis schokari*
Fouette queue	*Uromastix acanthinurus*
Varan du désert	*Varanus griseus*
Cobra	*Naja haje legionis*
Vipère naine	*Vipera monticola*
Vipère à corne	*Cerastes cerastes*
Gecko de Pétrie	*Stenodactylus petrie*
Batraciens	
Crapaud vert	*Bufo viridis*
Crapaud de Mauritanie	*Bufo mauritanicus*
Grenouille d'Afrique du Nord	*Rana saharica*
Crapaud de Brongersma	*Bufo brongersmai*
Oiseaux	
Tourterelle des bois	*Streptopelia turtur*
Hibou	*Bubo (bubi) ascalaphus*
Perdrix	*Alectoris barbara*
Pigeon biset	*Columba livia*
Moineau	*Petronea petroronea*
Outarde Houbara	*Chlamydotis unulata*
Insectes	
Abeille jaune (endémique)	*Apis melifica sahariensis*
Abeille noire	Apis melifica Intermissa

Hunting is practiced in the region in an organized, formal manner as well as an traditional and the non-organized way.

Hunting which is traditionally practiced is performed individually and collectively. The most prized species are the gazelles, barbary sheep and houbara bustard. The latter is highly sought by foreign hunters, coming mainly from the Middle Eastern countries which practice hawk hunting.

In traditional practices, hunting is a means of entertainment and a source of protein as well. An estimate of the quantities taken from animals has not been made as of the fact that many samples are done illegally (poaching). What is certain is that hunting has existed in the region for centuries and the population attaches a particular interest to this practice. However, during recent years, and according to the opinion of the local population, the game has declined a lot due, as cited, to the excessive and uncontrolled practices and the succession of several drought periods.

The decline in the game had negative impacts on the population's well being (loss of sources of protein) and also on the balance of the ecosystem. In addition to the direct benefits of this biodiversity, gaming also provides several environmental functions.

2.1.2.2. Forces of change and pressures

The increase in population creates additional needs for food and drugs, resulting in an increase of the exploitation of the natural resources: aromatic and medicinal plants, timber, game, etc. The needs for firewood increase with the increase in population. It is difficult for this quite poor local population to have access to alternative sources of energy.

Firewood is also used in craftsmanship such as pottery or in Moorish baths and collective bread ovens. The cooperative Mouye in Goulmima, well known in the region through its production of pottery, uses local wood. It exploits thus the palm groves (producing or not), and wood coming from the rangelands (jujube tree and others) or elsewhere (Middle Atlas). The shortage of this product obliges artisans to use old tires for cooking, which has an adverse effect on the environment.

Population growth is also accompanied by agricultural and buildings expansion and the building of infrastructures on the natural grounds. These expansions contribute to the destabilization of the functioning of natural ecosystems, and affect their integrity and participate therefore in destruction of housing conditions and loss of biodiversity.

Sand encroachment and desertification are two major natural forces that have anthropogenic causes, which contribute to the loss of natural habitats and their plant and animal resources. These phenomena cause changes in the living conditions of the ecosystems and some species lose conditions for their development or their livelihoods.

The difficulty to effectively implement laws regulating the practice of hunting due to lack of sufficient resources and to the low awareness of the local population, the change in pattern of consumption, behavior and life of the local population create new needs. Searching for additional revenues to meet this need leads to an overexploitation of the biological resources.

2.1.2.3. State of biodiversity and impacts

Biodiversity in oases, often endemic and remarkable, is quite important in variety and number. However, much of this heritage is threatened with extinction mainly because of the direct or indirect human actions. We are witnessing a deterioration of natural habitats due to their over-exploitation caused by population growth and also by the disintegration of the rules governing the practice of transhumance and management of natural resources in general.

The number of species, animals or plants is declining due to the increase and acceleration of the extinction rate of species and destruction of their habitats. The impacts of this degradation will be reflected negatively on human well-being by reducing the quantity and quality of goods and services provided by the ecosystem and on the functioning of the ecosystem.

Figures 24, 25 and 26 illustrate the evolution of the vegetation index between the years 1972, 1987 and 2001. The vegetation index is correlated with various parameters, namely the amount of productivity and biomass of vegetation. Agricultural lands along the rivers as well as marginal lands located on the boundaries of the oases characterized by their high productivity are now losing their exploitable potential following the drying and consecutive sanding related to the growing desertification.

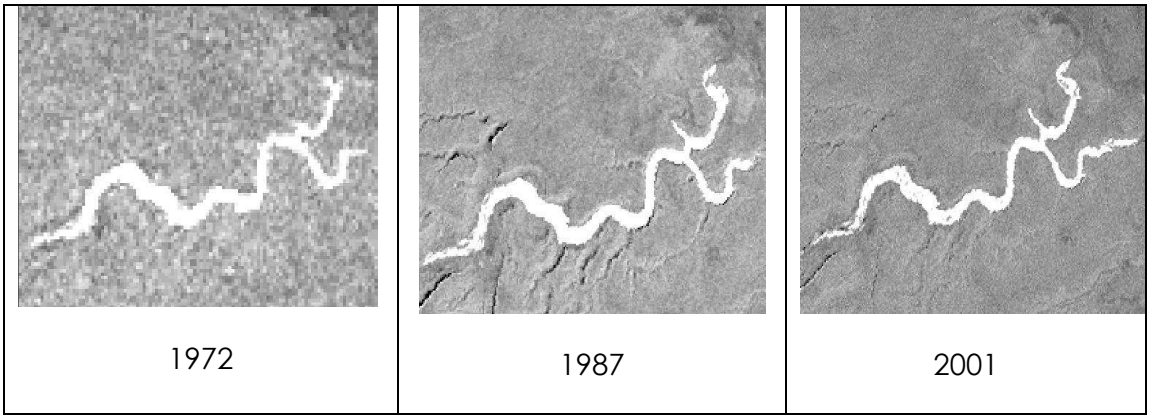


Figure 24 : Indice de végétation dans la palmeraie de Zaouit Aoufous durant les années 1972, 1987 et 2001

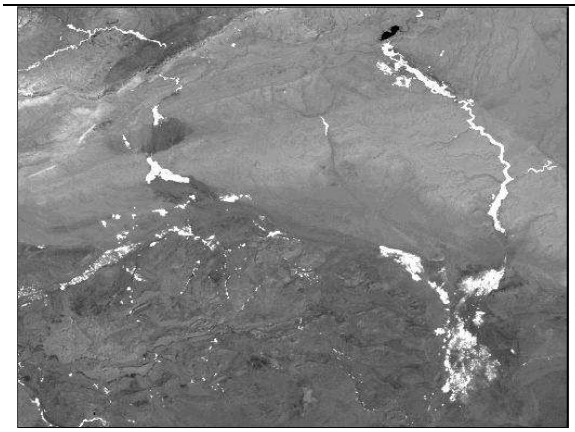


Figure 25: Indice de végétation durant 2001 dans les oasis du Tafilalet

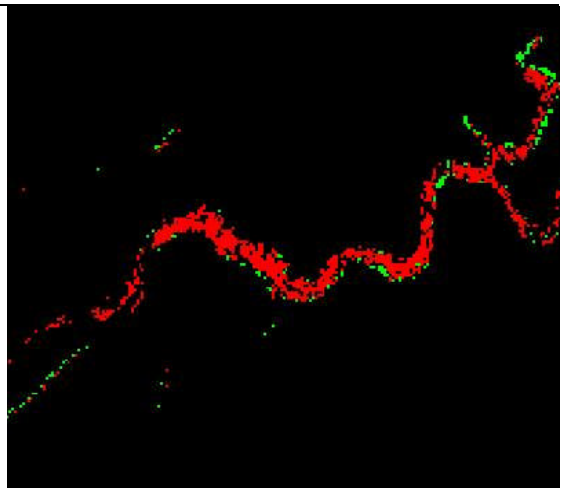


Figure 26 : Changement dans l'indice de végétation NDVI

The agricultural expansion at the expense of the natural ecosystems contributes to the dwindling of the animal and vegetable biological wildlife richness. Species of local plants and animals are thus threatened by degradation or even by extinction because of this problem and also because of sand invasion and severe weather conditions (droughts).

Vegetation cover as a whole witnessed a significant decline in the recent years. The demand for firewood and other plant and animals products led to an overexploitation of natural resources, resulting in a decrease in their productivity and hence, a reduction in the quantity and quality of goods and services provided by the ecosystems. Well being of the local population, whose life depend in a way or another on the consumption of these goods and services, will be partly or fully undermined.

2.1.2.4. Answers

Some associations have developed projects for the protection of vegetation by the economics of firewood. Examples include the construction of the solar Moorish bath ('Hammam') in the Ksar of talált (Tinjdad) and dissemination of improved homes. This project is funded by the program FEM-PMF/PNUD (Morocco GEF) in partnership with local associations.

Some local development initiatives are underway in the region to create employment opportunities and also to strengthen the capacity of local associations to supervise the public and raise awareness about the environmental protection.

A site of biological and ecological interest was created in 1996 by the forestry authority, yet no legal status has been given to this place so far. However, at the national level, a law concerned by the protection of the areas is under development and once enacted, it will be a tool to protect certain places that will be classified as protected sites.

Laws concerned by the protection and enhancement of the environment and the studies of the impact on the environment have been enacted since 2003, and the publication of their decrees of application is underway to be completed.

2.1.3. Water abstraction:

2.1.3.1. Rendered service

Water used in the oases is of two sources, surface water and groundwater. This water is used by the population, for domestic and agricultural uses, and other uses as well. Its operation was for a long-time accompanied by development and establishment of customary rules commonly known as "water rights".

The right to use irrigation water was probably related to land ownership and was associated with areas held by each beneficiary or community of irrigators. However, development of ownership (sale, inheritance, exchange, etc.) led to the deregulation of these systems, resulting in a situation where water is no more "associated" with the land .

Irrigation water is delivered through a complex drainage system to the palm groves, through a series of dams or diversions thresholds constructed along the main axis of each river. These waters are mobilized within the framework of an irrigation by diverging the river runoff using diversion dams, then channeled through a network of ‘souaguis' which bring the water to the plots (Figure 27).

In the past, diversion thresholds were consisted of an earthen dam whose capacity varies from a few tens of thousands to one million cubic meters. They regulated the flow of water by ensuring safe drinking water, irrigation water and water for cattle. These developments fit naturally into the landscape without creating particular nuisances.

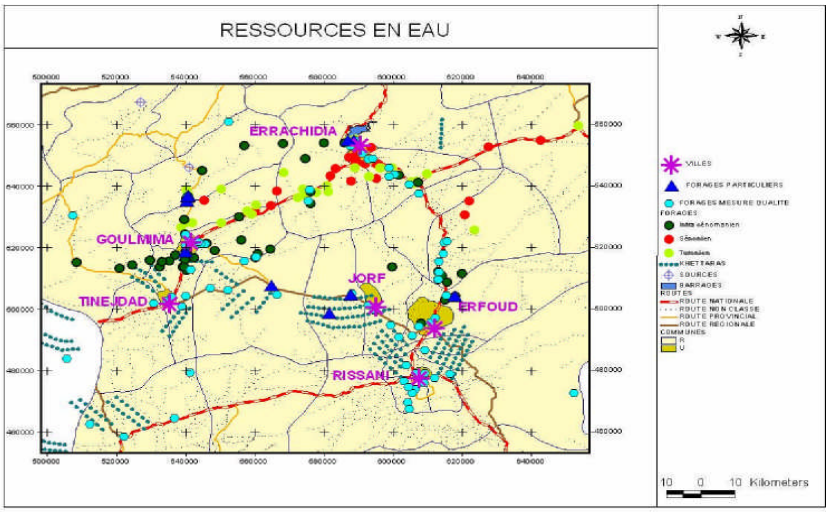


Figure 27: water resource and mobilization in Tafilalet

Other surface water resources are used for domestic purposes but especially for irrigation. The mobilization of water is now provided by the dam of Hassan Addakhil. The annual average of the dam releases in 1971-1972 to 2005-2006 is 84 Mm3 and the annual average of entries is 100 Mm3. This reflects a lack of releases of 40% and 37% of entries. In addition to the waters of the dam, flood waters are also used for irrigation.

Occasional irrigation is done by the floods (photograph 13). This practice is very common in all oases. The population attaches a great importance to floodwater because it requires no investment, pumping for example, and because the law on those waters is collective, with a priority of upstream to downstream mobilization. The distribution of water between the different dams is based on a previous agreement between the beneficiaries. They had established a sharing of the floodwaters and designed diversion dams so that they derive only the fraction of water corresponding to each right. To preserve these rights, it is usually strictly forbidden to build a new dam, to raise an existing dam, and to broaden an intake of 'seguia'.

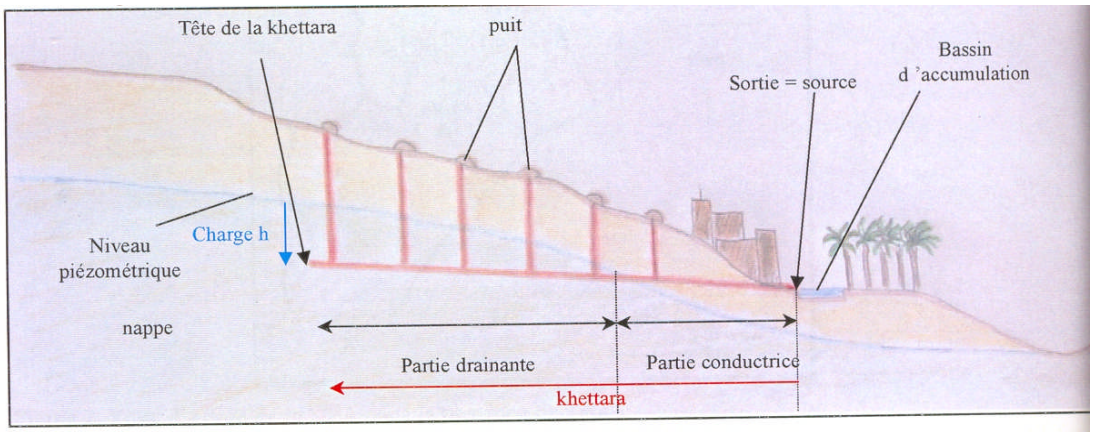
Photo 13: irrigation by flood waters

For a long time, farmers have developed clever processes of mobilization of groundwater or surface water and have been innovative in the techniques of water irrigation control, using rudimentary techniques that are adapted to the violence of floods, to the influences of the high evaporation and sand invasion. These facilities have proven their effectiveness over centuries of exploitation. The 'Khettarats' are an example of these mobilization techniques of underground waters.

Groundwater in the region emerges from four deep aquifers that are: Jurassic, Infra-Cenomanian, Turonian and Senonian, in addition to the groundwater layer (Quaternary) and ground fractures in the Paleozoic and Precambrian eras in its downstream part. This water supplies the population of the oasis of Tafilalet by drinking and irrigation water through the 'Khettarats', wells and the drilling of the palm groves.

The 'Khettarat' (photo 14) is a system of abstraction of groundwaters. It was invented in Iran and was introduced into the Maghreb by Arabs during their conquests. This technique began to develop in the Taflalet since a long time ago.

Photographie 14: Vue de surface (en haut) et shémas d'une découpe verticale (en bas) d'une 'khettarat'



In 1967, Tafilalet had 570 'Khettarats' with a total length of 2900 km. There are 450 left but only 250 are currently operational. Since 1970, the number of 'Khettarats' in service became more and more reduced for mainly due to the competition of the trailer-pumping, the difficulty of their maintenance and the prolonged droughts.

The management and maintenance of 'Khettarats' are made by traditional grouping of water rights holders. Maintenance consists mainly of a flushing of the earth and sand accumulated in the gallery of 'Khettarat' and on the well walls. Right holders are responsible for the expenses necessary for this cleaning work.

Managing water distribution of 'Khettarats' is based on water rights, established by a customary law on the basis of the contribution of each person in the construction of the project. It is a system of distribution based on a water tower which gives each user the right to irrigate his fields for a number of days according to shares whose unit is called 'Nuba' (corresponding to a period of 12 hours). The 'Khettarats' are widespread in Tafilalet and exist in the studied sites of Taltafraoute, Jorf El Bouya and Achbarou. They are much more abundant and complex in the region of Jorf_Bouiya.

Before the advent of pump stations, water from the groundwater was mobilized by a traditional system known locally as 'Oughrour'. This system allows the pumping of groundwaters by animal or human force. Besides the difficulty of the task, the collected volumes and the irrigated areas were

very small. The emergence of modern pumping has condemned this technology to disappearance (photograph 15).

Photo 15: Vestiges of Oughrour (Tighdouine, Tinjdad, Errachidia)

On the other hand, there are approximately 7,000 private wells, of which 4000 are currently in use, equipped with pumps with a capacity of 8 to 18 HP and 4 to debit 10l / s (ORMVA TF-1981, 2006).

The mobilization of waters by pumping stations is widely available in Tafilalet. The development of this method of mobilization goes back to the early 70s, thanks to remittances the immigrants living in Europe sent. There are two types of pumping stations: private and public. The collective pumping stations, whose number exceeds 100 units, have been created by the TF-ORMVA and transferred to farmers' cooperatives. They debit a volume of water that varies from 20 to 100 l / s. On the other hand, there are approximately 7,000 private wells, of which 4000 are currently in use, equipped with power motor-pump ranging from 8 to 18 HP and 4 to debit 10l / s (ORMVA TF-1981, 2006).

From 1956 to 1957, three pumping stations (IRE 796/56, 798/56, 791/56) were installed at Ferkla, both of them in Bour El Khourbat. They worked with an annual pumped volume of 0.5 million m3. Agricultural cooperatives were created in 1958. The town of Bour El Khourbate has experienced an intense increase of more modern and more powerful pumps, since the early 70s, with rates up to 90 l / s (Margat, 1958; Kabiri, 2001, 2003, 2004 and 2005; Kabiri et al. 2001; Boudad and Kabiri, 2002, HR 2004).

Consumption of irrigation water in Tafilalet is estimated at 558 Mm3, of which 35% is surface water and 63% groundwater. Figure 24 below illustrates the types of water sources used in the five studied places. It is about the irrigation pumping from wells using, the mobilization of groundwater using the system of 'Khettarats' and channeling of the surface water by 'seguias'.

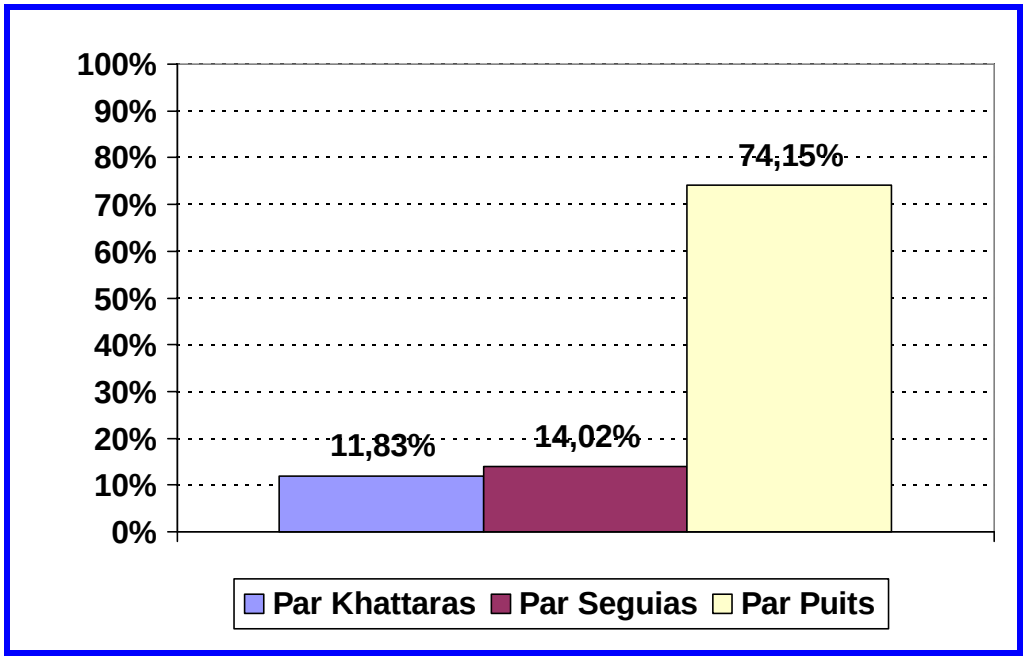


Figure 24: Irrigation systems of the UAA of the five 'Ksours'

Approximately 2% of water in the region is for drinking (Drinking Water Supply DWS) and 98% for agriculture. DWS, which is 100% provided by groundwater (boreholes 674/39, 1227/48, 1238/48 etc.), is of 14 Mm3 (Mahboub and Kelly, 2006). The drinking water supply is of 100% in the urban area and it is 85% in rural areas (Errachidia Monograph, 2006).

2.1.3.2. Powers of change and pressures

Agricultural practices unsuitable to the local climate are causing, more and more, water shortages. These practices accelerate the overexploitation of groundwater which has reached depths of 20 m on average, in some areas depth exceeds 30m. Farmers depend more and more, to exploit groundwater, on traier-pumps, creating wells, drillings and even underground tunnels (Achbarou, Meski and especially Bour El Khourbat). The consequence of these practices, among others, is the raising of the rate of salt water which can sometimes reach 8 g / l.

Errachidia region is currently experiencing a huge water pumping site, many of which are beyond control and regulations in force. This site is spread from the upstream to downstream of the oasis as in N'Zalla (Rich region) along Ziz at Bour El Khorbate, in Ferkla and in south of Taltaffarout in Ghéris, etc.

The proliferation of these pumping direct systems (trailer-pumping), from groundwater, is a worrying phenomenon. Overexploitation of groundwaters may, in extreme cases, dry up groundwater, especially because the region is too dry, or cause the salinization of the soils irrigated by these waters. This phenomenon is getting more erious with the development of mechanized irrigation and farming practices in the palm grove, threatening, accordingly, the oasis agricultural production’s sustainability. The excessive pumping, whose effects are more devastating to downstream areas, is further complicated by the increasing population growth.

The irrigation technique used in most cases is the gravity method (photograph 16), which is characterized by a low productivity. This irrigation system generates a lot of water loss, attributed to whether leakage and infiltration or evaporation of water in pipes and fields. According to the surveys conducted in the five 'Ksours', 94% of farmers use this system while the rest use localized irrigation.

An investigation on water-pumping conducted within a radius of 1 km in the area of Meski between 25-02-2004 and 02-03-2004 by the Regional Directorate of Hydraulics Guir--Rheris- Ziz (RDH-GRZ) revealed (Mahboub and Kelly, 2006) that:

50 ha are irrigated from ground waters;

23 pumping points taking from wells and boreholes;

150 l / s is the total flow operating in the region;

23 points in total in this layer

18 wells /23 are unauthorized and operate a flow of 115 l / s.

Photo 16: Gravity Irrigation

According to results of the investigations conducted in Bour El Khourbat (Abane et al., 2005; Ouhejjou, 2005; Kabiri, 2004), it is reported that the existence of more than 2000 powerful and functional traitor-pumps during the 70s. In 1985, the number of these stations was 573, only 41 of which were authorized. They pumped 580 l / s per day, which corresponds to about 19Mm3 per years.

According to the RDH GRZ and ORMVA / TF, 650 l / s enter, upstream, into the water and 125 l / s dissipate laterally. This means that 89% of the entering water is pumped while only 7% is permitted (RDH, 2003).

In 2001, a rate of 247.62 l / s of water was pumped at Bour El Khourbat on a total of 929.30 l / s in all oases of Ferkla, a share of 27%. The annual volume taken from this site is 8.61 Mm3 a total of 29 in Mm3 Ferkla (30%). The irrigated area in the same site is 813 ha compared to a total irrigated area of 3203.82 ha (25%)

In Bour El Khourbate, groundwater has been exploited, since a long time ago, by traditional means, well known in Tafilalet as 'Oughrour' and 'Khettarats' but also by a few trailer-pumps of cooperatives (ORMVA / TF, 1997, 1999 , 2001; Margat, 1958; Kabiri, 2005, 2004, 2003, 2001; Kabiri et al. 2001). This town has witnessed an increase use of more modern and more powerful trailer-pumps, since the early 70s, with rates up to 90 l / s (Margat, 1958; Kabiri, 2001, 2003, 2004 and 2005; Kabiri et al. 2001; Boudad and Kabiri, 2002, HR 2004).

From 1956 to 1957, three pumping stations (IRE 796/56, 798/56, 791/56) were installed in Ferkla, two of them in Bour El Khourbat. They worked with an annual charge of 0.5 million m3. In Lahssini,

downstream of Ferkla, another well is localized with the reference (IRE: 793/56). It has a diameter of 3m and a total depth of 23m. Its piezometric average depth is 12.4m. The power of the motor installed in this well equals 40 HP. It has an exploitation average flow of of 90l / S (Margat, 1958; Kabiri 2005).

All important sites for this study are concerned by pumping. In Meski, floods of few tributaries of the river of Ziz, releases from the dam of Hassan Eddakhil and especially Turonian outlet water (Meski source) and recently private wells and / or drillings, the main water resources. The excessive pumping at the level of this perimeter may result I the drying up of these resources.

In Bour El Khourbat, farmers obtain water from groundwater exclusively by the trailer-pumps. The number of operating pumps exceeded 700 at the beginning and is only a dozen now. The excessive pumping in this area has significantly contributed to the depletion of groundwater in the oasis of Ferkla. This site is suitable for "Bour" lands where immigrants from the region invested a lot in agriculture.

At Bouiya, farmers obtain water from groundwater through the three 'Khettarats', upstream trailer-pumps and flood waters. This site is positioned under the level of the prevailing winds. This complicates more farmers' life and work conditions.

Taltafraout owes its existence to the water of 'Khettarat' which taps water from the sub-Cenomanian. This site is currently experiencing an accelerated expansion of the agricultural lands towards the South of the palm grove by the development of trailer-pumps.

Achbarou is a site where agriculture has developed thanks to: i) sustainable water, ii) groundwater, iii) water divisions in the primary and the Precambrian. This groundwater was mobilized by the 'Khettarats' and now by few trailer-pumps.

In the oases of Tafilalet, water resources suffer from some polluting attacks. In the ponds of the river of Ziz and Ghéris, many urban units dump their waste in the rivers. Signs of eutrophication, due to pollution, appear in the reserve of the dam of Hassan Addakhil. The discharge of wastewater into waterproof pits (lost wells) consists of a contamination risk of groundwaters.

In a tributary of the river of Ziz called Oued Lahmer, downstream the city of Errachidia, wastewater is discharged directly into the river. An estimation of the flow of wastewater discharged by the city of Errachidia, made in 1994, based on drinking water consumption, indicated a value of 44.8 l / s, a total of 1.41 Mm3/ year.

Tourism development is another motive force that exerts pressures on water resources. Hotels' infrastructure and the development of upscale hotels necessitate the exploiation of the resources to meet the demands and requirements of customers, who often exceed the supply and the limits of the environment. For instance, very large quantities of water are required to meet the needs of the customers, almost exclusively foreigners, (to fill the swimming pools). This type of hotels or inns is located in the regions of Erfoud and Merzouga. There no big hotels in the studied sites, but few projects are planned in Meski.

Photo 17: patterns of use of the irrigation water (canal, 'seguia, trailer-pump and 'Khettarats')

2.1.3.3. State of the water resource and impacts

Groundwater resources used in Ziz, Ghèris and Maeder are valued at 264 Mm3/an, and the currently operated volume is estimated at 193 Mm3/an (RDH, 2007). The results of the piezometric follow- up of some groundwater (Turonian and Quaternary) in the period of 1998-2005 (Kelly and Mahboub, 2006) indicate the depletions of the source of Meski and hence the corresponding layer, this is most likely due to excessive pumping. Indeed, there is an overexploitation of the groundwater in the area of Meski and Bouzmou where twenty wells and boreholes draw water with an average flow of 12 l / s (Mahboub and Kelly, 2006). The majority of these wells have no water drawing authorization.

The combined effect of the intense exploitation and lack of food especially during the years of drought caused a dramatic decline of the alluvial sheet (Figure 25), which is the most requested, which resulted accordingly in the degradation of ecological conditions with serious consequences for the entire population and especially for farmers in the oasis (loss of years of labor, capitals, etc..), and those of Bour El Khourbat, in particularly.

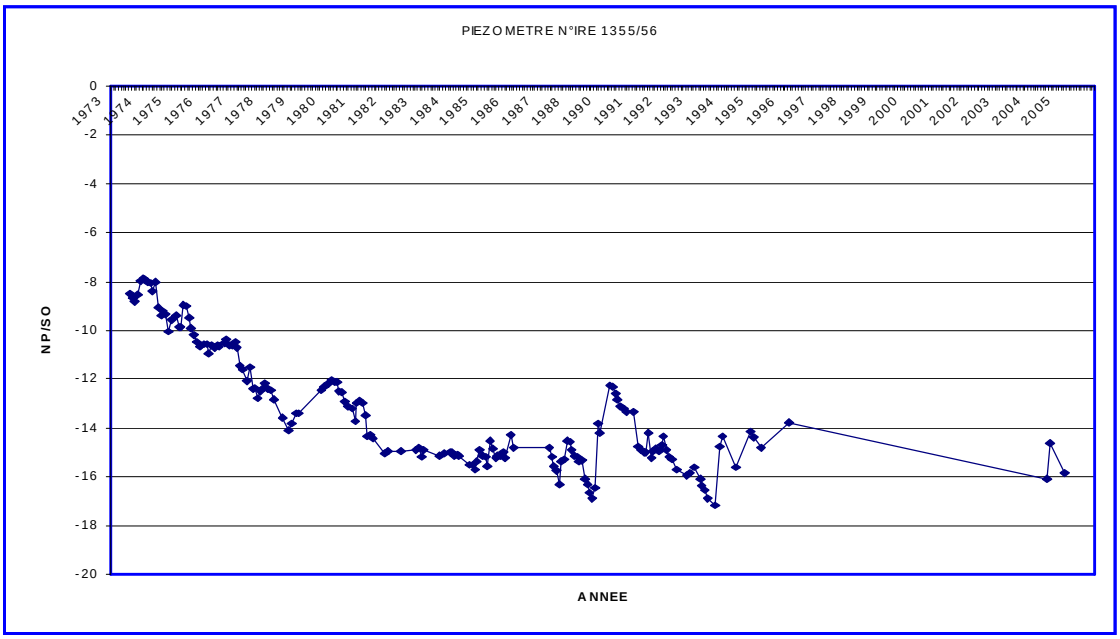


Figure 25: Evolution of the piezometric level of the groundwater of Ferkla (RDH, 2006)

Heavy pressures on groundwater resulted in the decline of water supplies and even their disappearance (eg Ferkla). This is illustrated by the number of wells in the area affiliated to the Office, a figure that reaches 7000 wells with a high concentration in Bour El Khourbat (over 2000), (1600 to 1700) in Rissani and (700 wells) in Erfoud, which are most threatened by saline risings.

The surveys and questionnaires conducted in Bour El Khourbat (Abane and al., 2005; Ouhejjou, 2005; Kabiri, 2004) indicate the existence of more than 2000 powerful and functional trailer-pumps during the 70s. In 1985, the number of these stations reached 573 only 41 of which were authorized. They charged 580 l / s per day, about 19 Mm3 per year.

Concerning the supply and demand for water, and according to available data (Mahboub and Kelly, 2006) covering the period of 1939 - 2004, supply has always exceeded the demand, particularly since the early 80s. However, the province of Errachidia, largely characterized by limited water resources, low and irregular precipitation and successive droughts, can make very fragile the balance supply - demand. The water table is most requested, but also the most vulnerable.

Investigations conducted within the framework of this project in the five 'Ksours', indicate that only 33.64% of respondents believe that water is available, while 66.36% claim that water is insufficient or even not available. This reveals that water resources in the area are inadequate and do not meet the needs of most farmers either for drinking or irrigation water. Approximately 47% of the population of those 'Ksours' is organized in a water management association and 53.1% are not.

The dam of Hassan Addakhil (Figure 26) with a capacity of 380 Mm3, dominates an area of 27,500 ha. Its condition was normal in 1972 because that year did not witness drought climate, unlike 1987 and 2001, and particularly 1987.

Figure 26: State of the dam of Hassan Addakhil in 1972, 1987 and 2001

The annual average contributions in site of the dam of Hassan Eddakhil from 1939 to 2005, indicate a decline and overexploitation of the resource. Indeed, the averages obtained (Mahboub and Kelly, 2006; Bousfoul and al. 2005) are:

1939-1971: 199 Mm3

1939-2005: 146 Mm3 (-24%)

1971-2005: 103 Mm3 (-87%)

Piezometric data available from 1991 to 2006 using various piezometers (Figure 27), installed and monitored by the RDHE (IRA 1334/48 and IRA1939/48 on the river of Ziz and IRE 963/47in Tarda river) indicte an overall decline at the piezometric level of the Turonian groundwater in the different areas of Errachidia and also those of the Quaternary (RDH, 2006). This decline in observed clearly from the mid 90s (-7m to -10 m). From 2001 to 2004, the piezometric level is below 10 m with, however, sometimes, signs of recovery (food?), quite tentative from 2004 (RDH 2006).

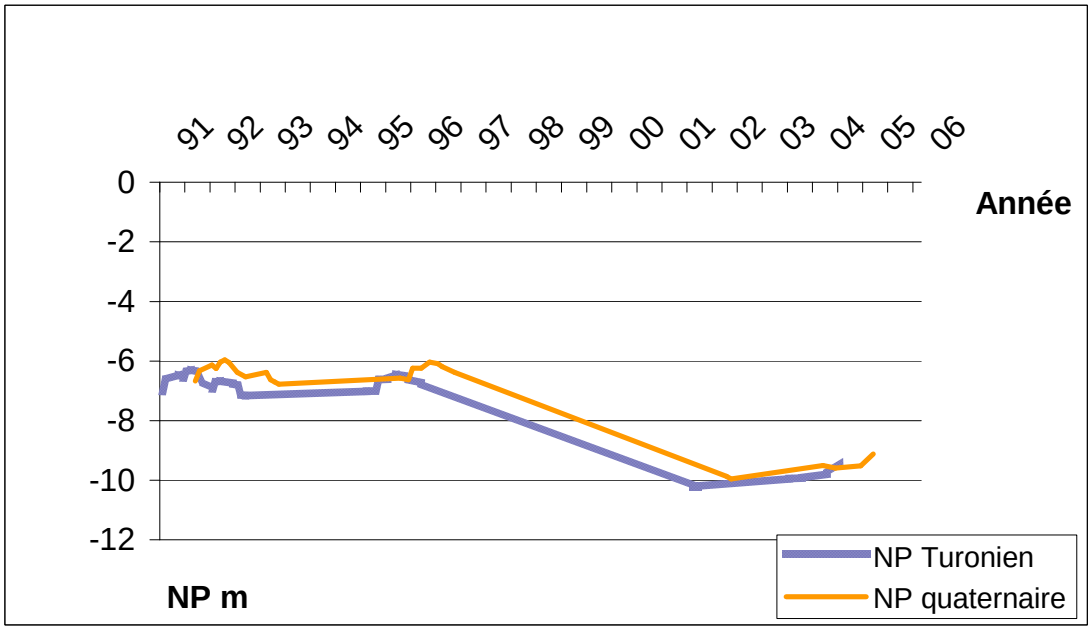


Figure 27: Piezometric fluctuation of the Turonian and Quaternary groundwater (IRE: 1939/48) from 1991 to 2006 (RD H2006)

Water in the Turonian of Meski and its immediate surrounding environment is, therefore, in a very alarming situation. The results obtained through the gauging follow-up of the Meski source indicate that there are three major periods of plight of the source (Deficiency) whose level is below the average of 0.2 m3 / s. These are the periods from 1972 to 1975, from 1982 to 1990 and from 2000.

The flow rate is superior to 0.1 m3 / s in the first period and tends to zero in the other two periods. The periods in which the source has a significant rate ("surplus") are from 1975 to 1982 and mainly the 90 decade, with a slight decline towards 1995, but not below 0.2 m3/s.

Figure 28 below illustrates the trend towards the depletion of this important source which plays the role of water supplier and attracts tourists.

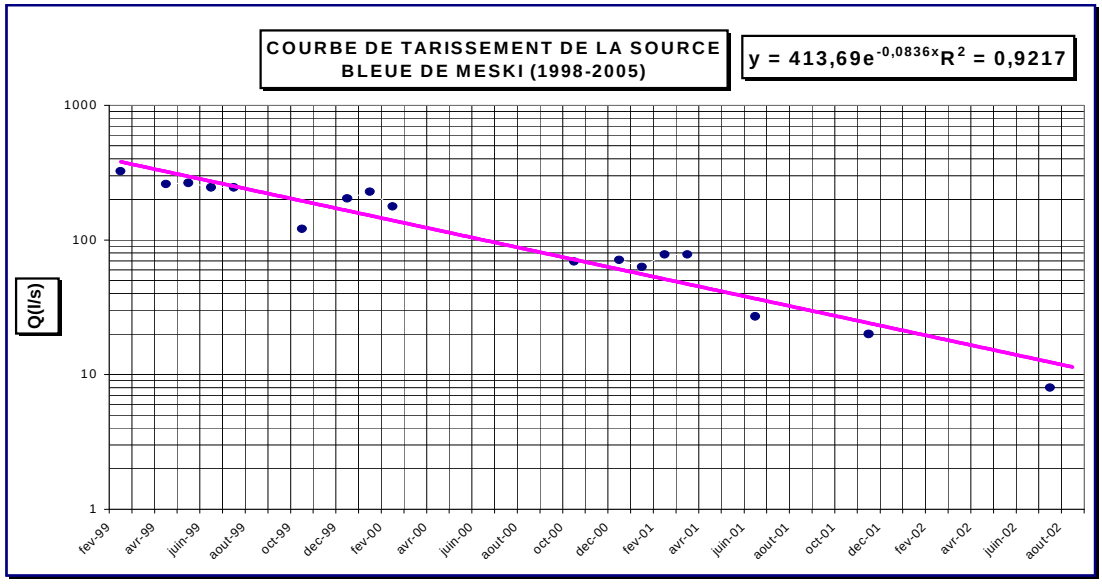


Figure 28: Hydrographs of the source of Meski (RDH, 2006)

Available data on the piezometric level of the water layer of Maeder since 1968 (Dayat of Maeder: IRA 192/65, 185/65 and 178/65) (Figure 29) indicates a decrease in its level from 1968 to 1979, then an increase is observed from 1980 for 5 years before gradually relapsing and tending towards zero from the early 90s until the present. The facts are the same as El Bour Khourbat (Ferkla).

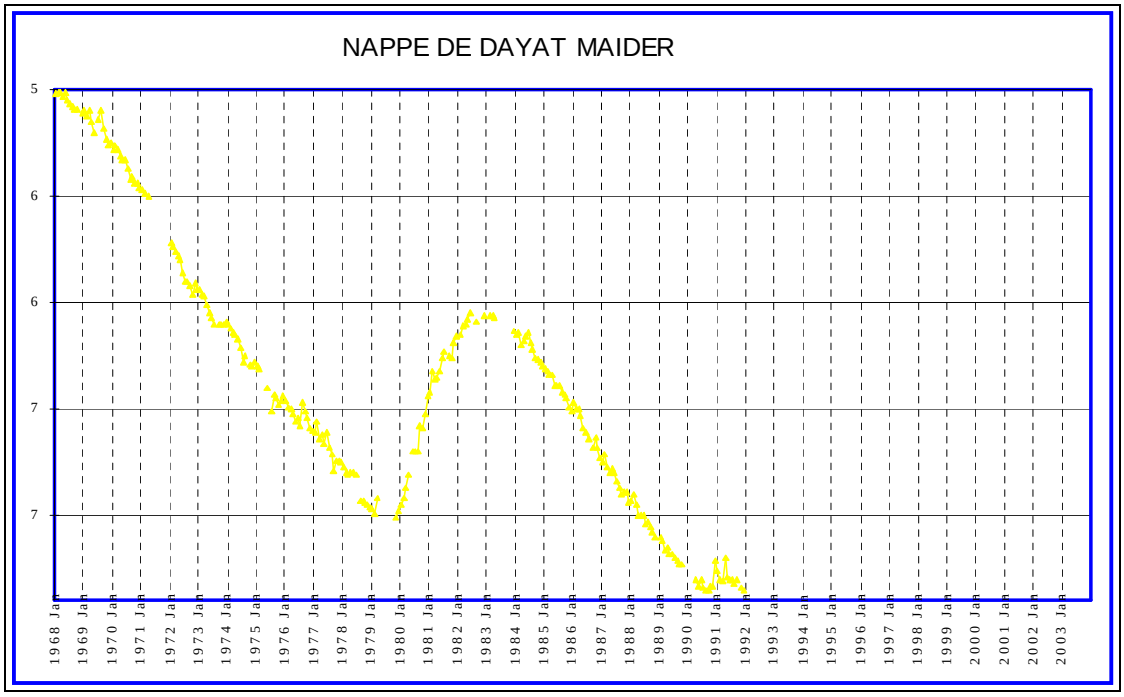


Figure 29 Evolution of the water of Dayet Maider (RDH, 2006)

The introduction of modern hydraulic systems instead of preferment traditional systems, such as' Khettarats', with practices characterized with high waste rates, imposing water drawings that are still important on the largest underground aquifer, has adversely altered the balance of supplies and resources, amplifying the consequences of drought and especially of an arid climate which seems to be a historical component (Boudad and Kabiri; Kabiri 2005).

The progressive and dramatic shortage of water resources is the combined result of the natural cycle of drought and anthropogenic activities. This shortage has negative impacts on both the agricultural productivity and human health and well being.

The majority of wells and 'Khettarats dried up and were accordingly abandoned. They become the first places for garbage par excellence or even septic tanks that pollute groundwater, especially this year when it is sufficiently powered. Several decisive factors participated, in recent years, in this shortage, mainly:

• Lack of and / or poor dam maintenance;

• poor water management of the dam of Hassan Addakhil;

• natural cycle marked by drought;

• human behavior and agricultural practices which do not consider the situation of shortage;

• The proliferation of trailer-pumps caused the almost total depletion of the reserve. Farmers were forced to deepen their wells, to dig for others and even to make tunnels to store water.

Water quality in the Oasis Systems of Tafilalet is threatened by pollution. Indeed, the province of Errachidia is characterized by the lack of sanitation and wastewater treatment. The liquid

discharges from urban centers are directly discharged into rivers, which have a low capacity of natural purification especially during the periods of low water level.

The results of tests carried out by the RDH 2003_2004 (Mahboub and Kelly, 2006) indicate that 22% of measured points (surface water) are beyond the standards required for NH4 +. The most affected sites (NH4 +> 8 mg / l) are located around the largest cities in the region; Goulmima, Errachidia and Rissani in the ponds of Ghèris and Ziz. Up these places water has a good quality (0.1 mg / l).

Social structures were created and evolved around water resources, very long time ago (Khrouch, 2006; Kabiri 2004, 2005). They are supervised by an elected 'Sheikh' and other representatives of each ethnic group situated in the 'Ksar' having water rights. The Sheikh's main role is the management, organization, follow-up, surveillance and also, if necessary, the adjustment of conflicts that may arise between the users (Khrouch, 2006; Kabiri, 2004, 2005). Not very long ago, this structure was marginalized and destabilized probably for political reasons. The result was total anarchy in the whole system, over-exploitation of natural resources, non maintenance of palm groves, non supervision and management of rangelands, etc. (Khrouch, 2006; Kabiri, 2004, 2005).

2.1.3.4. Answers

The depletion of surface waters during recent years prompted the ORMVA / TF to invest more in raising floodwaters, multiplying facilities along the rivers (Fig. 31; photograph 15) as the following list shows:

• along the main axis of the river of Ziz, the chain is followed by a series of diversion dams: Malou N'Ait Yaakoubi, Tamagourt, Mzizel, Tighrmatine, Tagoujilte, Ighjd, Tasarkloute, Talaatmaiite (on the river of Nzala), Guercia, Tagzirt, the dam of Adakhil Hassan, Aoufous, Douira, El Borouj, Oulad Zohra, Sifa, El Ghorfa, Mhaleik, Rassif, Ounguagua, Sefsaf, Slawa, BouHmara, Aghzir, Chmoukh and Tamzguidat to the North of Merzouga .

• On the main axis of of the river of Ghèris, the following diversion dams are succeeded downstream: Izeghm, Semgat, Timzguit, Signiss, Tadighoust, Tazoughmit, Tifounassine, Goulmima, Ouakka, Baakram, Tagountast and Mezlahagt (tributary: river of Nbour). On its tributary to Ferkla we meet also:

On the rivers of Tangarfa and Ifgh: Aït Labzam, Tayrza, Talalt, Tighfert, Ifgh

On the river of Ferkla (Toudgha): Sdaff, Mohamed V, Tamazirt, Aït Frah, Ait Hammou, Aït Assem, Lahssini. Downstream of the junction of the two rivers Ferkla and Tangarfa, another dam is recently constructed which is of Chtam, then dams of Frifira, Meroutcha and Mellab after the junction of the river of Tangarfa, of Ferkla and Sat.

On the river of Sat, there are dams of: Satt, Gardmeit and Frifira,

From the Ksar of Touroug, we can see, downstream, another series of these diversion dams: Lagfifat, Sidi Majbar, El Gara, Lahmidi, Moulay Ibrahim Monkara, Mharza. Throughout these different rivers, there are around 30 levels;

• in Maeder, the hydrographic network is composed from East to West: the river of Mssissi which bears the name of the large village it crosses, Reg river (or Fezzou wadi), which runs near the village of Alnif and Achbarou, Hssia river crossing Aït Saadane and Taghbalt wadi (or Tazarine) West through Tazarine, Taghbalt and Oum Jrane.

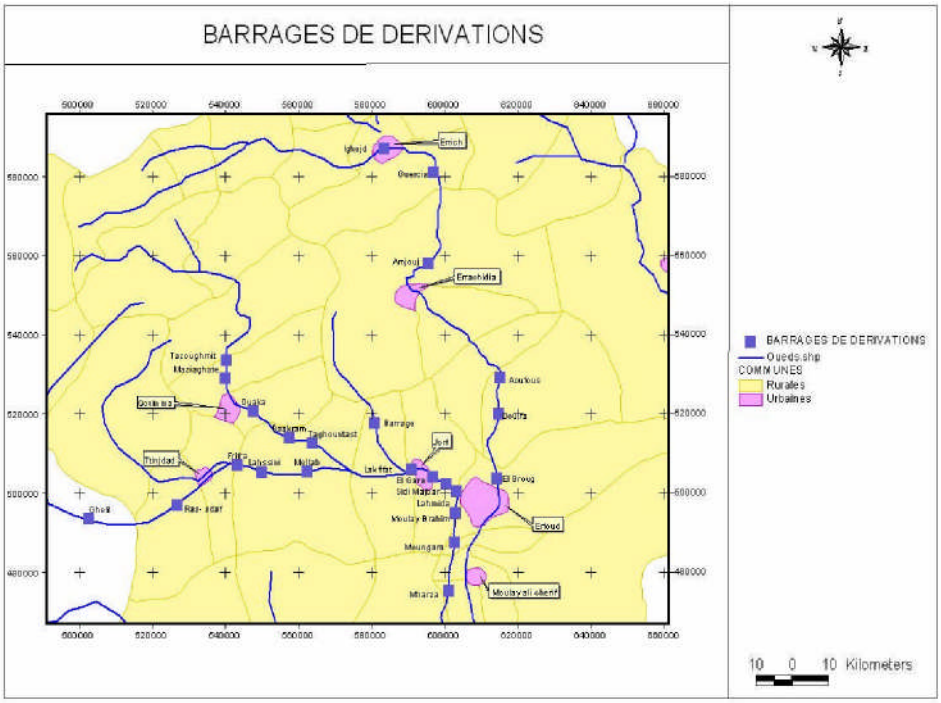


Figure 31: Diversion Dams in Tafilalet

These diversion dams (photograph 18) are generally constructed of concrete or masonry. Some more modest small dams are often washed away by floods. The majority of these structures is presented in the form of long weirs established in a straight line or broken across the bank of the river. The diversion structures may be a simple opening or may consist of several orifices, with or without guard gates, which tend to ensure the stability of flows. On the main axis of the rivers and / or their tributaries, there is a series of diversion dam, named by the name of the palm grove it irrigates.

To allow water to flow better in traditional canals ('souaguis'), dredging operations are carried out regularly by the communities which rely on the water these channels carry. Traditionally, the cleaning is done by all users in an operation called 'Twiza', an unpaid and voluntary activity(photograph 19).

Photo 18: a Dam in the river of Ferkla

Photo 19: Cleaning out 'Souaguis' in the oasis of Ferkla

Facing the problem of water wasting and within the context of water rarity and overuse, the Morocco took some technical, social, legislative and legal initiatives and commitments in order to rationalize the exploitation of this resource . The oasis agriculture through the establishment of its soil and the climatic conditions prevailing in the area consumes a lot of water and that is the reason why we are currently encouraging the use of irrigation techniques with a good productivity (Ouhejjou, 2005):

• To avoid seepage loss, the channels in the land of yesteryear are now often replaced by canals equipped with a waterproof surface, or by prefabricated channels, sealed and placed on supports so that their slope can be easily adjusted. This is illustrated in the palm groves of Ait Ben Omar, of Jorf and of Alnif by Japanese cooperation (JICA) (photograph 38);

• The storage basins are also used (photograph 39) to overcome the problem of water shortage as in the palm grove of Ait Ben Omar at Ferkla.

The irrigation carried out using the 'drip by drip' method (photographs, 38 and 39) starts to prove its importance in the region because farmers are convinced of the fact of resource rarity. Well performed, this technique can reduce water consumption because it does humidify just the portion of land located in the immediate vicinity of roots, and it limits the losses caused by evaporation, runoff or deep infiltration.

2.2. Regulatory Services

The climate is pre-saharien with a highly continental influence. It is conditioned by the Eastern High Atlas that stops ocean influences in the North and offers a characteristic bioclimatic layering between the zones of the North Mountains, areas of piedmont in the center and the areas of the palm groves to the South. Indeed, the climate is from North to South: sub-humid with cold and very cold winters, semi-arid to arid with a tempered and Saharan winter. Regarding palm groves, date producing palms create an indispensable microclimate favorable for the proper development of the underlying cultures. This space is also a barrier to the influences of the desert in the south. It can block desertification progress. These limits vary over time and space.

The oases also play an important role in restricting the movements of sand and the progress of desertification through the natural curtain of vegetation that they constitute at least locally, in some

areas. They also contribute to the fixation of carbon dioxide by storing the this gas in the biomass and soils. They, thus, participate in the regulation of climate through the reduction of greenhouse gases in the atmosphere.

The oases also have a role in recharging the water layer by reducing the velocity of flood waters and through the vegetation that allows the infiltration of water into the soil and hold it there.

These regulatory functions are very affected by the loss of vegetation, erosion of biodiversity and disruption of the functioning of the ecosystems and natural cycles. The pressures that induce these changes are anthropogenic (overexploitation of resources, changes in soil use, population growth, lack of awareness, etc.)..

2.3. Cultural Services

2.3.1. Tourism

Oases by their position in the middle of an arid landscape and dunes are considered to be a true haven for many tourists who are looking for a different lifestyle. With their diverse landscapes, the richness of their traditions and age-old cultures and the uniqueness of their climate and lifestyle, oases are privileged destinations of a certain category of tourists who seek to discover different natures and cultures. They also provide agricultural landscape; dominated by market garden activities, crops in terraces of grain and orchards sheltered by palm trees really contribute to the attraction of tourists.

The nature of the oasis region is characterized by exceptionally rich and varied landscapes between valleys, canyons, oases, mountains, springs and the desert. This richness and diversity allow the development of nature based activities, such as hiking or riding in the mountains, fishing sports practiced according to the seasons, exploring the wildlife, flora and sites that are still intact and virgin.

Oases have specificities likely to meet the needs and trends of tourism demands: need for individuality, seeking calm and air, authenticity and simplicity, desire for adventure and freedom, discovery of local traditions, etc.. Oases are areas of attractions for adventurers of the desert by their cool climate that contrasts the warm climate of the arid and Saharien, dominant in the South.

They are visited by a large number of tourists coming in search for an exotic world performed by their original landscapes, and by the presence of a typical architecture of 'Ksours' and ‘Kasbahs’. This architecture is a world unique heritage. It is distinguished by its defensive design, with generally four corner towers, sometimes decorated with rich motives in their upper parts.

Cultural tourism is practiced thanks to the presence of an architectural and urban heritage and the specific richness of traditions and customs observed in the different tribes of the region. The area is valued by tourism of nature that has its appeal in the landscape diversity and desert dunes of Merzouga, its lush palm groves, its' Khettarats', agriculture, etc. ..

The rich and varied Folklore, reflecting the strength of the oral culture, still very much alive, souks, which are considered as real crossroads of exchange and discovery of local products, sand dunes, in Merzouga for example, all attract tourists and visitors. The source of Meski, consisting of a swimming pool, two spas, Hammat My Ali Cherif and Hammat My Hachem, known for their therapeutic qualities of water, also attract several national and international tourists.

Water sources such as Meski’s (photograph 20) in the river of Ziz provides a relaxation and recreation environment for the surrounding population and the passengers. The site is home of a

major biodiversity of flora and fauna. It also provides the market of Errachidia with some agricultural products, namely vegetables.

Photo 20: recreation in the source of Meski

The oasis of Tafilalet is endowed with a rich and varied folklore, reflecting the strength of the oral culture, still very much alive which consists of a popular heritage and a means to communicate the local culture. We also meet the 'Moussems' which are places for meetings and festivities to the premises which are a real attraction for tourists. Date Festival, the Moussem of Lmichil and festivals of ‘Melhoun’ music are among the most known ‘Moussems’ in Tafilalet. 'Souks' are also a real crossroads of exchange and discovery of the local crafts that draw their authenticity and keep their secrets and originality in the oasis culture.

In addition to the sand dunes of Merzouga, which have an international reputation and are frequented by visitors during the months of July and August to take sand baths at high temperatures that reach sometimes 45 ° C or in order to see the fabulous sunrise and sunset behind the dunes from 200 to 250 m high, other sites are also valued in the tourist industry, such as the lodgings of Bour El Khourbat, Taltfraout in the outskirts of the city of Errachidia, etc.. A museum, displaying the local culture through an exhibition of ancient items of different sectors and local life, was recently established by the local population in Tinjdad; it was expanded on a large area located in the road of Tinjdad-Ouarzazate.

The oases of Tafilalet have other attractions that deserve to be valued, to name a few:

• Rissani with its 'Ksour (Abou Aam, Abar, Oulad El Halim), the ruins of Sijilmassa (archaeological site), Moulay Ali Cherif Mausoleum, tomb Zaouiat of Sidi El Ghazi. Mausoleum My Ali Chérif characterized by its Arab-Islamic architecture and represents the shining and glorious era of Tafilalet and makes it one of the great historical monuments in Morocco;

• Marble workshop on the road to Tinejdad: black marble studded with fossils from the quarry of Goniatite and Ksar Maadidi with its adobe walls, and finally

• 'casbahs' or' Ksours' built of backed clay without surfaces, forming a chain along the impressive valley of Ziz and Ghèris. Among these 'Ksours', are Ksar Igoulmimne, Ait Assem (Tinjdad), Meski, Haroun in Rissani , Maadidi in Erfoud, Abou Am Rissani, the Faida in Rissani.

2.3.1.1. Powers of change and pressures

Hotel infrastructures in the region of Errachidia progressed by more than 100% since 1994 and represent 28% of the capacity of the region. During recent years, the region has known the construction of several simple hotels and inns, in most cases built by local investors in response to a growing demand for different forms of tourism in the desert and the mountains, namely in Merzouga, etc.. (Monograph of the Province of Errachidia, Provincial Delegation of Tourism).

The site of Merzouga currently knows an increased investment of tourism and is likely to endanger the sustainability and quality of goods and services offered by the oases. If this trend continues, these goods and services will be damaged eventually.

2.3.1.2. State and Impacts

The province of Errachidia has a high tourist quality guaranteed by its geographical position and by its historical past and is thus characterized by the presence of a large number of distinct sites that annually receive many visitors.

Despite the great tourist values offered by the oases, this sector suffers from non-valuation of its products. Indeed, according to surveys, only the 'Ksar' of Meski benefits from the existence of the blue source developed as a swimming pool, offering visitors the peacefulness and tranquility. The valley that links it to the city of Errachidia consists also of a significant number of 'kasbahs' and remains, and of panoramic views offering to the area attractions and advantages for development of tourism projects.

In the five 'Ksour', there is a lack of tourist infrastructures. These 'Ksours' suffer from non-valuation of their tourism products and are just a passing zone for tourists to the towns of Ouarzazate and Zagora. They contribute to the creation of low incomes for tour guides, bazaars and fiscal service of towns.

According to respondents, two inns are being built at the 'Ksar' of Meski, an inn is situated in the 'Ksar' of Bouiya and of an unclassified hotel and another inn are in 'Ksar' of Taltafraout, a hotel restaurant and a guest house are in El Khorbat, while in Achbarou, these infrastructures are almost absent.

Tourism activity, often conducted in a commercial manner, is not much beneficiary for the local population. As a result, this population sees tourism just as a consumption of local goods and services without having a positive impact on neither the human welfare nor the local environment and its resources. The development of a tourism that respects natural and social environments, conducted with a spirit of equity and sustainability should be promoted in the region.

A well conducted tourist activity will have double advantages, it will allow economic growth in the region through the establishment of direct or indirect jobs and the promotion of a renewed and an innovative approach to planning that can save the region and ensure preservation of its environment.

2.3.1.3. Answers:

The policy of tourism development of the country is now geared towards the diversification of the Moroccan tourist product to be more attractive to potential tourists. Instead of focusing mainly on

seaside tourism, which is also the main component of the Moroccan tourist product, we try to encourage non-traditional destinations and new products.

Tourisms of the desert, nature, culture, etc. are niches, among others, that are explored. The oases of Tafilalet have great potential to be developed. Agencies and organizations involved in the tourist activity are prospecting the possibilities to better exploit the local potentials of the oases. Several initiatives of preservation of the oases, including the initiative of human development and so on, are being carried out and the tourism development activity of the oases is one of their worries.

2.3.2. Craftsmanship:

Craftsmanship in Tafilalet is of a traditional type. The oasis region is known for its rich and diversified craftsmanship quality that is a cultural heritage issued from age-old traditions and various influences. Indeed, this heritage is mainly characterized by the existence of several types of crafts activities, among which are the manufacture of carpets, pottery, basketwork, ceramics, sculpture, jewelry, etc.

Craftsmanship has a double interest, economic and cultural. It is an important lever in promoting the socio-economic population of the oases, by creating incomes to agricultural activity. The most common craftsmanship products in the five studied 'Ksours' are the making of baskets and bassinets, embroidery and traditional sewing performed at a women's club in Meski.

The marketing of products is manufactured locally in the neighboring markets. The trade organization has begun in some places but in a modest manner and the development of the sector is limited by the narrowness of outlets of the made products. The activity is still a privileged sector of employment and of self-employment, thanks to its low capital and its close relationship with the service trades.

Another well-known craftsmanship in the region is the work of the stone (photograph 21). These are the effects of drought that led people to give up working the land and to give this craftsmanship (Kabiri 2006).

Craftsmanship of the stone is concentrated in the region of Erfoud and exerts intense pressures on the fossiliferous careers, namely the Devonian limestone. The blocks are returned to the workshops, whose number exceeds twenty, and where work is very carefully done, first manually and then by machine.

The ornaments and decorations are made of exceptional beauty and demonstrate once again the ingenuity of the oases' man. This type of work greatly contributes to the tourist fame of the oases of Tafilalet around the world. Moreover, some of these exhibitions have been displayed outside of Morocco (USA, France, Germany, Spain, Italy, China, etc.).. The incomes from this activity were the source of living of several families and led to the settlement of young people and therefore limit the rural exodus and immigration.

Photo 21: Craftsmanship in fossiliferous stone of Tafilalet

2.3.2.1. Powers of change and pressures

The existence of rare and well preserved fossils (photograph 22) attracts more and more amateur and professional tourists. Accordingly, there is an increased pressure and an uncontrolled exploitation of minerals and fossils levels, of archaeological material, namely rock art print and recently meteorites.

Supply quarries of raw materials are not present in the study sites of this project but exist in the immediate vicinity of sites of Achbarou in Alnif and Bouiya in Erfoud and Fezna.

The population growth, openness to other regions, the ease of communication between different regions of Morocco and also with strangers, lack of employment opportunities in the region, and external demand are the major forces of change that generate pressures of over-exploitation and wastage of this resource that, beyond its commercial aspect, it also has cultural and historical interest. A passion towards the practice of this activity is likely to threaten the resource itself and therefore to eliminate the essential purpose of this craft.

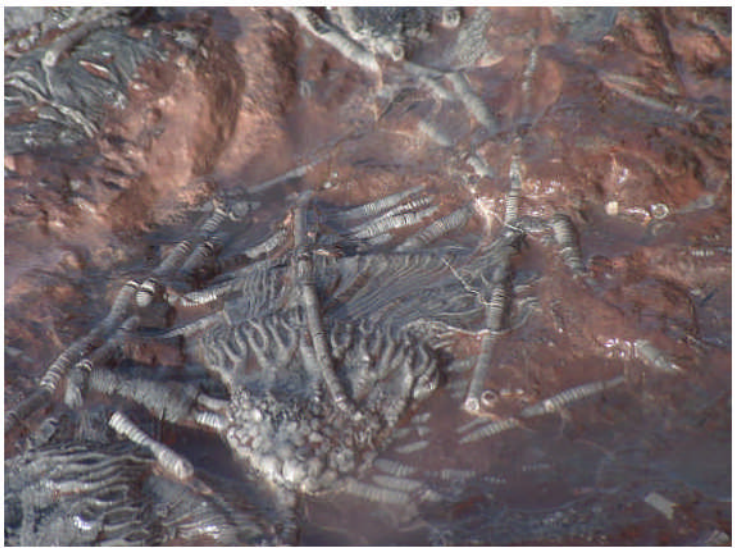


Photo 22: Fossil Echinoderms of Tafilalet

2.4. Conclusion of the chapter

The state of the ecosystem of the oasis of Tafilalet corresponds to the changes it suffers from because of the effect of natural or anthropic pressures performed within it.

The ecosystem, with all its components, presents a state of degradation resulting from both human activities and natural factors, showing an overuse of water and vegetation and causing specific problems such as siltation, desertification, economic poverty and the deterioration of living conditions. The apparent causes of this state are of two categories: socio-economic and natural.

The natural constraints are mainly the result of harshness of weather and soil conditions in the region. Successive droughts have severely limited the environment production and have increased its vulnerability. They have promoted wind and water erosion of soils, scarcity of water resources. Faced with this situation, rural people have developed aggressive attitudes towards the environment and the pressures on natural resources to ensure their survival.

The socio-economic constraints are mainly due to the dominance of farming carried out in a system dominated by micro-property which is characterized by low productivity. The region is also subject to other legal and institutional constraints and technical one as well; lack of coordination between different stakeholders, the non-integration of sector-based policies, and the absence of a clear and objective view for the protection of natural resources.

Non updating of legal texts regulating the rights of use of rangelands, the weakness of the intervention (research and development), aging and infection of planting of olive trees and palm trees are all problems that arise with acuity.

These environments are experiencing an overwhelming situation due to the acceleration of the effects of desertification, a highly irrational exploitation of water resources that are rarefying under the combined effect of the successive periods of drought, population growth and cultural practices completely inadequate to the production system of the oasis.

3. Scenarios

3.1 Introduction

A scenario is neither a prediction nor a projection. A scenario deals, however, with plausible situations in an attempt to explain a future evolution, either quantitatively or qualitatively. It can help developing and testing different strategies and action plans, synthesizing and communicating complex information to decision makers, providing information on changes in driving forces and clarifying the implications of potential future trajectories while providing some clarifications on the options for intervention.

As well, a scenario also helps understanding the differences in players' perspectives and exploring the consequences, educating and raising awareness of the public. A scenario is developed, accordingly, to give a broader perspective of the evolution of things to help decision makers to think about the future.

It also help understanding and communicating the assumptions on which people build their futures. There is a distinction between exploratory and anticipatory scenarios, between basic and alternative politic scenarios and between quantitative and qualitative or combined scenarios.

Exploratory scenarios are based on a reflection from the present into the future by exploring the development of uncertainties and change forces and testing the impact of the implementation of various policies.

Anticipatory scenarios, also called normative scenarios, are based on the reasoning from the future to the present, looking at how to achieve a specific end, and showing how we can reach an environmental objective. Basic scenarios, also called usual scenarios, are based on the description of the future in which no policy other than the current policy will be adopted.

Alternative scenarios take into account new policies or measures added to those already adopted or those for which an agreement has already been concluded, and where assumptions about major change forces differ from the usual assumptions.

Qualitative scenarios are considered as future development narrative scenarios. They are presented in a chronological history or in the form of diagrams, pictures or other illustrations. They consist of numerical estimations about the future development, and are presented as tables, graphs, maps etc. They usually use data chronological series and mathematical models.

To build different scenarios on the evolution of the oasis ecosystems, we will have to agree first on what is likely to persist over time and what is fundamentally uncertain. Taking into account the uncertainties, we can therefore identify the points upon which those different scenarios can be built.

3.2 Methodology

The design and use of scenarios is a highly participatory process that involves several perspectives and multiple and multidisciplinary views on a certain issue. Building Tafilalet scenarios, we conducted a very detailed analysis by some local individuals from different sectors and fields of activity. These individuals are well informed, aware of and curious to explore new ideas. In the workshop of scenario development, there was a strong involvement of the local people and civil society in general, in addition to some representatives of various public and private institutions.

The type of scenarios envisaged by this evaluation is the qualitative. They are narrative and were developed in a participatory way. They are presented in the form of chronological histories and are illustrated with diagrams and tables.

The main steps we followed to build the scenarios of Tafilalet are those advocated by EME:

- ✓ Inviting identified stakeholders during the diagnosis in a workshop for participatory and collaborative reflection on the possible scenarios;
- ✓ identifying future challenges, relying on the results of the diagnosis and the validation and enrichment of the workshop participants;
- ✓ imagining through a brainstorming and conducting further analysis of best and worst futures of the Oases of Tafilalet;
- ✓ reflecting on what should be considered as responses to target a desirable future;
- ✓ determining the ecosystem services to be considered to ensure their sustainability;
- ✓ identifying trends and current driving forces, even the most improbable, and which have significant impact on future developments;
- ✓ determining the number of future years to be considered and the interval period;
- ✓ considering revising the possible scenarios after receiving feedback.

3.3 Issues

Before starting building possible scenarios the main problems facing the ecosystem of the oases of Tafilalet were recalled. Three key issues arising from the already established diagnosis were submitted and then validated by the participants. The major conclusions of the diagnosis concerned the increasingly run low water resources, the declining biodiversity and the increasing

sand encroachment. These results were discussed by the participants and a consensus was reached on their veracity.

3.3.1 Water issue

Water is rare in the region due to the arid and desert climate in the area characterized by very low rainfall, irregularly distributed along the year. Although it is a scarce resource, water is subject to strong pressure induced by human activities and especially for less valuable agricultural purposes. Besides, the commonly used irrigation techniques, gravity and unimproved canal irrigation, are of low efficiency and consequently help wasting this resource.

Even if the use of more efficient irrigation techniques that help saving water, such as the sprinkler or localized irrigation techniques, is encouraged by the Moroccan government, allotting substantial subsidies, the use of these techniques remains always very low and is limited to individual initiatives that have low impact on the collective practices. The application of law 10-95 relative to water is not yet into force.

The use of such techniques is confronted by some reticence that have its origin in some ancestral habits which considered water as a private property and that its use must be free from any charges, contrary to the principle of 'user must pay' and to the state ownership of water , which the provisions of the new law stipulates. Tafilalet water is also polluted by nitrates, which probably have their origin in the use of agricultural inputs or domestic discharges that are often channeled into septic tanks.

Water scarcity and its irrational use threaten the human well being in different ways. The deterioration of the available water quality and quantity has a diverse effect on the human economic, social and health conditions, due to the lack of hygiene, the spread of waterborne diseases, loss of agricultural productivity, and hence income, change in the functioning of the communities, the creation of use and user conflicts, etc.

The question that arises here is how to ensure the availability of water resources in sufficient quantities and maintained quality for sustainable human welfare and ecosystem health, particularly when the current and predictable climate conditions are not clement.

3.3.2 The issue of ‘sand encroachment’

Sand encroachment is a real and permanent threat to the oases. This adversity has always been fought against since the old days by the local population. Recently, some actions were taken by some state institutions, governmental organizations or NGOs to fight this troublesome phenomenon.

The fight against sand encroachment is carried through mechanical or biological techniques. Several administrations are involved in this fight or trying to understand the sand encroachment

process. Human well-being is undoubtedly affected by the consequences of this phenomenon; through the creation of other charges to fight sand encroachment or for infrastructure rehabilitation (irrigation canals, roads, housing, etc.), loss of agricultural productivity or lands, the spread of diseases related to wind and transported particles such as eye diseases, etc.

The question here is how to control this phenomenon so that its impact on human well-being would be reduced and insignificant in the future.

3.3.3 Biodiversity degradation

thanks to their diversity, oases are home to a rich animal and plant biodiversity, often endemic and remarkable. This biodiversity is found both in the wild and domesticated in agriculture as well. Agro biodiversity provides a wide range of fruit trees with several species of date producing palms. Research has shown that in several places in the oases, wild plants are used by man for food or fodder, as fuel or for medicinal or flavoring purposes.

Most of these species are threatened with extinction mainly because of human actions. Indeed, lands supplying these plants are degraded due to the over-exploitation of rangelands and the disappearance of the governing rules of transhumance practices.

The number of species, animals or plants, is decreasing due to the increasing and accelerating rate of species extinction as is the case for mammals (hare, jackal, fox, etc.)., birds (eagle), reptiles (quillfish, cock, lizard, viper, cobra, etc.), amphibians (the endemic frog), bees (yellow bee), etc.

In agriculture, the loss of agro-biodiversity is resulted from the disappearance of clones of date producing palms and other fruit producing trees. This disappearance, caused by the shortage of water resulting from recurrent droughts or due to pathogenic attacks such as' Bayoud', constitutes a threat to the integrity and functioning of the oases ecosystem and also to the welfare of human beings, who depend on this ecosystem.

The question that arises here is how to protect this natural heritage for the benefit of both the ecosystem and human beings?

3.3.4 The issue of 'worsening of the living conditions'

Another issue was added by the participants of the workshop. It is the deterioration of the living conditions of the local population and social welfare. This deterioration is manifested in the loss of a number of ecosystem services such as food, water, security, landscape, etc. The low income obtained from agriculture which is considered as the backbone of the local economy, the high cost of living and the emergence of new requirements caused by market forces and the current pattern of consumption led to a relative decline in the local population's living standards.

The question that arises here is how to ensure descent living conditions and favorable to human development in an environment subject to natural and anthropogenic pressures?

3.4 Change driving forces

The exercise of scenario development focused on the four aforesaid issues. We have identified change driving forces responsible for each. The identification process consisted of a brainstorming session in which each participant was asked to register three driving forces that he considers important on separate sheets. The driving forces identified by the participants were discussed openly by the entire group of participants, seeking a consensus on the most significant change driving forces relative to the considered issues. These forces are listed below in relation to each considered issue.

3.4.1 Change driving forces relative to the issue of 'water':

- The weak mobilization of surface waters (a lot of surface waters flow during flood periods and are not mobilized due to the lack of hydraulic structures made for this purpose. These waters could, in addition groundwater, provide the agricultural sector with irrigation water);
- Population growth (as elsewhere in the Moroccan rural areas, population growth is important and the pressure on the limited natural resources increases, accordingly, in order to meet the basic needs of the population, and sometimes in response to a commercial demand . The more the population grows the more the needs for domestic and irrigation water increase, and the more the production of wastewater and solid waste, which contribute to the pollution of several water resources, increases);
- Lifestyle changes (due to the globalization of information, satellite television, internet, development of means of communication and transport, oases communities are no longer isolated and close. Today, other needs are created by market forces and the requirements imposed by a new lifestyle create additional pressure on water resources);
- The urban sprawl (with population growth, cities that were only limited to one or more 'Ksours' are extended following the construction of new housing units and infrastructures. These extensions require the use of water during the installation and the operation as well, which creates additional pressure on this resource whose quality is also threatened by domestic discharges);
- Tourism development (tourism sector is one of the most water demanding sectors. The development of the oasis tourism concept makes additional pressure on water resources);
- The agricultural expansion and intensification (the needs for irrigation water, caused by the agricultural intensification, which aims at more profitable speculation, and the agricultural

extension on the rangelands, which aims to increase crop production, require large water supplies, especially as irrigation techniques used are not efficient enough(gravity irrigation);

- Low level of awareness (the low level of people awareness about environmental problems and their present and future consequences, and the roles and functions the ecosystems play in the provision of goods and services that contribute to human well-being, is a driving force that causes the degradation of the natural environments, including water pollution and excessive use. The research of immediate benefits without worrying about the sustainability of this advantage leads to the overexploitation of common resources (groundwater) whose management is subject to open access);
- Non-application of or insufficient respect to the laws in force (the absence of application decrees of certain laws (the protection of the environment, impact studies, law on water, law on waste), non-compliance to the rules, laws or customs in force concerning the use of water which led to anarchy in the use of this resource, non-application of the 'user pays' and' polluter pays' principles, environmental impact studies are absent or inadequate, etc.).

3.4.2 Change driving forces relative to the issue of 'sand encroachment':

- The use of non-suitable means and techniques to fight sand encroachment (the fight against sand encroachment requires the use of mechanical, biological or combined mechanical-biological fixing techniques. In both cases, pertinent choices must be made on the biological material used, the mechanical structures to build, the location of these means, and many other parameters essential to the success of the operation. Several means adopted to fight sand encroachment have not reached the expected goal because of their low efficiency);
- Excessive livestock (the studied area has an economy based on the agricultural exploitation associated with an extensive breeding of sheep and goats. Plants are over-grazed which allows sand to invade agricultural lands and infrastructures);
- The agricultural expansion (the expansion of agriculture at the expense of the lands occupied by natural vegetation increases wind erosion and hence the movement of sand);
- The uncontrolled urban sprawl (the expansion of anarchical constructions eliminates the natural barriers that help preventing sand encroachment);
- Low level of awareness (the educational low level of the local population and the lack of awareness of the dangers of sand encroachment on infrastructures, agricultural lands, housing units and human health as well, are a flaw in the fight against this scourge and eradicate its entire causes).

3.4.3 Change driving forces relative to 'Biodiversity':

- Population growth (population growth creates additional needs for food and medicine. Several aromatic and medicinal plants are exploited in the region for both domestic and marketing purposes. The local wildlife is hunted in an organized and regulated way and traditionally and illegally as well. Recently, an overexploitation of biological resources has been witnessed in the region because of, inter alia, population growth);
- The urban sprawl (the expansion of residential or infrastructural buildings is carried out at the expense of biodiversity natural area);
- Lack of conservation of ex-situ species (no programs for the conservation of ex-situ biodiversity with the establishment of gene banks);
- Water irrational management (the use of water to meet development needs (food production through agriculture, drinking water, etc., without worrying about the ecological major role water plays for the animal and plant biodiversity, is one of the driving forces behind biodiversity degradation, especially moist lands (construction of a dam on the river of Ziz, etc.));
- Desertification (the phenomenon of desertification causes change the conditions of the ecosystems and several species accordingly lose the conditions favorable for their development or their subsistence);
- Lifestyle changes (change in consumption patterns, behavior and way of living creates new needs. The search for additional income to meet these needs lead to the overexploitation of biological resources by the population);
- Change in land use (agricultural expansion at the expense of natural ecosystems contributes to the diminishing of wildlife richness, relative to both animals and plants. Intensified agriculture based on monoculture, selected plant varieties and seeds and on other agricultural inputs contributes to the loss of the agro-biodiversity. Besides, the conversion of natural lands into lands for the construction of housing units and infrastructures reduces the natural space and habitats of the flora and fauna);
- The market forces (to become competitive in the market and to meet the demand for a given product quality, farmers are moving towards the high output and commercial value productions. Some varieties and cultivars of the local date producing palms or fruit producing trees disappeared in the region to make room for other introduced or locally selected varieties. This contributes to the loss of the local biodiversity, which, even if it is probably not very productive according to a commercial point of view, could have other unknown or probably neglected virtues);
- Locust invasion (the fight against locust invasion by means of insecticide treatments through aerial spraying contributes to the killing of several animals, birds, reptiles and

others and also affects several plants. Biodiversity, accordingly, suffers from adverse consequences);

- The agricultural expansion and intensification (see change in land use);
- Tourism development (tourism, with the attendance of the natural environments, hunting practices or the harmful results of gear motors on the fragile natural areas, affects the tranquility and the integrity of the natural habitats).

3.4.4 Change driving forces relative to the issue of the 'worsening of the living conditions':

- Accentuation of poverty (lack of employment opportunities, the reduction of the productivity activities that are the basis of the local economy, weather conditions that become increasingly difficult, etc. accentuate the economic poverty of the local population and force this population to be increasingly dependent on natural resources whose stock continues to decrease with time. The people get poorer and their living conditions are deteriorating due to the lack of financial means necessary to obtain adequate food, drugs to fight diseases, children school fees, drinking water and adequate sanitation system, etc.).
- Ignorance / Illiteracy (ignorance and illiteracy characterize a large portion of the active population, which are therefore poorly skilled and less able to claim more remunerative work positions, both in the region or when they migrated to other parts of the kingdom. This lack of qualification makes the population more vulnerable. They are sentenced, accordingly, to perform low-paid work activities such as farm workers, laborers in construction activities, etc.);
- Exclusion and marginalization (for its climate and its natural potential, the area does not attract many investors, either at the agricultural or the industrial level. Due to its low economic development, the area is relatively marginalized. Besides, like many rural areas in Morocco, some communities are relatively isolated and difficult to access because of the impassability of their tracks. The population are therefore excluded and marginalized with a limited access to health and educational services education.);
- Change of the way of living (because of the globalization of information , electricity introduction and all accompanying equipments: satellite TV, agricultural, craft, or industrial machines, fridge, etc., the lifestyle in the countryside has changed. Nowadays, many changes occurred in the practice of the farmer profession. Other professions have been introduced as well. New needs are created either by necessity or in pursuit of a more luxury and well-being. Emigration has increased because of the openness to the outside world which attracts the young people of the villages by the gleaming of its easy life image, and communication easiness and the availability of transport means, etc. Men often emigrate and abandon their wives in the village with limited resources which obliges them to be dependent on money transfers from their husbands);

- Market forces (the market based on supply and demand and on monetary exchange, offers new consumption and equipment products and demands new products and services which have never existed in the oases. These forces encourage people to adapt themselves to new production, consumption and living conditions. A lot of needs that did not exist are now a necessity);
- Isolation (some places lack means of communication and transport. The communities are either isolated or far away from basic public services such as health centers or schools. Market access is sometimes very difficult and goods supply or the marketing of local products are disabled, making the living conditions of the local population more difficult indeed).

3.5 Classification of the driving forces by category, importance and uncertainty

A recapitulation and a classification of the drivers which are behind the four identified issues were made by the participants at the workshop. After collecting and eliminating redundancies, change driving forces that cause or exacerbate the four identified issues, not by order of importance, are as follows:

A. Isolation
B. Agricultural expansion and intensification
C. Ignorance / Illiteracy
D. Poverty
E. Population growth
F. Excessive livestock
G. Market forces
H. Change in the way of living
I. Exclusion and marginalization
J. Inadequate mobilization of surface water
K. Inadequate governance
L. Urban sprawl
M. Changes in land use
N. Tourism Development
O. Locust invasion

3.5.1 Categorization

Among these forces, some have a direct impact and others have an indirect impact. A direct driving force directly affects the functioning of the ecosystems and its impact is likely to be measured to a certain degree of accuracy, while an indirect driving force diffusely operates, often acting on one or more direct driving force(s). The influence of an indirect driving force can be determined only through an understanding of its impacts on direct driving forces. In Table 3, below,

we differentiate between the driving forces identified by their direct or indirect impact. We distinguish nine indirect driving forces and six direct driving forces. The degree of interaction and influence of a direct driving force over other indirect driving forces is illustrated by the table below. The symbol '*****' is used to signify the existence of the influence and the number of symbols which measure the degree of impact (Table 4). The more important the impact is the more the number of symbols is important.

For instance, poor governance has a significant impact on the agricultural expansion and intensification because the laws and regulations in force relative to irrigation water, the use of agricultural inputs and spatial planning are not enforced rigorously. Governance has a limited impact on locust invasion as well. It can be explained by the methods used to fight this scourge, which are often not effective and efficient.

Change driving forces	Direct Impact	Indirect Impact
A. Inadequate governance		X
B. Agricultural expansion and intensification	X	
C. Ignorance / Illiteracy		X
D. Poverty		X
E. Population growth		X
F. Excessive livestock	X	
G. Market forces		X
H. Change in the way of living		X
I. Exclusion and marginalization		X
J. Inadequate mobilization of surface water		X
K. Isolation		X
L. Urban sprawl		
M. Changes in land use	X	
N. Tourism Development	X	
O. Locust invasion	X	
	X	

Table 3: Classification of the driving forces according to their direct or indirect impact

3.5.2 Ranking by order of importance

Besides, another classification of these driving forces was established depending on the pressure they make on the ecosystem. This classification was carried out by comparing, two by two, the driving forces (pair comparison), then voting for the most important, in terms of impact, between the two compared forces.

Before seeking the vote of the participants, an explanation of the two driving forces in competition and how they act on the identified issues was given by the facilitator of the workshop and

discussed briefly by assistance to better clarify the issues and allow the participants to assess the significance of this or that driving force.

The vote is made by absolute majority. In case of equality, the challenges shall be re-explained and vote takes place for the second time, and if it is not settled again, the leader shall have the casting vote. After comparison of all pairs, the whole number of times the driving forces are quoted is calculated, with the corresponding notes assigned to them. Then the classification is carried out by order of importance. The results are reported in Table 5 below.

DF	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Note	3	9	10	9	7	10	1	13	7	6	14	3	8	0	5
Rank	9	4	3	4	6	3	10	2	6	7	1	9	5	11	8

Table 5: Classification by order of importance of the driving forces

The resulting ranking of the first pair classification ended up in vote equality concerning some driving forces, as shown in Table 5 (see above). To separate the driving forces that occupy the same rank, a second vote was conducted after discussing analyzing the pressure each force makes on the ecosystem for the second time. The final obtained ranking is presented in the second column of Table 6, below.

1st ranking	**2nd ranking**	**Change driving forces**
1.K	1) K	Inadequate governance
2. H	2) H	Change in lifestyle
3. F-C	3) C	Ignorance / Illiteracy
	4) F	Excessive livestock
4. D-B	5) D	Poverty
	6) B	Agricultural expansion and intensification
5. M	7) M	Change in land uses
6. E-I	8) E	Population growth
	9) I	Marginalization and exclusion
7. J	10) J	Insufficient surface water
8. O	11) O	Locust Invasion
9. AL	12) A	Isolation
	13) L	Urban Sprawl
10. G	14) G	Market forces
11. N	15) N	Tourism Development

	Direct change driving forces					
Indirect change driving forces	**Agricultural expansion and intensification**	**Excessive livestock**	**Urban sprawl**	**Change in land uses**	**Tourism development**	**Locust invasion**
Inadequate governance	***	**	***	**	*	*
Ignorance / Illiteracy	**	*	**	**	*	*
Poverty	***	***	*	**	*	-
Population growth	***	**	***	**	*	-
Market forces	***	**	*	**	**	-
Change in the way of living	**	**	***	*	**	-
Exclusion and marginalization	*	*	*	**	*	-
Inadequate mobilization of surface water	***	**	*	*	-	-
Isolation	**	**	*	**	-	*

Table 4: Relation between direct and indirect change driving forces

3.5.3 Classification by degree of uncertainty

A second classification of these forces was made according to the degree of uncertainty. In this classification, only the top ten driving forces, according to their importance, were considered. For this classification, each driving force was discussed in addition to its probable tendencies based on its past evolution, taking into consideration the current socio-economic context and the implemented or programmed planning. Moreover, a degree of uncertainty for its probable development was associated to each relevant force, reaching a consensus by the participants in this regard. Table 7, below, illustrates the result of this uncertainty associated to the different driving forces according to their importance.

Change driving forces	**Degree of importance**	**Degree of uncertainty (%)**
Inadequate governance	10	50
Change in the way of living	9	30
Ignorance / Illiteracy	8	30
Excessive livestock	7	20
Poverty	6	70
Agricultural expansion and intensification	5	50
Change in land uses	4	70
Population growth	3	10
Exclusion and marginalization	2	30
Insufficient surface water	1	40

Table 7: The degree of uncertainty associated with driving forces

Figure 32, below, illustrates the distribution of the driving forces according to the degrees of importance and uncertainty. This diagram proves that the most important and the most uncertain two driving forces in the future are the inadequate governance and economic poverty. These driving forces are called critical uncertainties.

For governance, the participants judged just 50% of probability, if the efforts made by the Government are maintained and effectively concretized, there will be a strictness in the application of existing laws (Law 10-95 on water, Law 11-03 on the protection and enhancement of the environment, Law 12-03 relative to impact studies on the environment, Law 13-03 relative to air pollution, Law on waste, forest laws (Royal Edict of 1917 and 1923 and other specific regulations), etc.) and an acceleration in the promulgation of new laws to fill the existing gap (law relative to the protected zones, etc.), or in the modernization of other laws that are not adapted to the current socio-economic and natural contexts,

and also in order to comply with international commitments especially with regard to the three Rio Conventions (biodiversity, climate change and the fight against desertification).

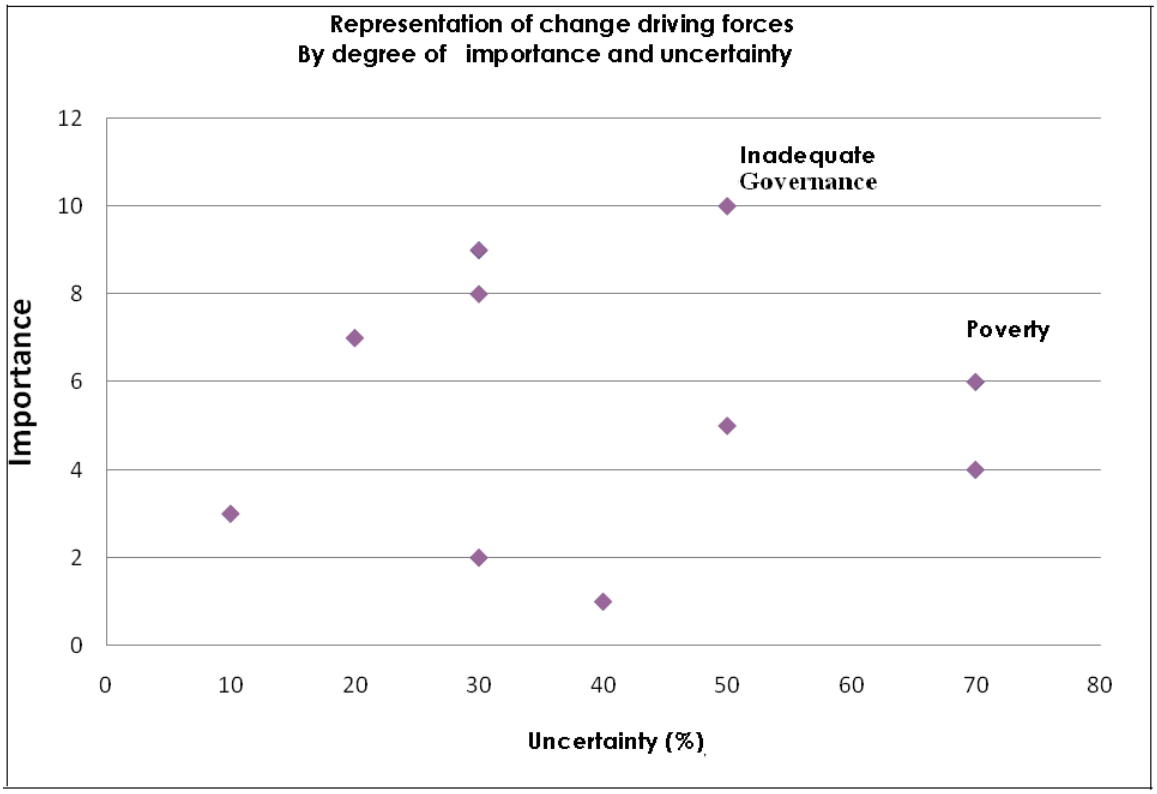


Figure 32: Driving forces according to the degree of importance and uncertainty

For the economic poverty, the participants are 70% uncertain about the development of this force in the future. In addition to the risk associated with the success of development projects, carried out in the region, and their efficiency. A considerable uncertainty is associated with the evolution of natural conditions related to climate change which will have an impact on water resources, agricultural productivity, human health, etc.

The way of living of the local population is very dependent on the exploitation of natural resources, especially water and soil which consist of the two main supports of agriculture, which is considered as the backbone of the economy through its two components, Crop and animal productions. Soil in the region is threatened by the increase in salt content and sand encroachment, whereas water is threatened by overexploitation and rainfall decreasing. The underlying development of these two risk factors is very unlikely. They are linked to both climatic conditions and the evolution of socio-economic, legislative and institutional conditions, in the region.

3.6 Scenarios

Future scenarios for the oasis of Tafilalet were developed, for a temporal period of twenty years, according to the two critical uncertainties: economic poverty and governance. Four scenarios were developed: A (Oasis of Tafilalet), characterized by the elimination of economic poverty and the improvement of governance, B characterized by the elimination of economic poverty but a decline in the quality of governance, C (SOS Tafilalet) characterized by an increase in economic poverty and a decline in the quality of governance, and D (Tafilalet Gazelle), characterized by an improvement in the quality of governance with an increase of economic poverty. These four scenarios are illustrated in Figure 33 below and are described in narrative and temporal diagrams.

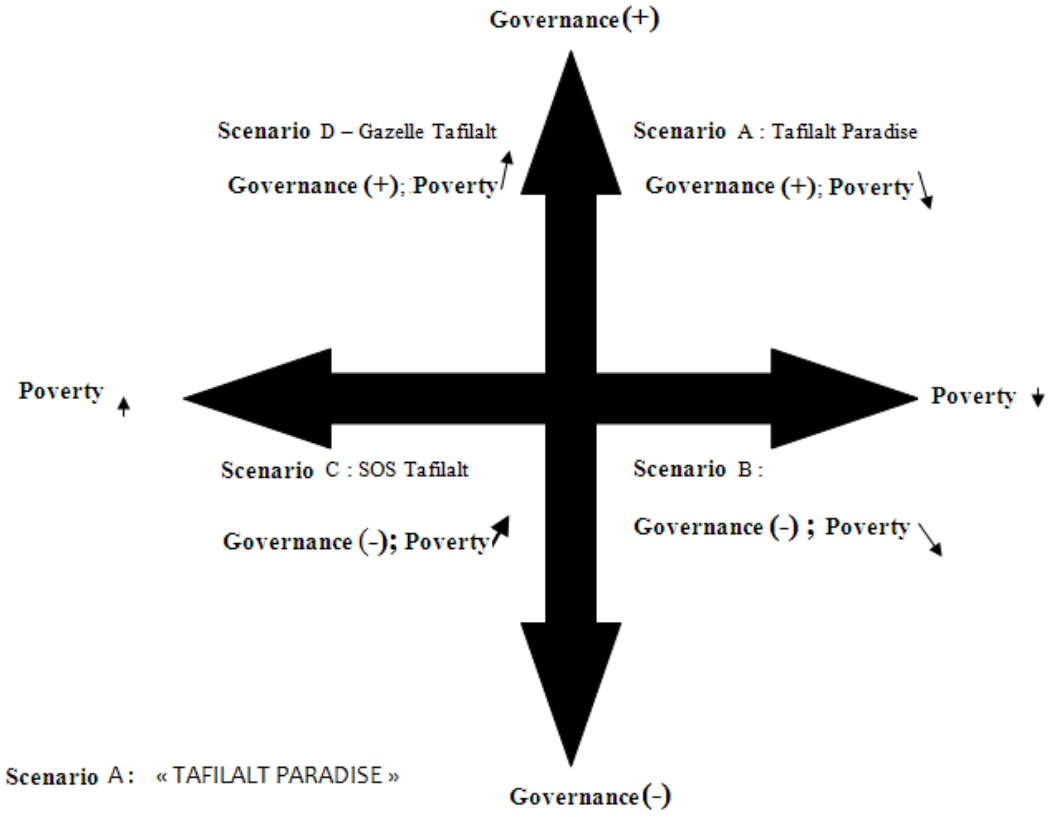


Figure 33: Diagram of the scenarios

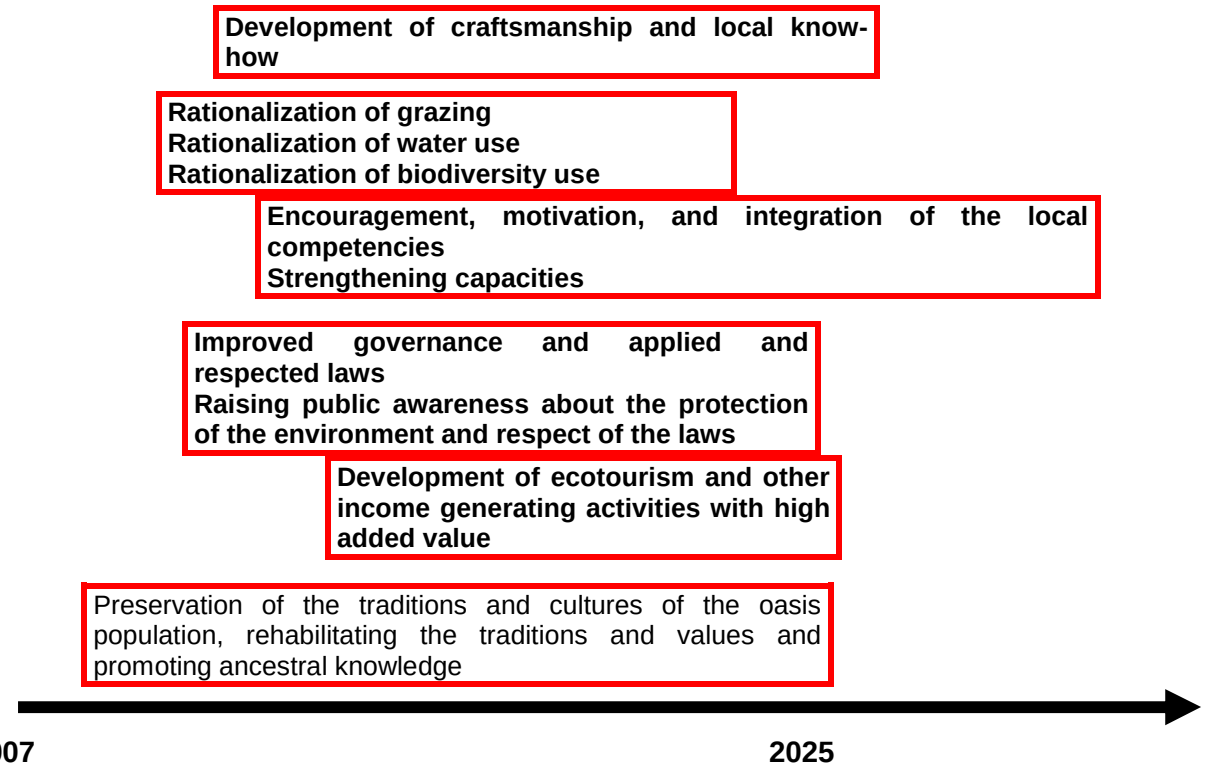
3.6.1 Scenario A: Tafilalet paradise

Currently, poverty is a fact in the region and the laws relative to the management of natural resources and environmental protection are not fully implemented. This failure is one of the reasons behind the irrational use of resources like water, rangelands, wildlife and others.

Scenario A, named by the participants as 'Tafilalet paradise', is a scenario based on the assumptions that poverty rate will increase in Tafilalet and governance will be improved in the coming years so that the laws in force and the traditional laws "*ALORF*" will be properly applied and poverty will disappear

eventually. This scenario describes the desired future and its main features are illustrated by the sequence diagram (Figure 34), below.

To move from current to the desired state, the laws already promulgated (Law 10-75 relative to water , Law 12-03 on the impact studies on the environment, Law 11-03 relative to the protection and enhancement of the environment, Law 13-03 relative to air, Law relative to waste, etc.) should, in ten years, be effectively and efficiently applied and have their entirely implementing decrees promulgated, and new laws should also be promulgated and implemented such as the law relative to the protected zones and the law on the coast, currently being developed.



Scenario A: "TAFILALT PARADISE": SEQUENTIAL DIAGRAM

Figure 34: Temporal diagram of scenario A

Programs to raise public awareness about the need and urgency to respect the laws and comply with the rules with a spirit of citizenship and collective responsibility are implemented. This will have a positive impact on the management of natural resources by ensuring the rational use and the total transparency in their governance.

Besides, in ten years, it is expected that the National Initiative for Human Development will reap its fruits by raising funds and resources to generate employment opportunities for the benefit of the poor local population. Some initiatives of the development and the exploitation of the potentials of the region within the context of sustainable tourism, ecotourism and income generating activities with high

added value will be carried out leading the region through a process of sustainable development. With the increasing of the income of local population and the implementation of formal educational, literacy and family planning awareness programs, there will be a decrease in the fertility rates and population growth will decline, accordingly.

With the new oasis development programs, established in the region (UNDP project coordinated by the Directorate of Land Use, the MCA project funded by USAID and led by the Prime minister, etc.), a dynamic of mobilization of financial resources and creation of domino effect for other activity sectors will be promoted in the oases and will have beneficial effects on the income of the local population.

For the biodiversity protection, laws in force such as the forestry legislations, laws on hunting and fishing will be applied with great effectiveness. The implementing decrees of other laws relative to the environmental protection (Law relative to water, Law on Environmental Protection, Law relative to impact studies on the environment, Law on air pollution, Law relative to waste, etc.) will have their implementing decrees published. The laws will be implemented effectively with full respect of their application and implementation. The law relative to the protected zones and its implementing decrees will see the daylight and will be implemented accordingly.

The exploitation of natural resources, forestry or other, will be rationalized to ensure the sustainability of these goods and services. Grazing in collective or private lands will be organized according to the traditional methods (Al ORF) of the management of common resources with respect to the carrying capacity of each place, providing a rotation to allow the regeneration of the place.

The local population and civil society will be involved in the reflection on the development of local laws and regulations to have the right to voice their views and grievances to ensure that laws developed are adapted to the oasis context. The authorities in charge of the enforcement of laws and regulations will have sufficient human and financial resources, to ensure proper implementation of these laws.

Local traditional organizations will resume their place in the management of the resources and the conflicts of their communities by applying the consensual customary laws. Local know-how concerning the management and exploitation of natural resources will be promoted and have a positive impact on the local people. Interest will be given to the traditional cultivation varieties and the local animal breeds to save and maintain the richness of the agro-biodiversity of the region.

Water is a scarce resource and strategic for the economy, the ecosystems and for the local population. It will be used in a rational manner through its maximum mobilization by means of hydraulic structures, and also through the parsimonious use of this resource, reducing thus its consumption in agriculture by the use of efficient irrigation techniques that are currently subsidized by the government up to 60% of the investment, using agricultural speculations that are less demanding

of water, eliminating any source of pollution which might affect its quality or quantity, adopting and using economic technologies or water recycling technologies in the domestic or other uses.

Formal and informal awareness and educational programs on the importance of water and its scarcity will be implemented in schools and for adult education (literacy). The initial and / or continuous training programs will be designed to integrate the curricula of the educational concepts for a sustainable future rather than being only limited to actions or to specific activities that tackle environmental issues.

Some initiatives aiming to strengthen the capacities of educators will be implemented to immerse them in the concept of sustainable development and show them how to act locally to implant the three economic, social and environmental dimensions in the reflection and daily behaviors of students.

In ten years, oasis traditions and cultures will be preserved. Local practices that strengthen the bonds of cooperation and communication between the members of the same community will be restored; for instance the concept of 'Touiza', which means the achievement of a collective work by all members of the community for the benefit of a member of this community. This concept can be followed in case of the incapacity of a member of the community to perform the tasks required, alone, or in case where people, in turn, help each other in order to perform seasonal works, such as the harvest for example.

This practice is very useful in such areas where people do not often have money to recruit salaried employees. Its interest also lies in the fact of consolidating cooperation bonds between the members of the same community and reducing interest conflicts that can be the result of weak communication between the contenders.

The collective way of living in a place surrounded by an outer wall, 'Ksar', adapted in the region contributes greatly to the consolidation of ties between the members of the community. True, such place seems to be designed as a collective residence. Yet individual private lives are respected too, in a place where people feel all concerned by the same worries of safety and well being. It is a lifestyle well adapted to the local climate conditions, with cold winters and hot summers.

This architecture and this puddle clay earth type of construction improve the internal conditions of thermal comfort, by reducing heat losses during winter and isolating thermally the internal atmosphere from the external heat, while ensuring a good flow of air inside the residences. This kind of architecture will be maintained and will continue to use the local building materials.

The feeling of living within a community governed by rules and customs relative to the population of the oases will be restored and the authority of the spiritual leaders ('Amghar') of the communities and the village councils ('Jemaa') will be maintained and strengthened to continue establishing the rules of communal conduct and a group deontology. The usual conflicts on the use of natural resources will be solved locally and the management of common resources will be restored and respected by the entire community of the oasis, such as the management of rangelands, water management, etc.

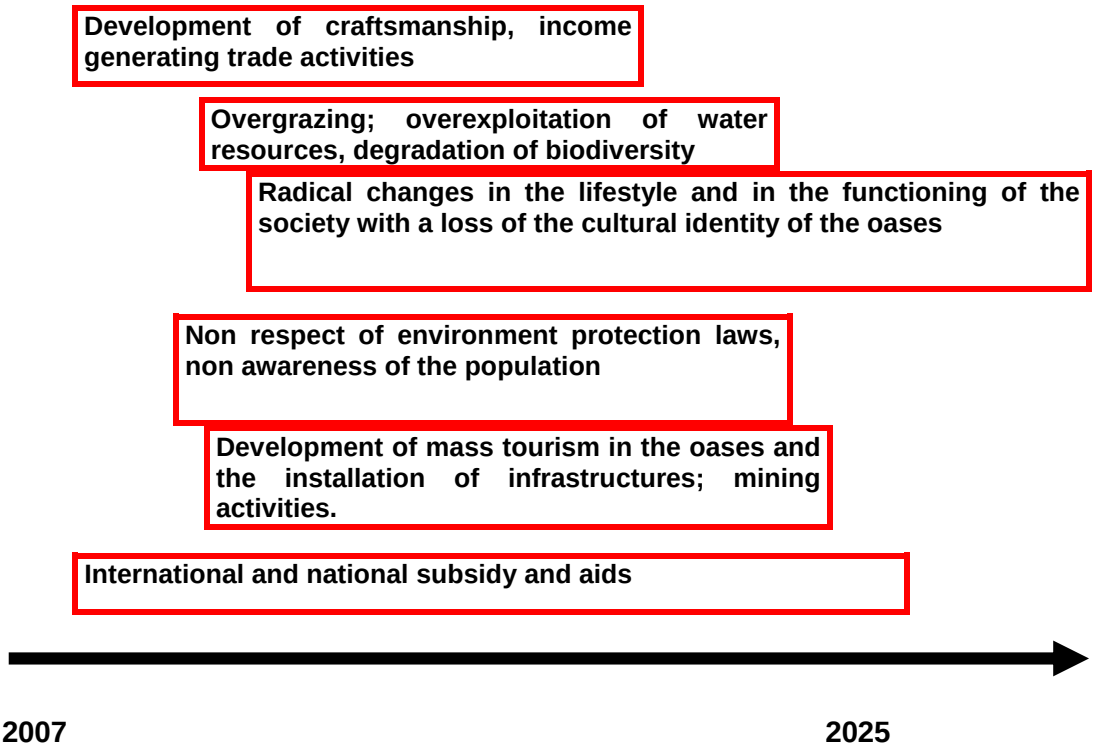
These management methods will be adapted to the development of the concepts (state ownership of water introduced by Law 10-95, modern institutional organization) and of technologies (new means of transport and communication) to be used properly to the benefit of the preservation of culture and the cultural identity of the population of the oases, rehabilitating its traditions and ancestral values.

3.6.2 Scenario B: "The laws are not enforced and poverty is reducing"

Economic poverty exists, for the time being, in the region. Besides, laws relative to natural resource management and environmental protection are not fully implemented. This fact creates a situation of overexploitation of some natural resources such as water, rangelands, wildlife, etc.

Scenario B is a scenario based on the assumptions that poverty will decline and eventually disappear in Tafilalet and that good governance will not reign in the coming years with many difficulties and barriers to respect the law in force and to maintain the practice of traditional laws. This scenario describes the future plans. Its main features are illustrated by the sequence diagram (Figure 35), below.

In ten years, it is expected that the Initiative for Human Development will give its results, mobilizing funds and resources to generate employment opportunities for the benefit of the poor local population. As far as tourism and income generating activities are concerned, some initiative aiming at the development and exploitation of the potentials of the region, with high added value, will be established, involving the region in an economic development process. With the increase of the income of local people and the implementation of formal education, literacy and awareness about family planning programs, there will be a decrease in the population's fertility rates and the demographic growth will accordingly decline.



Scenario B: Sequential diagram

Figure 35: Temporal diagram of scenario B

With the new oases development programs, which are established in the region (UNDP project coordinated by the Directorate of Land Use, the MCA project funded by the USAID and led by the Prime Minister, etc..), a dynamic of mobilization of financial resources and the creation of domino effect for other sectors will be promoted in the oases and will have positive effects on the income of the local population.

However, laws already promulgated which are relative to the protection of the environment (Law 10-75 relative to water, law 12-03 on the impact studies on the environment, Law 11-03 relative to the protection and enhancement of the environment, Law 13-03on air, Law on waste, etc.) will have no echo among the local population and people will be less inclined to respect them because the implementing decrees of certain laws are not yet published and also because of the lack of sufficient human and financial resources to establish an environmental police service, for example. Programs aiming to raise the awareness of the population will not be sufficient to have a real impact on people's behaviors.

Market forces, such as the demand for agricultural products with high added value will accelerate the transformation taking place in agricultural practices. There is a transition from a traditional food-producing system to a commercial production system that requires many water and agricultural inputs to be maintained.

This transformation, which will certainly generate an immediate income, will not be sustainable for the long term. There will be an exploitation of both agricultural lands through the intensification of cultivation and water resources through excessive pumping. This will cause infertility of soil due to the increase of salt content, already reached a significant level. It will also lead to the shortage of water due to the excessive exploitation and the use of inefficient irrigation techniques (gravity system), inefficient as far as the income is concerned. These resources are limited and are in a very vulnerable state that will not bear much uncontrolled pressure.

In less than ten years, water resource will be in a very critical stage since the climatic conditions and their foreseeable development would do nothing but aggravating the situation which will be the result of human activities. It is plausible that because of the climate changes there will be an average temperature increase, maximum and minimum, an increase in the number of hot days, extension of drought periods, reduction of precipitations, etc. This will aggravate the problem of soil salinity due to the increase of evaporation and of water scarcity.

Programs for tourism development in the region will be established with the building or major infrastructures. This will raise capitals in the region and help creating job opportunities, especially in services. Foreign investors will continue to focus on the region in the next ten years and real estate speculators will acquire traditional houses to turn them into foster houses or guest houses. All this will be performed within a lack of respect for the social and natural environment. None of the natural and social environmental impact studies will be performed in a rigorous manner. These projects will be motivated only by the economic profitability gained in the short term.

Pressure will be made then on water resources, traditional social lifestyle and the natural environment, landscapes or relaxation places. Because of the economic vulnerability that exists in the region, people will be very receptive to this kind of development that gleams immediate financial incomes. Monetary gain will outweigh the concern for loss of cultural identity or the environmental capital. These projects will not be sustainable because the attraction and advantages that have motivated them will be eventually eliminated by the tourism industry itself. Water, landscapes, lifestyle, local culture, traditions and indigenous knowledge, etc. are necessary ingredients for the subsistence of tourism in these areas. If these ingredients disappear, what will eventually be the case, the purpose of these projects will disappear as well.

Development, in this scenario, is directed towards an economic dimension with a short time vision. It is based on international aids (projects of cooperation that exist in the region), tourism development and agricultural intensification, low awareness about and limited promotion for the ecosystem protection policy, with reinforcement of the application of existing laws, and promulgation of new laws to fill the gaps, etc. From a purely economic perspective, this scenario will be profitable in the short term but will not be sustainable in the long term because the goods and ecosystem services (water, soil,

landscape, biodiversity, etc.), which are the basis of the economic activities, will be condemned to disappear or decline.

With lifestyle change, the new market forces, the globalization of information , mixture with new communities of tourists, the advent of new technologies and the creation of new needs among the local population, ancestral values, the culture and the local social lifestyle, indigenous know-how and the biological and landscaped values of the oasis ecosystems will be lost.

Within the possible context of this scenario, and to make things right, there must be an intervention to optimize the use of water resources, with adoption of the principle that water is ‘an economic good’ and that we must ensure its optimal allocation; enforce the law and promote the traditional methods and techniques in the management and mobilization of water (e.g. 'Khettarat'), which gave positive results in the past, benefiting from the inputs and concepts of an integrated and rational water management.

The government has already implemented some mechanisms to encourage water conservation (important subsidies), but it should be ensured that these mechanisms offer benefit to the small farmer of the oases who do not have sufficient financial resources to invest in modern irrigation systems, as the current production methods are more traditional and related to food-production and it is practiced on fragmentary and cramped parcels of lands.

Agricultural production, of crops and livestock as well, must be controlled and directed to be appropriate to the natural context of the area. Intensification and the use of more water demanding agricultural speculations do not correspond to the local natural conditions that are characterized by water scarcity, a relatively fertile ground, especially outside the palm groves, fragile and resilient ecosystems, etc. Actions to raise awareness of the population and to promote agricultural popularization should be implemented, as well as training programs for the benefit of farmers’ sons on rational techniques of irrigation water and on sustainable agricultural practices such as the organic agriculture, which has a high commercial value.

The commercial market gardening production (production of watermelon for markets outside the region) is growing in the oases. This practice makes use of a big quantity of water, especially when irrigation is done by gravity as is the case in the majority of farms. This agriculture is not sustainable because it exerts great pressure on water resources which is already in a critical situation. In addition, intensive rearing witnessed in the region which aims at milk production requires a lot of fodder which is locally produced (alfalfa and other), in an intensive way, using a lot of water and other agricultural inputs. To solve this problem, orientation and agricultural popularization programs should be implemented.

The region, where people live in harmony with the natural environment, is endowed with a rich history in the management of natural resources. Initiatives aiming to capitalize and develop the local know-how and should be encouraged. Oasis lifestyle should be promoted as well in order to preserve it as a cultural heritage to be developed and also as a lifestyle adapted to this environment.

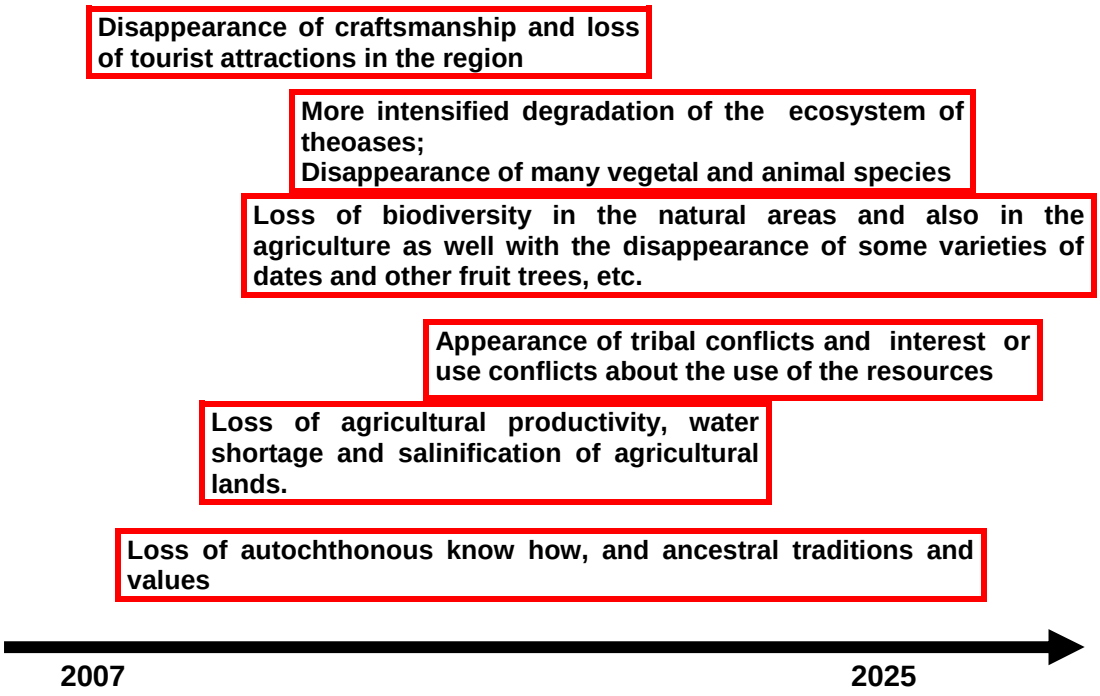
Programs to fight against desertification and sand encroachment in the region should be developed too. With the agricultural expansion and intensification, lands are exposed to a greater risk of sand encroachment and desertification. Currently in the site of Bour El Khorbat, there are many abandoned lands, while they were previously used for agricultural purposes. This is due to the declining of soil fertility and also to the shortage of water.

Civil society must be organized and strengthened to play an important role in both socio-economic development and the conservation of the Oases. With this end in mind, programs to strengthen the capacity of the associative fabric and production or marketing cooperatives as well must be implemented, and must tackle the procedures of the economic group or interest formation, management techniques of the institutions, techniques and methodologies to setting up projects, programs to raise public awareness, which civil society must multiply, etc.

3.6.3 Scenario C: 'SOS Tafilalet'

Economic poverty exists, for the time being, in the region. Besides, laws relative to natural resource management and environmental protection are not fully implemented. This fact creates a situation of overexploitation of some natural resources such as water, rangelands, wildlife, etc. Scenario C, named "SOS Tafilalet", is a scenario based on the assumptions that poverty is increasing in a context of non-application of laws and regulations. Good governance will not reign in the coming years and there will be many difficulties and barriers to enforce the law including traditional laws. This scenario describes the future plans. Its main features are illustrated by the sequence diagram (Figure 36), presented below.

The social conditions in the present situation are characterized by a high infant mortality rate because of malnutrition, poor hygiene and water-borne diseases or other diseases. Preschool education is almost absent in the area apart from a few Koranic schools that ensure this mission. There is a quite high rate of dropping out of school due to the remoteness of educational institutions, especially the secondary school and high school, and the rural villages and also due to the economic traditions and conditions that do not allow girls, especially in the rural areas, to continue schooling beyond the primary level, which increases the level of illiteracy within the society.



Sequential diagram: Scenario C: SOS Tafilalet

Figure 36: Temporal diagram of scenario C

The low level of the economic life, housing that is sometimes unhealthy because of lack of drinking water and often by lack of sanitation and basic hygiene. In general, living conditions are precarious, but are more serious for rural women who are charged with the burden of production and reproduction works. Women's illiteracy rate is bigger than man's which makes their situation more precarious with negative impacts on the living standards and on the social life.

Among the local population in general, and the young population in particular, there is also a lack of awareness about the problems of degradation in the oases. A large rate of migration to other regions in the Kingdom or abroad is also observed. This migration or rural exodus contributes to the abandonment of farming practices in some localities and the loss of the local know-how, through lack of young people succession.

The overexploitation of groundwater is caused by excessive pumping, which leads to the blight of palm groves. As for the agricultural production, there is a problem of local marketing and the difficulty of access to other markets because of their remoteness, which makes local products less competitive. The quality and quantity of produced dates suffer from a decline because of the diseases of 'Bayoud' ravaging the best varieties of dates ('Mejhoul', and 'Feggous). The range lands suffer from overgrazing which causes a loss of plant biodiversity and promotes the phenomenon of desertification and sand encroachment by the loss of the vegetation cover.

There is also a change in the social and cultural life of local communities due to the openness to the outside world, made easier by the development of communication and transport technologies. In addition, we have also witnessed, in the recent years, an increase in the difference between the levels of social lives of the poor and the well-off social classes. Begging phenomenon is developing among children, displaying an image that indicates the social exclusion, which reduces the quality of tourism attractions in the region.

In fifteen years, there will be more ethnic and tribal conflicts, more pronounced degradation of the oasis ecosystem, an extinction of several plant and animal species, a widening of disparities and inequalities, a deterioration in the living standards, and a total loss of local cultural identity and of the native know-how, etc., if the situation would not cease worsening and no actions are taken to reverse the trend

Some opportunities should be taken to be committed in a vision of sustainable development, namely the skilled human resources from the region who live elsewhere, the presence of large and important agricultural potentials, the regional potential of the solar energy, the sand dunes that can be exploited for tourism or medical interests, the local architectural and cultural heritage which is an asset for a sustainable tourism development, landscapes, local geology and geomorphology to be exploited for ecotourism and geo-tourism and mining resources, etc.

3.6.4 Scenario D: Gazelle of Tafilalet

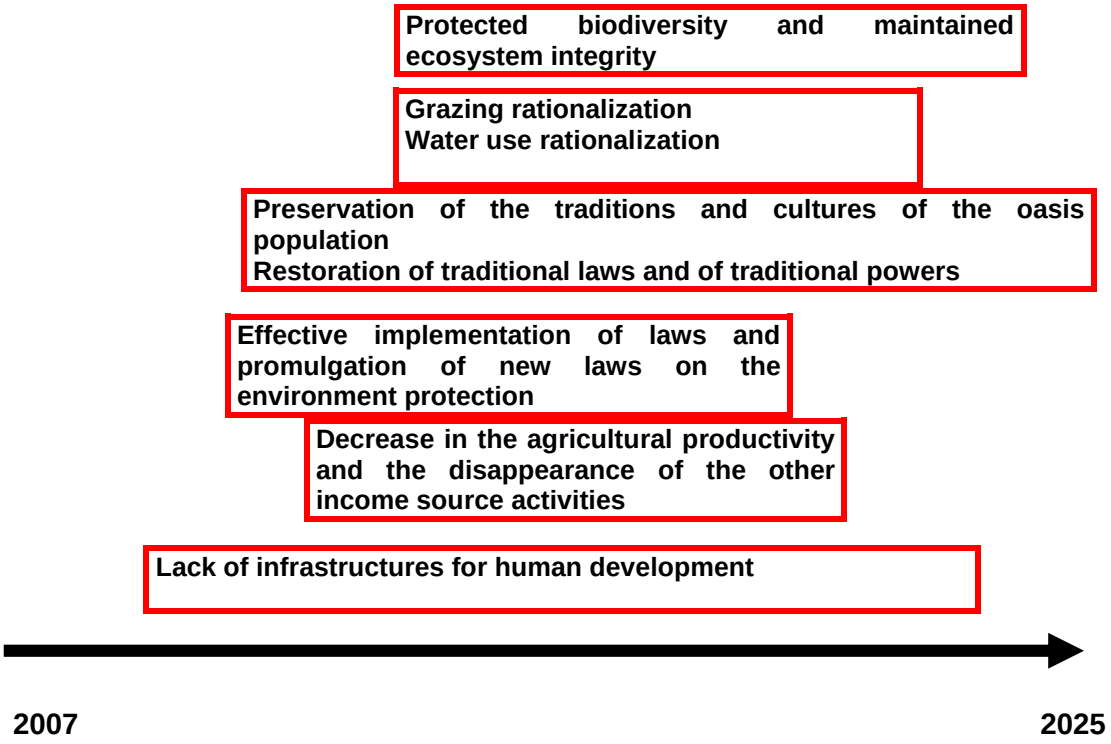
Scenario D, called “Gazelle of Tafilalet”, is a scenario based on assumptions that poverty is increasing in a context of good governance and effective implementation of laws and regulations. Good governance will not reign in the coming years with less difficulties and barriers to respect the implemented legislation and to maintain traditional laws. This scenario describes the future plans and its main features are illustrated in the sequential diagram presented below (Figure 36).

Oases are undergoing a phenomenon where laws are not fully implemented and respected, in particular, the traditional laws, which are being abandoned (ethnic groups, the authority of sheikhs ...), which has negative impacts on the lifestyles of the population of the oases, and also leads to ethnic and tribal conflicts.

Moreover, the persisting poverty led to a decline in the purchasing power of the population and increased unemployment rate, which provoked an increasing pressure on natural resources by the excessive exploitation. It also led to a rural exodus of the population in search for employment opportunities or better living conditions.

The future vision for the coming 25 years says that the application and enforcement of laws will have a positive impact on the economic, social and environmental fields. However, the persistence of poverty

will have an adverse impact on natural resources such as water, vegetation, fauna and flora and may also lead to rural exodus as well as other social problems.



Sequential diagram: scenario D "Gazelle of Tafilalet"

Figure 37: Temporal diagram of scenario D

To make things right, the intervention of the government is required in terms of the follow-up and enforcement of laws (namely the on water, traditional laws, ..), development of income generating activities which fall under the scope of sustainable development, sustainable and responsible tourism (ecotourism, geo-tourism ..), promotion of local competences, natural and cultural potentials, and of the autochthonous know-how, in order to better exploit the assets of the region.

4. Answers

4.1 Introduction

The future answers can be of several kinds, those relating to the reduction or annihilation of change forces, those that aim to reduce or eliminate the pressures on the ecosystem, those aiming at restoring or rehabilitating the state of the ecosystem, and those that aim to reduce the negative impacts resulting from changes in the ecosystems.

They may have legal, institutional or organizational characteristics. They can be performed whether by the governing authority or by the civil society, local population, private sector or the national or international cooperative organizations.

Several answers have already been made and others are being considered and should be adopted if we want to have a healthy ecosystem which will continue to provide goods and services for the benefit of the human well-being. These answers are listed in this document but do not purport to be complete because some performed or planned responses on a reduced scale of the ecosystem have not been identified or have been inadvertently omitted.

4.2 Integrated responses

At the national level, there is a legal arsenal for the management of natural resources. We can cite, for instance, forestry laws which dates back to nearly a century, hunting laws, water maws, the law on the protection and enhancement of the environment, the law on the environmental studies, the law on the solid wastes management, the law on air and other laws and regulations that concern either the protection or the development of natural resources and their environment. Other laws are also being promulgated. A law that would help put in place measures to protect and safeguard the natural environments is the law on protected zones.

Development initiatives aiming at supporting the fight against poverty have been implemented or are being developed. We can cite here the example of the National Initiative for Human Development (NIHD), which is being implemented in all Moroccan regions, especially in the poorest communities. Morocco is also committed to cross-industry policies that aim to meet the Millennium assessment goals. This is why several programs have been installed in different parts of the country. Some macro-economic projects in the region of Tafilalet are, for example, the safeguard of the oases and the draft of the Millennium Challenge.

These answers are more integrated because they cover large geographical areas and therefore involve many players and various economic sectors. The repercussions of such initiatives and the measures that result from them are often of a macro nature or are leading projects. They are considered as a preliminary step that leads to other similar projects in the region.

Several decisive factors have been combined in the recent years leading to the progressive and dramatic shortage of water resources in Tafilalet. These are mainly:

- lack and / or poor maintenance of dams
- poor water management of the dam of Hassan Addakhil,
- natural cycle characterized by drought
- human behavior and agricultural practices that are not adapted to the situation of shortage

The proliferation of motor-pumping caused, almost, the total depletion of the reserve. Therefore, facing the problem of water wastage in addition to its rarity and overuse, the Moroccan state took several initiatives and commitments of technical, social, legislative and legal natures to optimize the use of this resource. Measures to encourage rational use of water, either by reducing consumption or by improving the quality, were taken by the State. Law 10-95 on water predicted such initiatives; the application of the provisions of this law and its regulations is now highly promoted by the competent authorities.

The use of localized irrigation is increasingly used in Morocco, and the oases of Tafilalet are no exception. Recognizing the seriousness of the future situation, the Moroccan State encourages these methods which save water by funding up to 60% of the cost of the projects of drip wise and perhaps even more in the oases.

Few farms now use this technique. The results obtained, according to a financial point of view, due to water savings are encouraging. It is likely that this technique would be extended to other farms thanks to the success of some experiments but it would be confronted with the lack of financial resources of farmers, with local irrigation practices and with the difficulty of being adapted to all the cultural practices.

To satisfy the increasing demand, many test and surveys were undertaken in the region by the HRA, the rehabilitation of hydro-agricultural infrastructure by ORMVA / TF and the probable creation of a hydraulic basin agency in Tafilalet.

Studies on the vulnerability and the adaptation of the oases against climate changes and human behavior must be the subject of a multidisciplinary research program of the Moroccan university in partnership with specialized national and international research institutions. The integration of the concept of rational management of natural resources, especially water, and of the development for a sustainable future in the educational programs and research in training and research institutions falls squarely within the framework of the reform of the Moroccan university and its openness to the outside world.

Research programs must be accompanied by awareness campaigns to popularize the concepts of the integrated and participatory programs among the public, and especially the young population (photograph 40), support and training of local stakeholders and especially local communities and associations. This would aim to push people to change their behavior facing the challenges of over-exploitation of natural resources in a context of climate changes (drought, desertification, depletion of water resources, increase in temperature, etc.

Water solutions

Facing this crisis of water in the region, the Moroccan State committed itself, carrying out several projects, to first meet the needs of the population (ensuring supply), namely in drinking water and then to save, protect and enhance the resource and optimize its use. The willingness of the public authorities is reflected in the following interventions and actions:

- proliferation of boreholes and water points;
- rehabilitation of 'Khettarats';
- subsidies of techniques saving water up to 60%;
- development of hydro-agricultural infrastructures;
- creation of a water basin agency of Ziz, Ghèri s, Guir and Maeder;
- application of the provisions of law 10-95 on water ;
- equipping and following-up hydro-climatic stations;
- encouragement of following-up and research programs;
- Raise awareness of and training the civil society;
- civil society organizations and its encouragement including Agricultural Water Users Associations (AUEAs);
- drinking water supplies for the rural areas;
- liquid and solid purification;
- watershed management against erosion;
- encouragement of national and international cooperation and partnerships;
- application of traditional laws inherited from the ancestors (Al ôrf);
- encouragement of the use of the local know-how.

Photo 23: Session for awareness and trainings in favor of the students

Regarding soil, the noted losses in recent years are more numerous and have lead to a worrying reduction of the area of the UAA. Erosion of the soil of palm groves and of range lands due to heavy rains and the resulting floods is a serious and worrying threat.

The phenomenon of sand encroachment accentuates the decline of the UAA (we consider that 60% of the agricultural lands of Tafilalet are threatened by sand encroachment). Facing this situation which is more and more preoccupying, the Moroccan State, in collaboration with the local population, took several actions aiming at alleviating this scourge. Indeed, the fight against sand encroachment (photo 24) is a preoccupation that continues to challenge the public authorities, namely the regional representatives of the concerned governmental sectors, mainly ORMVA / TF and Waters and Forests, in order to protect the environment and improve the quality of life of local population.

To this end, many development and protection projects of the agro-ecological systems, the fight against sand encroachment, reforestation and pastoral improvements (grazing), were implemented in several oases. Despite these efforts and the importance of the undertaken actions, some vital areas and sectors are experiencing accretion of sands. Scientific research, awareness campaigns and the strengthening of the capacities of the local players and the encouragement of the local initiative are currently being promoted by the government.

Sand encroachment answers:
• research and development; • protection of hydro-agricultural infrastructures; • fight against sand encroachment (mechanical, biological, defending); •raising awareness and training programs; • creation of NGOs and specialized associations; • setting up and development of integrated projects; • development of renewable energies; • income-generating activities; • laws and conventions; • cooperation and partnerships.

Photo 24: Fight against sand encroachment in the oases (Bouiya, Jorf)

Biodiversity in the oases is the subject to scientific researches but it is still dispersed and non methodological. A rigorous and in-depth scientific work is required. Some works on the recovery of dates demonstrated some very ambitious very promising results.

Given Morocco's commitments towards the international community to safeguard the biodiversity and recognizing the importance of these services, and also some few in-depth studies on the biodiversity of the oases, bold and commendable initiatives(Figure 49) were undertaken at the level of scientific and technical research, development, protection, rehabilitation, partnership (vertical and horizontal).

Biodiversity answers:
• installation of goat, sheep, cattle and camel breeding cooperatives; • encouraging the creation of apiculture cooperatives (yellow bee); • initiatives to establish protected zones; • establishment of nurseries (date producing palms, jujube trees, and other trees); • Agronomic research programs and institutions of higher education; • raising awareness and training programs; • encouragement of civil society partnerships / State, national or international backing organizations; • promotion of local know-how and of traditions of natural resource management (transhumance practice of "l'Agdal", etc.).

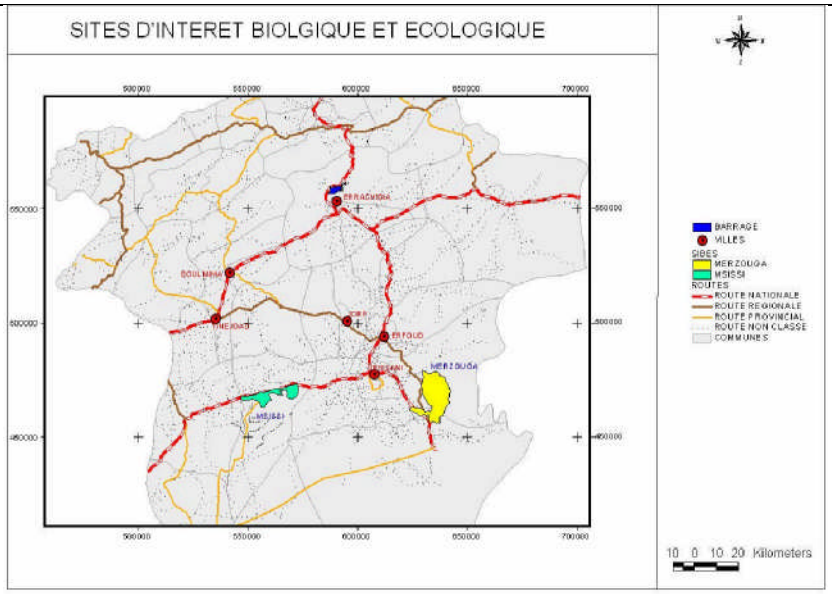


Figure 38: Sites of biological and ecological interest

Craftsmanship sector also reacts by developing and refining the final product. Still, there is much work to do in the future in the organization and flow of goods.

5. General Conclusion

In the past, human beings were an integrated part of the oases' ecosystem. They respected the ecosystem, adapted themselves to its conditions and derived different benefits from the various services this ecosystem can produce. Unfortunately, in recent decades, in addition to the effects of drought which has become structural, they no longer seem to be consistent with the management of their environment. Their only concern now is the durability of services provided by the ecosystem.

The disappearance of the oases is generally followed by the loss of vast desert areas. The trend toward marginalization, the progressive desertion of the oases as well as the dewatering and the desertification of these areas are factors of the loss of this territory with all its patrimonial value.

During the recent decades, the most significant factor of the gradual loss of the oases has consisted of the irrational exploitation of natural resources, caused by human activities that disturb the balance of the ecosystems, paving the way consequently to the progression of desertification.

The impact observed in the ecosystem of oasis of Tafilalet is the degradation of natural resources and all biotopes. This degradation has repercussions on the biomass and on the interactions, shelters and services that the ecosystem may provide to humans.

Natural and architectural landscapes are also in a situation that does not reflect the style and local identity. Urbanization is carried out with an uncontrolled manner. Besides, it does not respect usual local building regulations. The abusive and non-methodic exploitation of fossiliferous activities accentuate the disfigurement of the landscape of the oasis. Geological profiles, archaeological sites, 'Ksours' and ' Khettarats' are deteriorated and/or abandoned or even turned into landfill sites.

The rarity of water, which is paradoxically more and more polluted, never ceases aggravating and worsening. The lack of groundwater and its exhaustion induces the death of date palm and thus the disappearance of the main services and functions of the oases. The scarcity of the resource also causes conflicts of use and users. Flood waters are often lost because of these conflicts or because of the lack of maintenance of irrigation canals. This leads to an increase of water stress of the palm trees.

Hydro-agricultural infrastructures are sometimes non operational, destroyed by severe floods, or are invaded by sand. These sites are home for pollution again (solid waste) and, therefore, sources of all possible diseases and pollution of all the landscapes with detritus of households or packaging.

The direct impact is that the ecosystem is degraded and its biodiversity is therefore threatened. The

rural exodus, loss of the millennium local know-how, the loss of some key trades of the oases' system (pollinator ...), etc, are the result of this impact; and therefore the deterioration of the local life conditions and the loss of human well-being.

The current state of the oasis ecosystem of Tafilalet is very alarming but is not irreversible

- recession of sources and perennial flows;
- exhaustion of groundwater;
- recession and diminution of 'Khettarats';
- poor management of flood waters, mainly because of social conflicts;
- deterioration of water quality;
- Soil salinity;
- intensification of sand encroachment;
- eroded soil;
- altered biodiversity; reduction in the effective of date palms;
- loss of quality and quantity of palm dates production;
- Aging and infection of olive trees and other trees plantations;
- decrease in apiaries and know how;
- loss of soil fertility;
- abandoned farmlands;
- fragmentation of lands;
- transformation of the economy (transition from a traditional economy to a market economy);
- degraded lands;
- Growth of poverty;
- Increase of unemployment;
- degraded landscapes;
- Destruction of fossil quarries;
- traditional housing abandoned;
- limited or not applied legislative, legal and institutional framework;
- non favorable tenure in addition to the absence of acts of Moulkia for most of the beneficiaries.

This assessment of the oasis ecosystem of Tafilalet (catchments of Ghèris, Ziz and Maeder), indicates the existence of several factors that challenge and threaten the ecosystem in the present and especially in the future:

- Irregularity of the spatiotemporal distribution of water resources and their decline;
- overexploitation of groundwater and water inadequate management;

- erosion of catchments;
- solid pollution;
- floods l and low control of flooding waters;
- lack of compliance with the laws and the difficulty of their implementation;
- desertification (groundwater depletion, water pollution, land degradation, salinization, sand encroachment, poverty, etc.);
- deterioration of the biodiversity and of natural habitats;
- low level of awareness raising;
- low living standards and economic poverty;
- presence of very few integrated and participatory projects;
- modest scientific researches
- low level of cross-industry consultation and coordination;
- low level of local participation in the decision making process;
- etc.

Raising awareness about the importance of the preservation of these ecosystems should be promoted. Some scenarios have been drawn and, to move towards a desirable future, appropriate responses must be taken to reverse the degradation of the oases' ecosystems. These responses should be concerned by change forces, the pressures exerted on the systems, on the state of the ecosystem itself and on the impacts resulting from the degradation, in order to preserve the ecosystems and provide sustainable goods and services on which human well-beings depend. These responses can be induced by the government, by the civil society, by the private sector, by the governmental, non-governmental or inter-governmental organizations, by the various individual donors and by the local population. They must be implemented in a divided and participatory manner by all stakeholders.

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7. Appendices

7.1 Glossary

- **Khettarat :** drainage gallery which brings by gravity the water of the water-table to the surface of the ground.
- **OUGHROUR :** *System of drawing up by means of bascule goatskin known as "Dlou" with animal or human haulage.*
- **KSAR :** Collective urban area of dwellings inside a protective wall.
- **JMAA :** Grouping representative of a population which lives in community.
- **OASIS :** Space arranged and cultivated by the man in a very mineral context.
- **BAYOUD :** Mushroom parasitizes on the date palm.
- **MELK :** Private property of the ground or water with a traditional title.
- **D'MAN :** Endemic ovine race (Ewe).
- **KHALT :** Variety of date (hybrid).
- **AMGHAR :** Amazighe name, wise and elder person of the village, semi-officially invested authority within the community, person in charge of the management of water and palm plantation.
- **CHEIKH :** Arab name of 'Amghar', but which has an authority officially recognized in the modern system of governorship.
- **HAD ESSAIM :** Technique of community participation in a collective work (clearing out of the irrigation canal, for example), each household takes part in it in height amongst adult boys family members.
- **El ORF:** Settlement of conflicts and natural resources management according to the local habits.

7.2 Acronyms list

AEP : Drinking water supply

AFD : French Agency of Development

ADS : Agency of Social Development

AOFEP : Ferkla Oasis Association for Environment and Inheritance

ARVI : Atmospherically Resistant Vegetation Index

AUEA : Association of Agricultural Water Users

BM : World Bank

BMM : Business Motivation Model

CE : European Commission (EC)

CMV : Investment Center

CNULD : United Nations Convention on the Fight against Desertification

CRRA : Regional Center of Agricultural Research

DAT : Department Town and country planning.

DPSIR : Drivers **(**driving forces), Pressure (pression), (State) state, impact, Response (response)

DRH : Department of Hydraulic Region

DRPE : Direction of Research and Planning of water

EEM : Evaluation of the ecosystems for the millennium

ENFI : National school of Forest Engineers

FAO : Food and Agriculture Organization of the United Nations

FFM : French Fund for the Environment

FEM : World Fund for the Environment

FPEIR : Force Pressure State Impact Response

FSTE : Faculty of Sciences and Technology of Errachidia

GEMI : Global Environment Monitoring Index

HCEFLCD : High Commission for Waters and Forests and Fight against desertification

JICA : Japan International Cooperation Agency

MADRPM : Ministry for Agriculture, Rural development and Maritime fishing

MATEE : Ministry of Town Planning, Water and Environment

MM : World Mechanism

MSAVI : Modified Soi1 Adjusted Vegetation Index

NDVI : Normalized Difference Vegetation Index

ONEM : National observatory of the environment of Morocco

ONEP : National Office of Drinking Water

ONG : Non Governmental Organisations

ORMVA/TF : Regional Office of Agricultural Investment of Tafilalt

PAM : Medicinal and Aromatic plants

PAN/LCD : National action plan of fight against desertification

PAT : Tourist host country.

PMF : Program Micro-financing

PMH : Small and Medium sized Hydraulics

PNUD : United Nations Development Programme

PNUE : United Nations Environment Programme

POT : Oasis Project component Tafilalet

PVI : Pemendicular Veaetation Index

RBOSM : Reserve of Moroccan South oasis biosphere

RGPH : General census of the population and the Habitat

RIOD : International Network of fight against desertification

SACRI : Soil Adjusted Corn Residue Index.

SAU : Useful Agricultural surface

SAVI : Soi1 Adjusted Vegetation Index

SIBE : Sites of Biological and Ecological Interests

SIG : Geographical information system

TSAVI : Transformed Soi1 Adjusted Vegetation Index

UNESCO : United Nations Educational, Scientific and Cultural Organization.

UMI : Moulay Ismail University

USAID: United State Agency for International Development.

7.3 Authors List

- **Abdellatif KHATTABI** : Economist and forester, professor at National Forest School of Engineers, BP. 511 Tabrikt Salé Morocco, Phone: +212 61 21 08 54, Fax: +212 37 86 11 49 ; Email: a_khattabi@email.com

- **Charifia AL CHEIKH** : SIG Specialist, PhD at Mohamed V University, Faculty of Sciences Rabat Morocco, GSM : 212 212 6202 51 06 ; Email : charifaalaoui@yahoo.fr

- **Lahcen KABIRI** : Geologist and environmentalist, professor at Moulay Ismaïl University, Faculty of Sciences and Techniques Errachidia, Phone 212 35 57 44 97/84, Fax : 212 35 57 44 85, GSM 212 66 95 70 64 ; Email : kabiri_lahcen@yahoo.fr ;

- **Rachid EL BAYAD** : SIG Specialist, associate researcher at Mohamed V University, LASH / EMI, Mohammadia School of Engineers), B.P. 765, Agdal, Rabat, Morocco, GSM : 212 63 71 50 77 ; Email : elbayad@emi.ac.ma

7.4 Survey sheet

Q-1

Q-2

Q-3

Q-1: Survey sheet "ksar"

Date :

Survey No :

1- Identification of the "ksar"

Province :

Circle :

Rural Commune:

Ksar or douar :

2- Characteristics of the "ksar"

2-1 Demography

Total Population: ……

Household number: ……..

Ethnic Groups:……

2-2 Housing Nature

% cob……☐.. % hard……☐… % Mix……☐..

2-3 Migratory flow

Emigrants number……☐……

Emigrants number ……☐……..

3- Basic Infrastructures

3-1 Electrification : Yes ☐ No ☐

3-2 Drinking water : Yes ☐ No ☐

3-3 Sanitation : Yes ☐ No ☐

3-4 Schools ☐ (including Koranic schools) Number: ☐

3-5 Medical clinics ☐ Number: ☐

3-6 Roads ☐ (including secondary and tertiary roads)

Distance of the ksar compared to the main road in Km : ☐

Q-2 : Survey sheet "Household"

Survey No :…….

Survey Date:……

I- IDENTIFICATION

Surveyed person:……

Age……☐……..Sex……☐…….Family status……☐…….

Occupation:……

Ksar or douar :…… ……..

Commune rural :……Circle……Province……..

II- SOCIOECONOMIC CHARACTERISTICS

II-1 Household Structure

	Age groups (years)							
	< 7		**7-15**		**15-45**		**> 45**	
	M	F	M	F	M	F	M	F
School level Koranic school Primary Secondary University Without (alphabet)								
Carried on activities Agriculture Breeding Commerce Craft Industry Industry Emigration Tourist Guide Without activity								
Total								

II-2 Household source of revenue (%)

Agriculture ☐ Breeding ☐ Commerce ☐

Building ☐ Emigration ☐ Kraft Industry ☐ Others ☐

II-3 Housing structure

a) Type of building :

Hard ☐ Semi hard ☐ Cob ☐ Others

b) Mode of Housing :

Grouped ☐ Dispersed ☐

c) Equipment :

Water : AEP Network ☐ Well ☐ Fountain ☐

Electricity : Generator ☐ Network ☐ No ☐

Sanitation : Network ☐ Septic tank ☐ No ☐

II- 4 Agriculture

➔Nature of agriculture

Modern ☐ Traditional ☐ Mix ☐

Food-producing ☐ of Market ☐

➔Stratification of vegetation

Stratum Tree S. Shrubby S. herbaceous Mix

➔Lands Statute

Collective ☐ Domanial ☐ Melk ☐ Ha bous ☐

➔Mode of development

Direct ☐ Indirect ☐ Others……☐..

➔Nature of lands : Arable ☐ Heavy ☐ saline ☐

➔Irrigated SAU in %:

By Khettaras ☐

By Seguias ☐

By Well ☐

➔SAU Bour : ……

➔Number of palm groves

Living ☐

Withered ☐

➔ Is there a threat of the alive palm plantations by the disease of bayoud?

Yes ☐ No ☐ If so, does there exist a local knowledge to fight against this disease?.....

➔Destination of dates

Home consumption ☐ commercialization ☐

Animal feed

➔ Is there a local knowledge for the transformation of the palm tree products?

Yes ☐ No ☐

If so, which type of transformation?.....

➔Is there 'Maasras' ? Yes ☐ No ☐

If so, which type : Modern ☐ Traditional ☐

➔ Is there agricultural cooperatives

Yes ☐ No ☐

If so, which is the nature of this cooperative ? ……..

Practiced Cultures :

Type of cultures	**Surface**		**Quantities in Kg**			**sale**
	Irrigated	Bour	Collected	Home consumed	commercialized	Price for 1Kg in (DH)
Date palm . V. Majhoul . V. Fagouss . V Khalte... Others ….. **Fruit Trees** - Olive tree.. - Pomegranate - Almond tree - Others **Cereal-culture** - Wheat. - barley - corn - Other **Truck farming.** - potato - green bean - tomato - Others **Legume** - Dry bean - Broad bean - Others **Fodder Cultures** - alfalfa - ber - Others						

- ❖ Mode of ploughing……
- ❖ Periode of this ploughing……..
- ❖ Is manure used? Yes ☐ No ☐ If so, which type of manure ? Organic ☐ mineral ☐ and in which type of cultures this manure is used ?

- ❖ Expenses and expenditures :
  - of soil preparing……..
  - of seeds purchase……
  - manure purchase or/and fertilizer ……
  - water purchase……

- of harvest……..

- ❖ Agricultural equipments ……
- ❖ Hydraulic Equipments ……..
- ❖ Employed working force **:** ……
  - Men or women……

    type of work……..

    - number of hours per day ……

  - remuneration……..

II-5 Breeding and space management:

1- Structure of the herd

	Livestock in property						**Livestock taken in association**	
	< 6 months		6 -18 months		> 18 months			
	M	F	M	F	M	F	Type of Contract	Remuneration
Bovines : -local -improved								
Ovines **.** of man **.** Others								
Caprines								
Others								

2- Livestock Products

PRODUCTS	**Produced Quantity**	**Home consumed**	**Sale**			**Destination**		**periode**
			Qty	price	place	local	extern	
Milk								
Butter								
Wool								
Skin								
Others								

3- Herd food

3-1 Is the food done by

course (fallow) ☐ orchards ☐ fodder at cattle shed ☐

3-2 In which periods of the year:

Spring ☐ Summer ☐ Winter ☐

Fall ☐ All the year

3-3 Is there a complementary food for the cattle?

Yes ☐ No ☐

If so, which type of food and in which period?.....

4- Space use

4-1 What do you think of the load of the livestock on the courses?

Strong ☐ Average ☐ Weak ☐

Is there a overgrazing? :

Causes of the overgrazing?:

Adopted solutions?:

4-2 Is there an organization of the population for the management of space (course, oasis…)

Yes ☐ No ☐ If so, who?.....

Is there conflicts related to space use? :

Is there conflicts related to space users? :

If so, who conflicts are solve?

The traditional structures (Jemaa, etc) does play a part to manage the conflicts?

4-3 What do you think of the space state?

Deteriorated ☐ Little deteriorated ☐ Not deteriorated ☐

Which are the visible signs of deterioration?:

Causes of deterioration according to you? :

Historic of deterioration? :

Which are the answers or the temporary solutions brought?:

4-4 Are there nomads which attend the courses of the ksar?

Yes ☐ No ☐ If so, how many?.....From where do they come?.....and in which period of the year? :

Summer ☐ Fall ☐ Winter ☐ Spring ☐

4-5 Are there agreements between local population and nomads for the use of space?

Yes ☐ No ☐ If so, who……

5- Others activities related to stockbreeding

5/1 Aviculture

Type	**Number**	**Home Consumption**	**Sale**	
			Quantity	Price
Chickens				
Eggs				

5/2 Apiculture

Number of beehives	**Modern** (1)	**Traditional** (2)	**Production/year**		**Home Consumption**	**sale**	
			(1)	**(2)**		Qty	Price

II-6 Exploitation of the natural resources (rights of use)

a) Taking away of firewood

- Which is the total consumption/week/household?.....

- Place of taking away : Palm grove ☐ Forests ☐ Others……☐…

- Use : Heating ☐ Cooking ☐ Building

- Which type of wood?:

Dry palms dead Branches

Zizyphus ☐ feather-grasses ☐ Others ……☐……

- Means of transport:

Back of asses ☐ Back of women ☐ Others ……☐……

b) Taking away of the aromatic and medicinal plants

- Which is the exploited quantity ……

- The period of taking away ……

- Which are the taken species ……

- Use :

Traditional Medicine ☐ Beauty ☐ Others …… ☐

Which is the current state of the palm gove?

Which is the current state of the forest, if still exists?

Which is the current state of vegetable resources (aromatic and medicinal plants, for example?):

III- Management of irrigation water

a) Which are the availabilities of water?

Available ☐ Insufficient ☐ No available ☐

b) Origin of water of irrigation

Drilling ☐ Dam ☐ Source ☐

c) Which type of water table?

Deep ☐ intermediary ☐ superficial ☐

d) Is there a traditional organization of the population for the management and the control of water? Yes ☐ No ☐

If yes, who?.....

e) Which type of system of irrigation do you practice?

Drip system ☐ Pivot ☐ Gravity ☐

Which are the pressures on the resource water?

How the needs of drinking water are satisfied?

In the event of shortage of water, which are the solutions adopted to meet the needs?

IV- Activities of valorization (tourism)

a) Is the area attended by the tourists?

Yes ☐ No ☐ If yes, which is the most required tourist product?:……

Sand dunes ☐ Landscapes ☐ Traditional Architecture ☐

Kasbah ☐ Mousems and Festivities ☐ Others ☐

b) Which type of tourist infrastructure?

Hotels ☐ Inns ☐ Rest houses ☐

c) Did oasis tourism contribute to the improvement of the population quality of life?

Yes ☐ No ☐

d) Does oasis tourism have an negative impact on the population?:

Yes ☐ No ☐ f yes, which type of impact ?.....

e) Are there generating activities of income other than tourism?

Yes ☐ No ☐ si If yes, which……

f) Does tourism have an impact on the natural environment? If so, which?

j) Does tourism have an impact on the water resources?

VI- Stranding

a) Does the stranding present a threat to be feared?

Yes ☐ No ☐ If yes, since when.....

b) Which is the element more touched by this problem? ☐

Housing ☐ oasis ☐ Access ways

c) Is there a local knowledge as regards fight against the stranding? Yes ☐ No ☐ if so, which……

d) Are there traditional methods of follow-up and control of the stranding?

d) Are there interventions of the State for the fight against the stranding?

Yes ☐ No ☐ if so, in which projects?

.....

Q-3 : Questionnaire, biophysics component

I) Identification of the interviewed person.

a) date : ……
b) name :……
c) age :……
d) sex :……..
e) occupation:……
f) province : ERRACHIDIA
g) commune or municipality
h) Ksar : ……..

II) Water and use

1- ***From where does come the water you use? Is it of quality? Is there wasting of this water?***

Yes : No :

-is so, when?.....

-how ?.....

- what is necessary to make to fight against this wasting?.....

2- ***Is there a shortage of water? If so***

Period	Corresponding Effect
……	……
……	……
……	……
……...	……

3- Litostratigraphy :

- When you dig a well, which geological mean principal formations do you cross? Lands Furniture (0m à…..m)
- Lands hards (…..m à ……m)
- Schists (……)

4- Digging and deepening of well:

-Appearance date of the first moto pump : ……

-Disappearance date of the last Oughrour :

- Appearance date of drip system

- Period of wells deepening: ……

How much wells were dug by a machine (probe)?.....

5- Irrigation :

	wells	seguias	Flood waters	dam	khettarats	Others
Good						
Bad						
Explanation	…… … …… … …… …	…… … …… … …… …	……... . …… . …… .	…….. . …….. . …….. .	…… …… ……	…… … …… … …… …

1- Are there abandoned infrastructures for lack of water?

2- Are there abandoned lands for lack of water:

Yes : ☐ No : ☐

If yes :

-when? ……

-cause : ……..

6- Drinking water supply

Are you connected with ONEP water? If not which water you drink?

III Stranding

1- Are there abandoned lands and/or infrastructures for stranding?

2- Quote the various problems of stranding?

3- From where does sand come?

4- How do you fight against?

IV. Biodiversity

1- Which are the plants and/or animals which we can find in nature? For what are they used? Do you gather them? With which frequency? Where can we find them?

Name of the plant	Medicinal, aromatic, food or heating utility	gather frequency	Place where we can find it	Vernacular Name

Animal	Vernacular name	Frequent Observation	Place where we can find it

2- Do you know surfaces deforested or weeded because of the man? YES NO

If so, do you know why?

3- Do you know plants or animals which would have disappeared? YES NO

If so, which?

4- **Which would be the causes of their disappearance?**

- Dryness
- Man need
- Pasture
- Acridiens
- Herbicides
- Insecticide
- Diseases
- Others :

5- Do you know endangered plants and/or animals? YES NO

If yes, which plants and/or animals

6- Which would be the causes of their disappearance?

- Dryness
- Man need
- Pasture
- Acridiens
- Herbicides
- Diseases
- Others :

7- Are you conscious of the damage caused by the deforestation? YES NO

If so, can you quote some?

8- Do you think of protecting these plants and these animals? YES NO

If so, by which means?

9- Do you hear of the climate changes? Do you then observe them in your zone? If so, do you know their causes?

V- Agriculture and stockbreeding:

1- Name of lands: ……

2- Which are the cultures most usable and most profitable :

Date palm : Cereals : Alfalfa :

Truck farming : Others :

3- Which animals do you raise? What you give them to eat? From where come this food?

4- How are the courses? Quote the various problems which you do encounter in these zones? Is there an organization of these courses? If not why?

5- Have you lands completely abandoned because of:

Stranding : Lack of water:

Hydrous erosion : Others :

6- Did you achieve works of clearing out souaguis :

Yes : No :

-If so, when? ……..

-How ? ……

7- Do you always continue to maintain your souaguis, your khettarats and your dams with your own means?

Yes: No :

-If so, how much that costs you :

8- Do you think of improving your cultures? If so, who?

9- Do you think of cultivating the medicinal and aromatic plants? If so, who?

10- Do you think of developing your harvests? If so, who?

VI_ Intervention of the Government and Others

What makes the Moroccan Government, the civil society and the international community to attenuate all the problems arising?