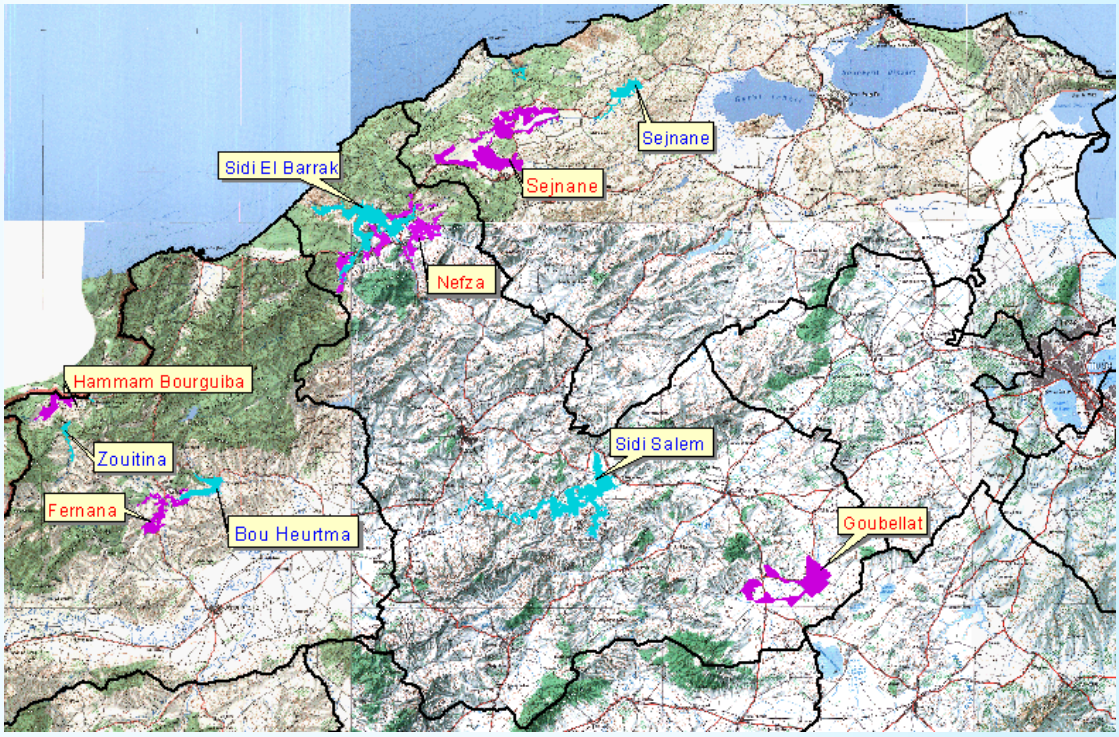
TUNISIAN REPUBLIC
Agriculture and Hydraulic Resources Ministry
D.G./B.G.T.H.

Study of integrated water resources management in the North of Tunisia



Final Report

SCET TUNISIE
2, Sahab ibn Abbad Street,
Cité Jardins, BP 16
1002 Tunis Belvédère – Tunisia
Ph : (216) 71 800 033 / Fax : 71 781 956
e.Mail : deha@scet-tunisie.com.tn

Ref: 04-55

Date:August. 2005

SUMMARY

LIST OF MAPS

Liste d'abréviations — List of abbreviations

AEP (Alimentation en Eau Potable)	Drinking Water Supply
ANB (Banque Nationale Agricole)	National Agricultural Bank
APD (Avant Projet Détaillé)	Detailed Preliminary Design
AVFA (Agence pour la Vulgarisation et la Formation Agricole	Agricultural Popularisation and Training Agency
BNA (Banque Nationale Agricole)	National Agricultural Bank
BTS (Banque Tunisienne de Solidarité)	Tunisian Bank of Solidarity
CES (Conservation des Eaux et des Sols)	Water and Soil Conservation
CFPA (Centre de Formation Professionnelle Agricole)	Center for Professional Agricultural Training
CNEA (Centre National des Etudes Agricoles)	National Center for Agricultural Studies
CRA (Centre de Rayonnement Agricole)	Center of Agricultural Influence
CRDA (Commissariat Régional au Développement Agricole)	Regional Direction of Agricultural Development
CROA (Comité Régional d'Octroi des Avantages)	Regional Committee for Benefit Granting
CTV (Cellule Territoriale de Vulgarisation)	Territorial Popularization Cell
DG/BGTH (Direction Générale des Barrages et Grands Travaux Hydrauliques	General Direction of Dams and Large Hydraulic Works
DG/PV (Direction Générale de la Production Végétale)	General Directorate of Vegetal production
ETP (Evapotranspiration Potentielle)	Potential Evapo-perspiration
ETR (Evapotranspiration Réelle)	Real Evapo-perspiration
FDR (Fonds de Développement Rural)	Rural Development Fund
FNS (Fonds National de Solidarité)	National Solidarity Fund
FODERI (Fonds pour le Développement Régional Intégré	Fund for Integrated Regional Development
FOSDAP (Fonds d'Orientation Structurel pour le Développement de l'Agriculture et de la Pêche	Structural Orientation Fund for the Development of Agriculture and Fishing
HMT (Hauteur Manométrique Totale)	Total Manometric Height
ODESYPANO (Office de Développement Sylvo-pastoral du Nord-Ouest)	North-Western Forests and Pastures Development Office
ONG (Organisation non gouvernementale)……..	non governmental organization
OTC (Office de la Topographie et de la Cartographie)	Office of Topography and Cartography

OTD (Office des Terres Domaniales) : Public Lands Office

PACFS (Petite Agriculture à Caractère Familial et Social) : Small Farms with a Familial and Social Character

PDAI (Programme de Développement Agricole Intégré) : Program for Integrated Agricultural Development

PDES (Plan de Développement Economique et Social : Economic and Social Development Plan

PDR (Programme de Développement Régional) : Regional Development Program

PDRI (Programme de Développement Rural Intégré) : Program for Integrated Rural Development

PPI : Périmètre irrigué public : Public irrigated area

RFU (Réserve facilement utilisable) : Easily Usable Reserve

RU (Réserve Utile) : Useful Reserve

SAU (Surface Agricole Utile) : Useful Agricultural Surface

SECADENORD (Société d'Exploitation et de Distribution des Eaux du Nord) : Northern Water Distribution and Development Company

SMEV (Surface Minimale d'Exploitation Viable) : Minimal Surface of Viable Exploitation

SMVDA (Société de Mise en Valeur et de Développement Agricole : Value Enhancement and Agricultural Development Society

SONEDE (Société Nationale pour l'Exploitation et la Distribution des Eaux : National Water Exploitation and Supply Company

UF (Unité Fourragère) : Forage Unit

ULAP (Union Locale des Agriculteurs et des Pêcheurs) : Local Union of Farmers and Fishermen

URAP (Union Régioanle des Agriculteurs et des Pêcheurs) : Regional Union of Farmers and Fishermen

URD (Unité Régionale de Développement) : Regional Development Unit

UTAP (Union Tunisienne des Agriculteurs et des Pêcheurs) : Tunisian Union of Farmers and Fishermen

UZB (Unité Zootechnique Bovine) : Bovine Zootechnical Unit

I - Introduction

I.1 - General socio-economic policy of Tunisia

I.1.1 - The priorities of national policy

a) The elimination of poverty

Tunisia's economic policy has aimed, since independence, for integral development of the country. Since the "Change" in 1987, attention has focused on the "shadow zones", primarily in rural areas and in the suburbs of agglomerations. For these zones a program of interdependent financing of infrastructures, Program 26-26, has been set up. As a consequence of this program's interventions, the proportion of the population living below the poverty line is constantly falling, and today is limited to approximately 400.000 people.

Thus, any agricultural development project which aims to improve the performance of the rural populations' principal source of income contributes to the elimination of poverty.

b) The search for regional balance

Moreover, the intrinsic tendency of development being to concentrate on coastal zones that have been favoured from the beginning, the Tunisian State has worked since the Eighties to encourage development efforts in the interior regions, and even more so in the border regions of the country. After the creation of the General Committee of Regional Development, an investment encouraging zoning structure was set up to support these areas, including:

- the reduction of professional taxes,
- a ten-year grace period before the application of income tax,
- an increase in subsidy rates for achieved investments,
- a provisional exemption from social contributions for locally recruited personnel.

Based on the mitigated success of these tax measurements, the State has reinforced its efforts for the past ten years by starting a policy of integration for rural areas. This policy focuses on upgrading the road network, specifically through the development of a motorway infrastructure comparable with the one that connects Tunis to the coasts of Sousse, and soon to those of Sfax. A 52 kms section of motorway now connects Bizerte to Tunis, and another section of 55 kms will connect Oued Zarga to Tunis in the Mejerdah valley. Because these two sections avoid crossing many villages, and therefore the speed limits imposed there, they effectively decrease the distances to Bizerte, Béja and Jendouba by a good half an hour.

I.1.2 - The agricultural policy of Tunisia

a) M/ARH position in the official Tunisian system

a.1) M/ARH role

The mission of the ministry of Agriculture and Hydraulic Resources is to carry out, in coordination with the ministries concerned, the state policy in the field of agriculture and fishing, to oversee the promotion of this sector, and to support the creation of a favourable climate for its development.

Thus, it is responsible for ensuring the mobilization of all available natural resources and for accomplishing all basic infrastructure works aiming at the conservation of farm land holdings, the conservation of the elements of production and their support in favour of a general and continuous agricultural development.

a.2) M/ARH attributions in matter of development

In addition to the preparation of projects of legislative and legal texts relating to the promotion and development of the agricultural sector and the reform of agrarian structures, the ministry of Agriculture and Hydraulic Resources has the following responsibilities:

1. to work out plans and strategies aiming at the qualitative promotion of agriculture, to adopt various programmes and projects of development within the framework of the development plan, and to follow up on their execution ;
2. to create the means and the methods necessary to achieve self-sufficiency and food safety, and to follow up on their execution ;
3. to develop the sector's upgrading programmes and to assist participating institutions in their application ;
4. to support the efforts of agricultural product exportation, to seek new markets and to follow the evolution of international trade in agricultural products ;
5. to take and propose appropriate measures to ensure the promotion of the sector ;
6. to design financing programmes for the agricultural sector and to execute them ;
7. to work out the terms of reference related to studies, research and experiments tending toward the development of the agricultural sector and to follow up on their execution ;
8. to ensure the coherence of regional programmes of regional agricultural value setting with the national development program.

It is responsible for implementing the means necessary for the promotion of the agricultural sector in order to:

1. preserve, promote and better use natural resources ;
2. protect water, soil and arable lands ;
3. encourage the diversification of Tunisian agricultural products ;
4. encourage the development of organic farming ;
5. study and carry out schemes and projects for hydro-agricultural development ;
6. re-equip farms and increase their productive capacities ;
7. to improve the technical level of all participants through the organization of agronomic research tasks, applied experiments, training programmes and popularisation actions ;
8. to train agricultural producers and professional organizations.

b) Agricultural policies carried out over the past thirty years

b.1) The initial policy of food self-sufficiency of the seventies and eighties

The agricultural policy of Tunisia in the beginning of the Seventies aimed initially at reaching self-sufficiency for the country's food requirements: to avoid any risk of disorganizing the world foodstuffs trade, the national levels of production must meet the Tunisians' food needs. This orientation towards the production of all the food and industrial products consumed in Tunisia allowed for the development of poultry and dairy bovine productions, and the reinforcement of durum wheat harvests.

b.2) The food safety policy of the nineties

But in the middle of the Eighties, the resounding failure of the " Sugar beet " and " Cotton " strains combined with persistent deficits concerning strategic cultivations, like Common wheat and Barley, and very strong fluctuations observed in olive oil exports, led the Tunisian State to redefine the concept of the term " food safety ", terminology used all throughout the nineties. The Agricultural trade balance of Tunisia must be in equilibrium. Exports of Tunisian agricultural produces (olive oil, dates, citrus fruits, wine, eggs) in an average year must be able to finance imports of structurally insufficient products (cereals, cattle food).

To take into account inter annual climatic variations, the surpluses recorded by the food trade balance during exceptionally rainy crop years must cover the deficits recorded during crop years marked by unfavourable climatic conditions (insufficient rainfall, episodes of hail, numerous sirocco winds).

b.3) The current concern to ensure the competitiveness of Tunisian agriculture

With the growing freedom of international trade, the Tunisian State has recommended since the year 2000 that the country strive for agricultural competitiveness. This orientation has been integrated into the design principle for regional agricultural maps.

According to its agricultural map, each CRDA will have to encourage productions for which its physical and human potentials allow it comparative advantages in relation to its principal customers, such as olive oil throughout Tunisia, dates in the Southern oases, wine on the slopes of North-Eastern Tunisia, Durum wheat, Barley and milk in Northern Tunisia, sheep in Central and Southern Tunisia, camels in the extreme South of Tunisia.

On the other hand, farmers should no longer be encouraged to produce certain over-subsidized products, such as common Wheat everywhere, sheep in North or durum Wheat, Barley and milk in Central and Southern Tunisia.

Finally, the practice of sustainable agriculture, or even of organic agriculture, is recommended because there is a significant consumer market on the northern bank of Mediterranean Sea.

b.4) Recent choices of the Tunisian Tobacco Board

In light of the development of anti-tobacco policies throughout the world, the industrial sector tends to develop light cigarettes manufactured from blond tobaccos. To reduce importation costs, the Tunisian Tobacco Board started to introduce new varieties of seedlings to provided leaves of the required quality. However, these new varieties cannot endure irrigation by relatively charged waters, and the production of traditional varieties in Central Tunisia has been prohibited for the short term.

On the other hand, this orientation has resulted in a search for new seeding surfaces in Northern Tunisian zones where irrigation water resources are of very good quality.

c) VIIIth Economic and Social Development Plan for Agriculture and Natural Resources

The V^{III} PDES was under execution in 1995-1996 during the irrigated perimeters feasibility studies and the signature of loan agreements between the JBIC and Tunisian government. During the preparation of that plan, several directions were enacted and they have been still guiding the country s' agricultural development policy:

- Investments and production systems reorientation according to the principle of comparative advantages.
- The continuation of institutional reforms, in particular, public services disengagement toward competitive activities for private and associative sectors.
- The rational use of resources, infrastructures and available potentialities.
- The encouragement of organized and efficient professional sector advent.

The axes of the agricultural development policy during the VIIIth PDES were:

1. Hydraulic resources mobilization, protection and rational use.
2. Agricultural environment conservation and protection.
3. Improvement of agricultural sector s' productivity
4. Improvement of the general environment of the agricultural activity
5. Implementation of plans relative to productions intensification and food processing industry development.

It's noticed that the three JBIC Projects respect the axes 1 and 3 as mobilizing hydraulic resources to improve the agricultural sector s' productivity in the five plains that were initially almost exclusively developed through pluvial cultivations.

d) Xth Economic and Social Development Plan for Agriculture and Natural Resources

The Xth PDES is the Plan being carried out in 2005 at the time water is being set up in irrigated perimeters. The axes of the agricultural development policy during Xth PDES aim at taking up the new challenges with which the sector is currently confronted.

d.1) Challenges to take up

Indeed, the agricultural sector, which has nearly ensured the food safety of the country while ensuring surpluses for certain products, is currently faced with new challenges:

- a greater openness to external markets, from which the need to adapt to the international environmental requirements of product quality standards;
- consideration of climatic conditions and adaptation of the development policy so that it attenuates the variability of the agricultural production and guarantees sustainable growth;
- management of production surpluses;
- sustainable management of natural resources so as to preserve ecological balances and to guarantee the sustainability of resource use.

d.2) The Strategy of the Xth PDES for the agricultural and Natural Resources sector

Taking the country's program of economic development for the next decade into account, the development policy of the agricultural sector will be built on the following bases:

- the appearance of structural surpluses related to the sustainable growth of agricultural production, which requires setting up a management strategy for these surpluses through exports and production diversification;

- sustainable rural development and improvement of farmers' living conditions and incomes to support them in this activity, in particular in difficult zones such as the North-Western mountainous zones;

- continuation of the mobilization of natural resources, in of particular water and soil, and rationalization of their exploitation;

- a pricing policy increasingly centred on market law, with a marketing strategy increasingly reliant on regulation mechanisms through storage or agro-industrial transformation to avoid a slump in prices during full production periods.

I.1.3 - The main socioeconomic indicators of the country

a) The national rate of poverty

Tunisia is one of the countries that had reduced its rate of poverty the most appreciably, the latter fell from 12.9 % of people leaving under the national poverty line in 1980, to 6.2% in 1995. In spite of the numerous granted efforts, some poverty pockets have still remained steady for a few years, probably in part due to the increasing unemployment rate.

The type profile of the poor presented in 1990 these following features:

- He lives in urban environment (the poverty in a urban environment concerns 7.3% of the population as against 5.7% in a rural environment). 16% of the urban are poor in the North west area,, and 15.7% in the centre west area.

- He is unemployed or born into a family with its head jobless (19.2% of the unemployed are poor) ;

- He belongs to a household made of more than 7 persons (10% of these households are poor and account for about half of the whole poor population) ;

- He lives in a rudimentary accommodation or in a hovel composed of less than 3 rooms (19% of these accommodation occupants are poor).

b) The national rate of unemployment

The unemployment rate has been evaluated to 15% in 1997, with rates reaching 21% in some west areas of the country, and this despite of an absorption rate of a constant increasing additional demand which attained 91.4% during the period 1997-2001. The unemployment didn't stop increasing since then, owing to limited economic restructuring consequent to the opening process and the liberalization on the one hand, and due to demographic development and the increasing part of the labour force in the total population (process that will continue until around 2030) on the other hand.

Therefore employment represents a national priority, since 63% of the unemployed are under 29 years old, that an increasing part of them are graduate of the higher education (4.0% in 1997 as against 0.7% in 1984) and that 49% of these unemployed are henceforth long run unemployed. But the privatization processes and the structural changes linked to the economic opening process would continue to involve job losses (around 13,000 redundancies in 1997).

Even if the feminine labour force is more educated than its male homologous (9.1% of women have attained the higher level, as against 6.4% of men), the female employment is seriously threatened because it's mainly concentrated in fields destined for distressing restructuring, linked to the globalization of the tunisian economy, such as agriculture and the textile industry.

c) The national rate of illiteracy

Even if it follows an unbroken regression, the rate of illiteracy remains high : 27% of the population above 10 years old is concerned, and notably 53% of the rural women. In 1999, the illiteracy was still affecting 8.5% of the aged 15-24, which has direct impact on the unemployment as 62.2% of the jobless persons were illiterate or at a primary instruction level in 1997, and that the academic failures and/or desertions pose important problems for the youth insertion in the socio-economic life.

d) The national rate of infant under five years old mortality

In terms of the indicators of the state of health of the population, the regression of the infant and children under five years old mortality is regular, and are estimated nowadays at 24 and 30 per 1000 leaving births respectively. The Table n° I-1 below submits the evolution of the global rate of infant mortality of the under 5 years old observed between 1980 and 1996 in the varied annual surveys realized and published.

Table n° I-1: levels and rates of infant mortality in Tunisia during 1980-1996 (in ‰)

Year	Rate of infant mortality	Year	Rate of infant mortality
1980	**75.0**	**1991**	**40.0**
1981	**71.0**	**1993**	**43.0**
1982	**64.6**	**1994**	**32.6**
1984	**51.4**	**1995**	**30.6**
1988	**51.6**	**1996**	**30.6**

Source : Annuaires Statistiques, Volumes 10 à 38

This Table n° I-1 shows a distinct evolution of this rate between 1980 and 1995. The Table n° I-2 below distinguishes the rate of infant mortality of those below 5 years old and its anticipated evolution until 2030 according to the sex.

Table n° I-2 : Evolution perspectives of the rates of infant mortality of the under 5 years old (in ‰)

Year / Sex	1995	2000	2010	2015	2020	2025	2030
Male	33.8	26.2	16.1	13.2	11.2	9.9	9.0
Female	27.2	20.9	12.7	10.4	8.8	7.7	7.0
General	**30.6**	**23.5**	**14.4**	**11.8**	**10.0**	**8.8**	**8.0**

Source : « Projection de la population 1995-2030, niveau national », Vol I, Ministère du Développement économique, INS juillet 1996.

This **Table n° I-2** shows only a little difference between boys and girls, which is in favour of the latter, more robust.

The Table n° I-3 of the page I-7 compares the rates of infant mortality of the under one year old according to the residence environment.

Table n° I-3: Comparison of the rates of mortality between 0 and 1 year according to the age by residence environment (in ‰)

Age (days)	TOTAL TUNISIA	environments		Rural rate /urban
		urban	rural	
0-7	**17.3**	11.8	22.1	187.3%
8-28	**9.4**	5.8	12.6	217.2%
0-28	**26.7**	**17.6**	**34.7**	**197.2%**
29-90	**9.6**	3.6	15.0	416.7%
91-180	**8.7**	6.6	10.5	159.1%
181-365	**7.7**	5.0	10.5	210.0%
29-365	**26.0**	**15.2**	**36.0**	**236.8%**
0-365	**52.7**	**32.8**	**70.7**	**215.5%**

This Table n° I-3 shows that the rural environment registers neo and post-neonatal rates of mortality twice as important as those registered in the urban environment, and for all age groups. This is also the case for the infant and under five years old mortalities.

The Table n° I-4 below compares at the same way the rates of infant mortality of those below 1 year old according to the residence area.

Table n° I-4: Comparison of the between 0 and 1 year rates of mortality according to the age by large area (in ‰)

Age (days)	TOTAL TUNISIA	Areas		Rate N-W /N-E
		North-East	North-west	
	Concerned Gvt	Bizerte	Jendouba, Béja	
0-7	**17.3**	12.6	11.4	90.5%
8-28	**9.4**	2.0	13.5	675.0%
0-28	**26.7**	**14.6**	**24.9**	**170.5%**
29-90	**9.6**	4.9	8.0	163.3%
91-180	**8.7**	7.7	4.0	51.9%
181-365	**7.7**	4.8	5.8	120.8%
29-365	**26.0**	**17.4**	**17.8**	**102.3%**
0-365	**52.7**	**32.0**	**42.7**	**133.4%**

This Table n° I-4 shows that the North-West area records neo and post-neonatal rates of mortality 1/3 times as high as those recorded in the North-East area, for all age groups. It's the same for the infant and under five years old mortalities. This is mainly explained by the presence of hospital structures in the North-East area.

e) National rates of malnutrition and growth delay

It seems that the same disparities between rural and urban environment are the same for the sharp malnutrition and the growth delay. These results are given by the national surveys on nutrition 1996-1997 published by the public health Ministry, and comprising varied indicators.

The chronic malnutrition rate of the under five years old reaches 8.3% with 1.5% of severe chronic malnutrition and a rate of prevalence anemia equal to 21.7%.

f) The national rate of vaccine coverage

The rate of complete vaccine coverage of children under one year old is superior to 90%, which almost allowed to eradicate the poliomyelitis, the neonatal tetanus and the measles.

I.1.4 - Presidential decisions for the XIth PDES

Here are the major decisions announced to Tunisian farmers on 104/16/2005 by his Excellency, President Zine El Abidine BEN ALI in the speech he gave for the opening of the XIIIth Congress of the Tunisian Agriculture and Fishing Union. In this speech, he presented his electoral platform, developed during the presidential electoral campaign of 2004.

a) Presidential decisions concerning hydraulic resources

1. "To undertake an evaluation of various irrigated zones in order to determine their level of exploitation, and to propose efficient solutions to improve their profitability[1]";
2. "To develop a study concerning water irrigation tariffs and to propose solutions in this matter in order to reconcile the profitability of hydraulic projects with the needs of farming activities."

b) Presidential decisions concerning protection against erosion

1. "To apply a plan which provides 345,000 ha of land with irrigation equipment, and the consolidation of that land by productive plantations."

c) Presidential decisions concerning small farms of a familial or social nature

1. "To develop a complete inventory of the pilot program set up to benefit 20,000 farmers who qualify for the PACFS, towards the goal of defining a strategy that would allow the promotion of the activities of this category of farmers and to improve their conditions".

d) Presidential decisions concerning agricultural education and training

1. "To set up an alternating training in order to ensure a balance between the education and training programs and the demands of this sector and to fill the gap between theoretical and practical training."
2. "To instil notions of quality and exportation as fundamental subjects in the programs of the various training programs."

e) Presidential decisions concerning the organisation of landed estates

1. "To automatically invest operations involved in the organisation of landed estates in projects of integrated agricultural development";
2. "To consolidate the financial resources of agricultural estate credit for the benefit of young

[1] *We can clearly see that mid-term evaluation program, with diagnostic constraints, here proposed, fits perfectly within the framework of the first presidential decision.*

farmers and holders of diplomas in agronomy and speed up the development of a legal framework to encourage co-exploitation, as well as exploitation by way of long-term lease, in order to gradually ensure the expansion of the surface areas of small and medium-sized land parcels, and to invest them in the economic circuit and to bring their produce to the markets";

3. "To find solutions to problems of indivisibility that are often the cause of poor exploitation, including the neglect of lands, and intensify the rhythm of reform of estate problems through the Agricultural Estate Agency, in order to attain the objectives fixed in this domain, and the fight against the dispersal of landed properties, by intensifying agrarian reform programs and overseeing their acceleration."

f) Presidential decisions concerning the promotion of agricultural products and the stakes of competitiveness

1. "To set up a "quality network," under the supervision of the Offices of basic products and mixed inter-professional Groups, while establishing procedures that allow for the guarantee of the network's efficiency, in order to establish, for agricultural products, distinctive signs to benefit their distribution on international markets";

2. "To establish a new partnership between producers and exporters, on the basis of mutual trust, in order to guarantee an acceptable equilibrium between the two and ensure the interests of one another as well as the foreign client, while conferring a more important role to the mixed inter-professional Groups in the stimulation of exportation, the exploration of new markets, and the presentation of our products and their characteristics";

3. "To expedite the setting up of decisions made at the level of the Superior Counsel of Exportation and Investment, in order to establish an executive program for the classification of agricultural and fishing products on our exterior markets."

I.2 - Integrated water resources management in Northern Tunisia

The national policy of integrated water resources management in Tunisia is based on several strategic studies:

- the master plans for Waters of the North, Centre and South (in the Seventies);
- the study "Economy of water 2000" (1990-1995);
- the study on "the natural resources strategy" (1997);
- the study of "the sector of water" (1997);
- "Decennial strategy of water resources mobilization" (1991-2000);
- "Water XXI": the water sector strategy in Tunisia (1998).

This last document, which recalls the policy to be adopted concerning the management of water until 2030, will be detailed in **§ I.2.1 – c.1)**

I.2.1 - A rather dry climate marked by strong inter annual variability

a) General climatic tendencies of Tunisia

All over Tunisia, the climate gets its characteristics and its rhythm from the general atmospheric circulation, including:

- in winter, reinforcement of air masses and polar disturbances, which cause fresh episodic infiltrations accompanied by rainy periods ;
- during the hot and dry season, contributions of hot and dry sub tropical air.

During transition seasons (autumn and spring), one notes an aero logical swinging which undergoes and reflects the principal climatic components without a precise calendar or rhythm, a swinging characterized by a space-time irregularity and an unequal dynamism. The aero logical and frontal transitions can be:

- short or spread out over these two seasons, by respectively giving short or long rainy seasons;
- early or late, advancing or delaying rains.

The geographical progression is not homogeneous either and, if the North-West is often touched on by Mediterranean fronts and disturbances, they concern the Centre of the country only episodically and unequally, and rarely concern the South. The unequal dynamism depends on the hygrometric and thermal conditions of the air masses concerned, and the hydrous and thermal state of the ground:

- weak contrasts reduce instability, and consequently precipitation ;
- very marked gradients generate a great instability, and thus strong winds or intense localised downpours.

b) Distribution gradients of the various climatic parameters

All the climatic parameters, namely sunshine, temperatures, nebulosity and precipitations, calm and winds, evaporation or evapo-perspiration and hygrometry, are distributed through the country according to several gradients ordered by the effects, classified by descending order according to the position in latitude (North-South), in altitude (plain-relief) and of continental characters (littoral-interior). In fact, the bio-climatic division of the territory partially follows physiographical subdivisions, since one can identify 3 great bio-climatic fields:

- a northern, Mediterranean field wet with a superior semi-arid,
- a central field of Mediterranean-Saharan, semi-arid, and arid contact,
- a Saharan, arid southernmost field, arid to hyper-arid.

This variability is the consequence of the combination of several scales:

- on a national scale, one notes in the North-South direction a regular decrease of annual and seasonal rainfall totals, as well as the number of rainy days ;

- on a regional scale, temporal differences are recognized : autumnal rains prevail in the North-West and decrease in frequency while going towards South, whereas spring and estival rains are increasingly better represented to the South and the West ;

- on a local scale, one always notes a better rainfall on raised areas than on neighbouring plains.

As it is shown by the bio-climatic map of Northern Tunisia, the projects financed by the JBIC belong to the northern field which extends wholly on 28,000 km^2, that is to say 17% of the national territory, and receives precipitations varying between 400 and 1,200 mm which account for 41% of the precipitation volumes in Tunisia.

c) Marked rainfall risks

The annual average precipitations and the average number of rainy days give only one statistical idea which should not mask the great variability and unequal distribution in time and space of annual precipitation.

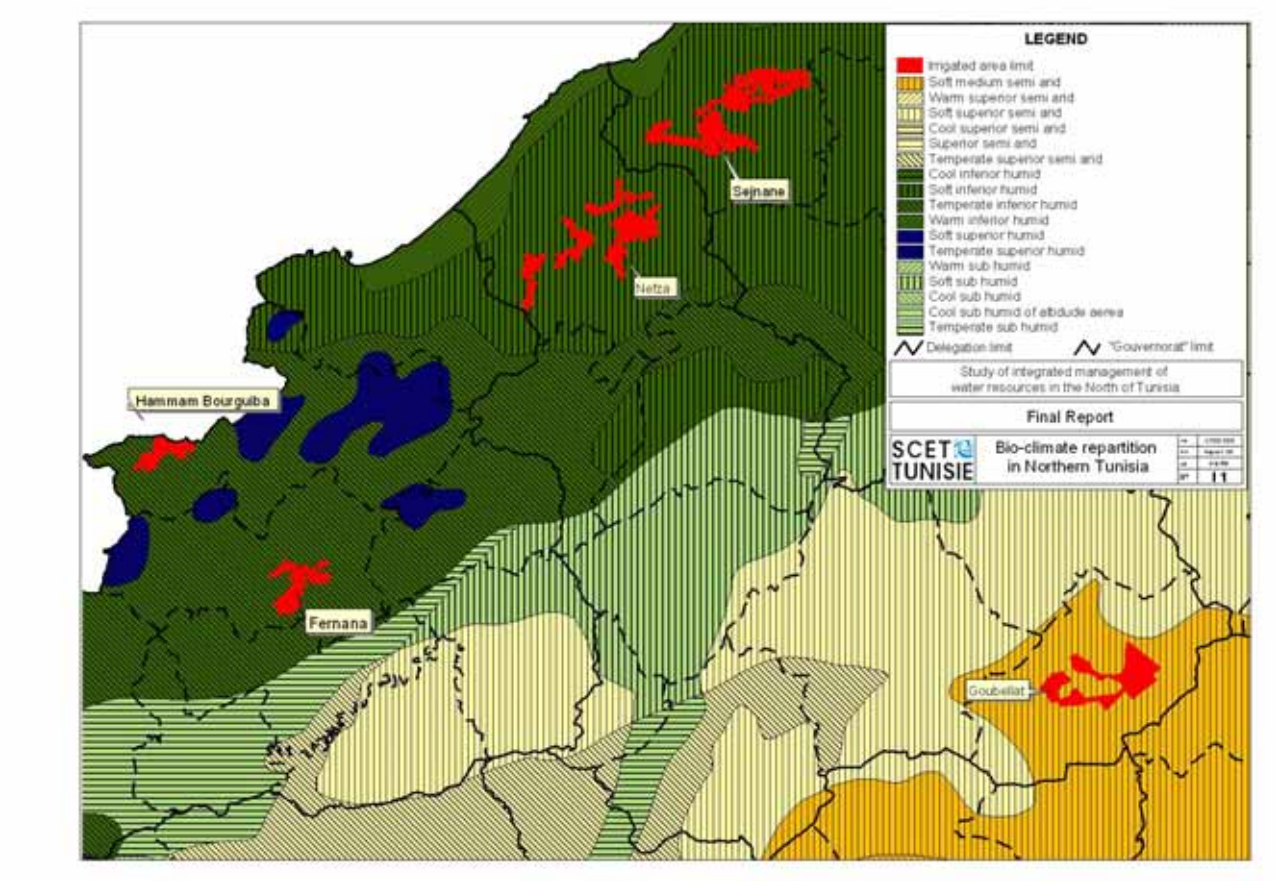
c.1) Risks of the precipitated total

Indeed, normal or average annual rainfall is very rare, and wet or dry years follow one another without precise periodicity. Thus the analysis of long weather series make it possible to distinguish between sequences or pseudo-cycles of dry years (1918-19 to 1926-27, 1942-43 to 1947-48, 1962-63 to 1968-69) and of wet years (1927-28 to 1934-35, 1952-53 to 1960-61, 1969-70 to 1975-76).

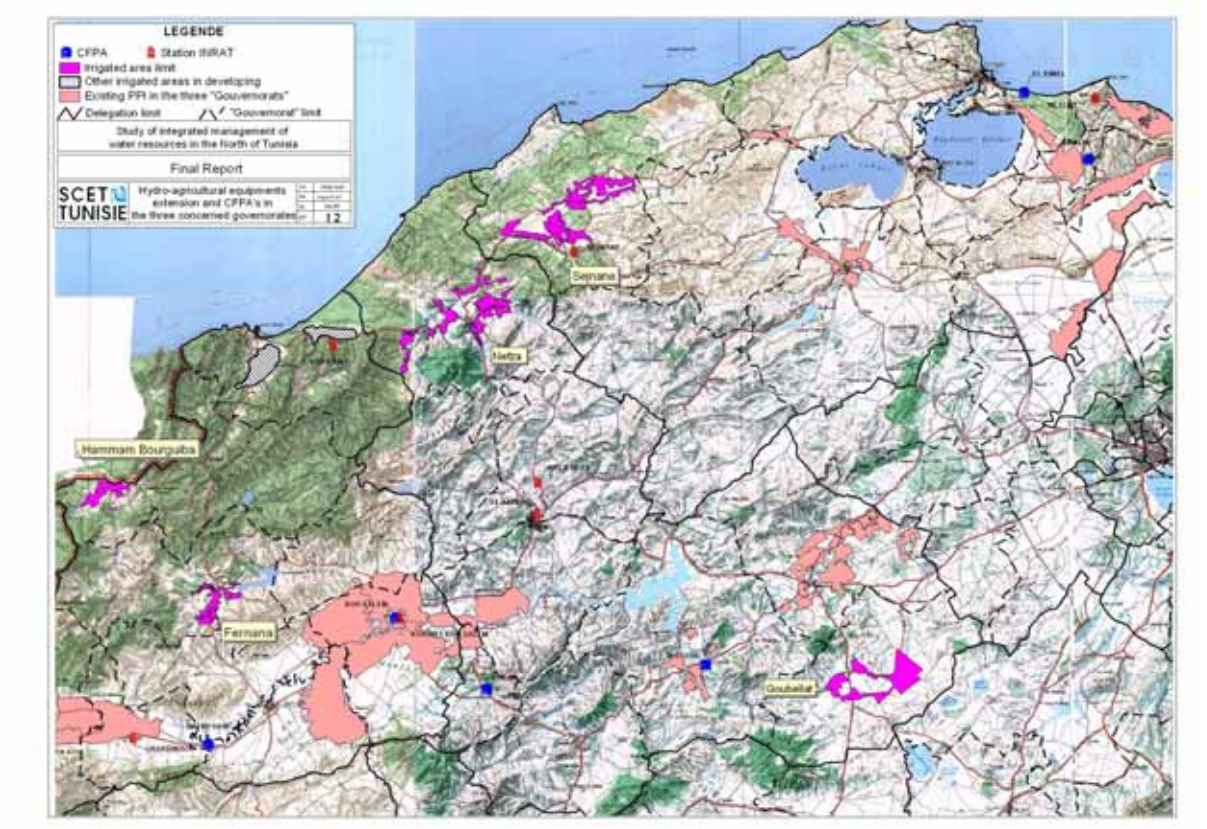
The duration of these pseudo-cycles, in which one notes the occurrence of one or two exceptional years, can thus be estimated between 5 and 10 years.

c.2) Risks of the temporal distribution of precipitations

Moreover, the wet or dry character of one year does not depend only on total precipitated volume, but also to a large extent on the temporal distribution of these rainfalls. Intense, but overly concentrated rains can fill ponds and cause floods without making a wet year, while a total that is lower that average, but well distributed on a large number of rainy days, benefits infiltration, water tables, forest and pastoral coverage and rainfall cultivations.



Map n°I-1 : Bio-climate repartition in Northern Tunisia



Map n°I-2 : Hydro-agricultural equipments extension and CFPA's in the three concerned governorates

However in all areas of the country, the number of rainy days is as variable as the annual rainfall totals. The North-Western area is the zone where this variability is the lowest, and where torrential precipitations are the least frequent, because it is characterized by more frequent descents of "Mediterranean polar air ", made up of fresh and wet Atlantic air supplied with polar air, which gives precipitations the possibility to cover the whole of Atlases' Tunisia.

d) Coherence of the three Projects with the climatic changes and the recorded hydrous deficits

It was seen that Tunisian climate is marked by strong inter-annual irregularities. Any hydro-agricultural installation allows to mitigate in the arranged grounds the effects of an insufficient rainfall.

Even in average year, the climatic conditions in the TS-P7 Project two arranged plains lead to the appearance of a summery hydrous deficit which prevents the practice of the summery cultivations in pluvial mode.

d.1) A TS-P7 Project in coherence with climatic changes and the recorded hydrous deficits

d.1.1) Useful rain fall on Nefza and Sejnane perimeters

Table n°I-5 below displays the results of these calculations starting from the average values recorded between 1901 and 1990 on the closest weather stations to Nefza and Sejnane perimeters, respectively Tabarka and Sejnane stations.

Table n°I-5 : Average useful rainfall calculated for stations close to Nefza and Sejnane between 1901 and 1990

Month / weather Station	Jan	Feb	Mar	Apr	May	June	July	August	Sep	Oct.	Nov.	Dec	**Year**
Tabarka													
Rainfall (mm / 84 years)	160.1	126.0	88.8	69.6	40.2	16.1	3.9	9.7	51.6	118.4	141.8	172.9	**999.5**
Rainy days average n°	16	14	11	10	7	4	1	2	7	11	13	16	**112**
Useful rainfall (mm)	128.1	100.8	71.0	55.7	32.2	12.9	3.1	7.8	41.3	94.7	113.4	138.3	**799.3**
Sejnane													
Rainfall (mm / 84 years)	150.5	109.6	83.6	60.7	37.1	11.4	2.4	9.3	42.8	98.3	123.5	169.1	**896.7**
Rainy days average n°	16	13	12	9	6	4	2	3	8	11	13	16	**108**
Useful rainfall (mm)	120.4	87.7	66.9	48.6	29.7	9.1	1.9	7.4	34.2	78.6	98.8	135.3	**718.6**

Knowing that Nefza plain is located halfway between these two weather stations, one can consider that it is the average of the useful rainfall of the two stations that constitute useful rainfall on the grounds concerned by the installation of the irrigated perimeter in this plain.

d.1.2) Temperature change on Nefza and Sejnane perimeters

The air temperature is an important weather element for plants development and water needs. The air temperature spacial distribution in an area is mainly conditioned by physio-graphical factors: the relief (altitude and exposure), the ground s' cover and nature, the proximity of water large surfaces and the winds mode.

Table n°I-6 on page I-15 displays the monthly and annual average values of maximum, minimum and daily air temperature average, the average thermal amplitude and the values of the absolute maximum and minimal temperatures observed during the period 1901-1990 at the stations of Bizerte and Tabarka.

Table n°I-6 : Values of the air temperature (°?C)

Station	Month θ averages (ºC)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct.	Nov	Dec	**Year**
Bizerte	Absolute maximum	24.0	28.0	31.2	33.0	39.0	43.8	45.0	48.0	45.0	37.0	35.0	25.3	**48.0**
	Maximum	14.5	15.4	17.5	20.0	23.1	27.8	30.2	30.9	29.2	24.9	20.6	16	**22.5**
	Average	11.3	11.6	13.4	15.4	18.4	22.5	25.2	25.9	24.4	20.4	16.4	12.6	**18.1**
	Minimum	7.7	7.8	9.4	10.9	13.7	17.8	20.2	21	19.6	16.0	12.0	9.2	**13.8**
	Absolute minimum	0.0	-1.0	1.0	1.0	7.0	8.0	8.0	12.0	10.0	7.0	3.0	00.	**-1.0**
	Thermal Amplitude	6.8	7.6	8.1	9.1	9.4	10.0	10.0	9.9	9.6	8.9	8.6	6.8	**8.7**
Tabarka	Absolute maximum	25.0	29.0	34.0	35.0	38.5	42.0	45.0	47.0	43.0	40.0	31.0	29.0	**47.0**
	Maximum	15.1	15.7	18.4	20.7	23.5	27.9	30.5	31.0	29.0	24.4	19.9	16.1	**22.7**
	Average	11.1	11.4	13.4	15.2	18.7	22.5	24.9	25.6	23.9	19.8	15.6	12.3	**17.9**
	Minimum	7.2	7.3	8.9	10.9	13.5	17.3	19.4	20.1	18.7	15.2	11.3	8.5	**13.2**
	Absolute minimum	0.0	0.0	1.0	4.0	5.0	7.0	11.0	12.0	8.0	5.0	2.0	-1.0	**-1.0**
	Thermal Amplitude	7.9	8.4	9.5	9.8	10.0	10.6	11.1	10.9	10.3	9.2	8.6	7.6	**9.5**

We concluded that the monthly values of the air temperature vary with some regularity during the year, with a maximum in July and a minimum in January. The weakness of the annual thermal amplitude reflects the coastal situation of these two stations. Moreover, the absolute maximum temperatures are higher than 40 ºC during the period June-October, and zero or negative absolute minimum temperatures are recorded during the period December-February.

As we know that Nefza plain is slightly more continental than Tabarka station and that Sejnane plain is more continental than Bizerte station but located at a higher altitude. So, we can consider that these average values in the stations constitute quite close values to the observable average values in the two irrigated perimeters.

d.1.3) Potential evapo perspiration in Nefza and Sejnane perimeters

Table n°I-7 of page I-15 presents the evapo perspiration monthly values calculated regarding the Blanney-Criddle empirical formula.

Table n°I-7 : Calculations of the average ETP by Blanney-Criddle empirical formula

Average ETP	Altitude (m)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	**Year**
Tabarka														
Monthly	66	41.3	42.9	64.2	82.9	121.4	158.0	190.6	188.7	145.8	103.0	63.6	45.0	**1 247.5**
Daily		1.33	1.52	2.07	2.76	3.92	5.27	6.15	6.09	4.86	3.32	2.12	1.45	**3.42**
Bizerte														
Monthly	5	40.5	42.1	63.0	84.8	122.5	160.4	195.5	192. 3	147.7	103.7	64.3	44.8	**1 261.7**
Daily		1.31	1.49	2.03	2.83	3.95	5.35	6.31	6.20	4.92	3.35	2.14	1.44	**3.45**

As we notice the closeness of these values, and that Nefza plain is slightly more continental than Tabarka station, and that Sejnane plain is more continental than Bizerte station but is located at a higher altitude. Therefore we can consider that these values are quite close to the average values for the grounds concerned with the installation of the two irrigated perimeters.

d.1.4) Monthly hydrous deficits calculated for both Nefza and Sejnane perimeters

Diagram n°I-1 below compares these ETP and useful rainfall monthly distributions calculated for Mjez El Bab station, and allows to visualize the monthly distribution of the hydrous deficits, considering the average deviations between these monthly data.

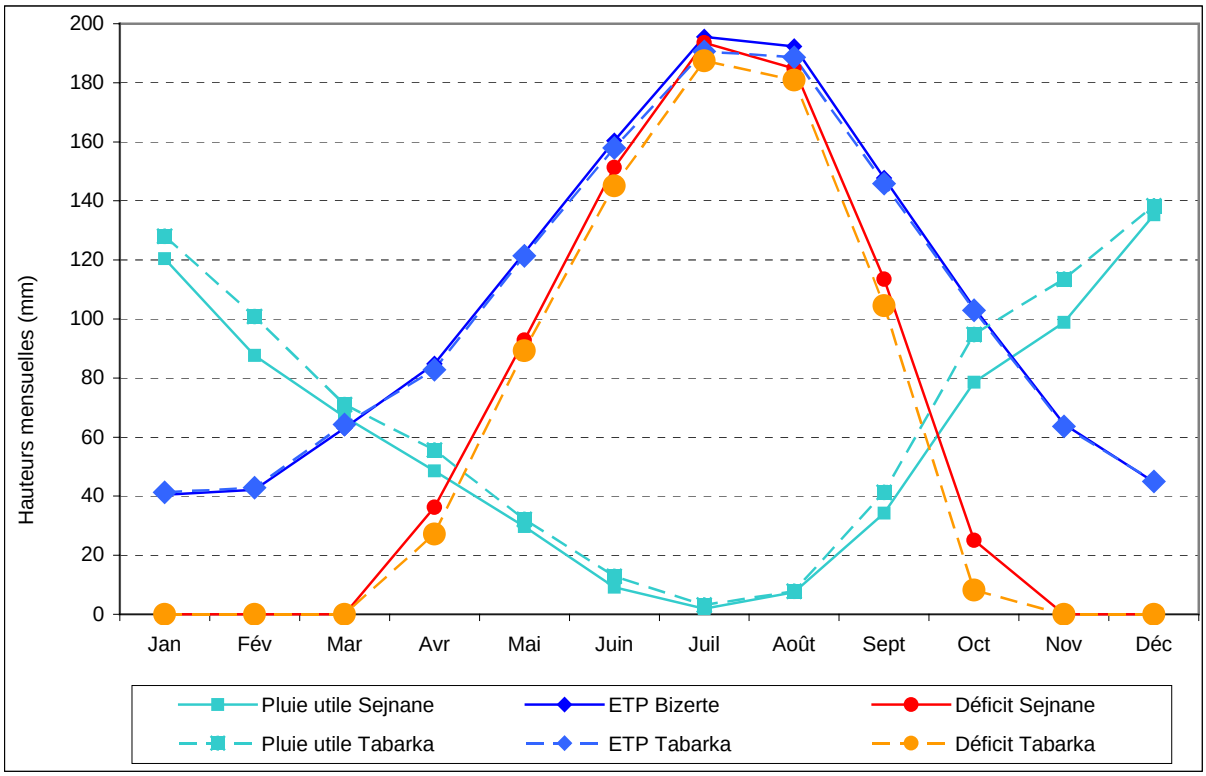


Diagram n°I-1 : Comparison of the monthly values of the useful rain, the ETP and the hydrous deficits

This **Diagram n°I-1** allows to note a strong concentration of the hydrous deficits between September and May. The seasonal distributions of these hydrous deficits are indicated in **Table n°I-8** below.

Table n°I-8 : Seasonal value of the deficits in Tabarka and Sejnane

Station	Season hydrous Deficits	Winter	Spring	Summer	Autumn	Year
Tabarka	Quantity (mm)	0.0	261.6	472.9	8.3	742.8
	Proportion (%)	0.0%	35.2%	63.7%	1.1%	100%
Sejnane	Quantity (mm)	0.0	280.3	491.9	25.1	797.3
	Proportion (%)	0.0%	35.2%	61.7%	3.1%	100%

So, we can notice an almost concentration of the hydrous deficits between spring and summer, since these seasons concentrate respectively more than the half and the third of the annual average deficits. During these two seasons, the cultivation irrigation is essential to ensure them a good productivity.

d.2) A TS-P11 Project in coherence with the climatic changes and the recorded hydrous deficits

d.2.1) Useful rain fall on Goubellat perimeter

Table n°I-9 below presents the results of the useful rainfall calculations from the average values recorded between 1901 and 1990 on the great weather station close to Goubellat perimeter: Mjez-El Bab station.

Table n°I-9 : Average useful rainfall calculated for the station close to Mjez-El Bab between 1901 and 1990

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct.	Nov.	Dec	**Year**
Rainfall (mm / 84 years)	60.3	52.3	45.9	37.1	24.1	14.9	3.2	8.6	32.2	45.6	42.7	52.4	**412.7**
Rainy days average number	12	9	8	8	5	4	1	2	5	6	8	10	
Useful rainfall (mm)	48.2	41.8	36.7	29.7	19.3	11.9	2.6	6.9	25.8	36.5	34.2	41.9	**335.4**

knowing that Mjez-El Bab station has more rainfalls than Goubellat plain, we can consider that these values are slightly higher than the average for the concerned lands with the irrigated perimeter 's installation.

d.2.2) Temperature evolutions on Goubellat perimeter

The air temperature is an important weather element for plants development and water needs. The spatial distribution of the air temperature in an area is mainly conditioned by physio-graphical factors: the relief (altitude and exposure), the ground coverage and nature, the large water surfaces proximity and the winds mode.

Table n°I-10 below presents the monthly and annual average values of maximum, minimum temperatures and air temperature daily average, the average thermal amplitude and the absolute maximum and minimum temperatures values observed during the period 1901-1990 at Mjez El Bab station.

Table n°I-10 : Air temperature average values (°C)

Month averages (ºC)	Jan	Feb	Mar	Apr	May	June	July	August	Sep	Oct.	Nov.	Dec	**Year**
Absolute Maximum	28.4	30.6	37.4	38.0	43.0	45.0	49.0	48.0	47.0	39.0	32.0	26.7	**49.0**
Maximum	14.2	15.8	19.1	22.3	26.6	33.4	35.1	34.4	30.8	25.5	19.5	15.4	**24.3**
Average	9.5	10.5	13.0	15.8	19.7	23.7	27	26.8	24.6	19.3	14.6	10.9	**18**
Minimum	4.9	5.4	6.8	9.0	12.6	16.9	18.8	19.1	18.3	14.0	9.6	6.4	**11.8**
Absolute Minimum	-3.0	-3.8	-3.0	-0.6	2.2	6.5	11.5	10.0	8.0	5.0	0.0	-3.0	**-3.8**
Thermal Amplitude	9.3	10.4	12.3	13.3	14.0	16.5	16.3	15.3	12.5	11.5	9.9	9.0	**12.5**

We deduce from this table that the monthly values of the air temperature vary with a certain regularity during the year, with a maximum in July, and a minimum in January. The importance of the annual thermal amplitude explains the continental factor of the station. Moreover, the absolute maximum temperatures are higher than 40 ºC during May-August period, and negative absolute minimum temperatures are recorded during the period December-April.

knowing that Goubellat plain is slightly more continental than Mjez-El Bab station, but is also located at a higher altitude, we can consider that these values are quite close to the average values observed in the irrigated perimeter.

d.2.3) Evapo-perspiration in Goubellat perimeter

Table n°I-11 below presents the evapo perspiration monthly values calculated regarding the Blanney-Criddle empirical formula.

Table n°I-11 : Calculations of the average ETP by the empirical formula of Blanney-Criddle

Average PET	Altitude (m)	Jan	Feb	Mar	Apr	May	June	July	August	Sep	Oct.	Nov.	Dec	**Year**
Monthly	54	39.1	41.6	63.4	84.3	124.6	162.5	199.8	193.7	148.3	101.7	61.8	43.0	**1 263.9**
Daily		1.26	1.47	2.05	2.81	4.02	5.42	6.45	6.25	4.94	3.28	2.06	1.39	**3.46**

Once again, since Goubellat plain is slightly more continental and is located at an altitude higher than Mjez-El Bab station, one can consider that these values are quite close to the average values for the concerned plots with the irrigated perimeter 's installation.

Diagram n°I-2 of page I-18 compares these monthly ETP distributions and useful rainfall calculated for Mjez-El Bab station, and allows to show the monthly distribution of the hydrous deficits, considering the average shifts between these monthly data.

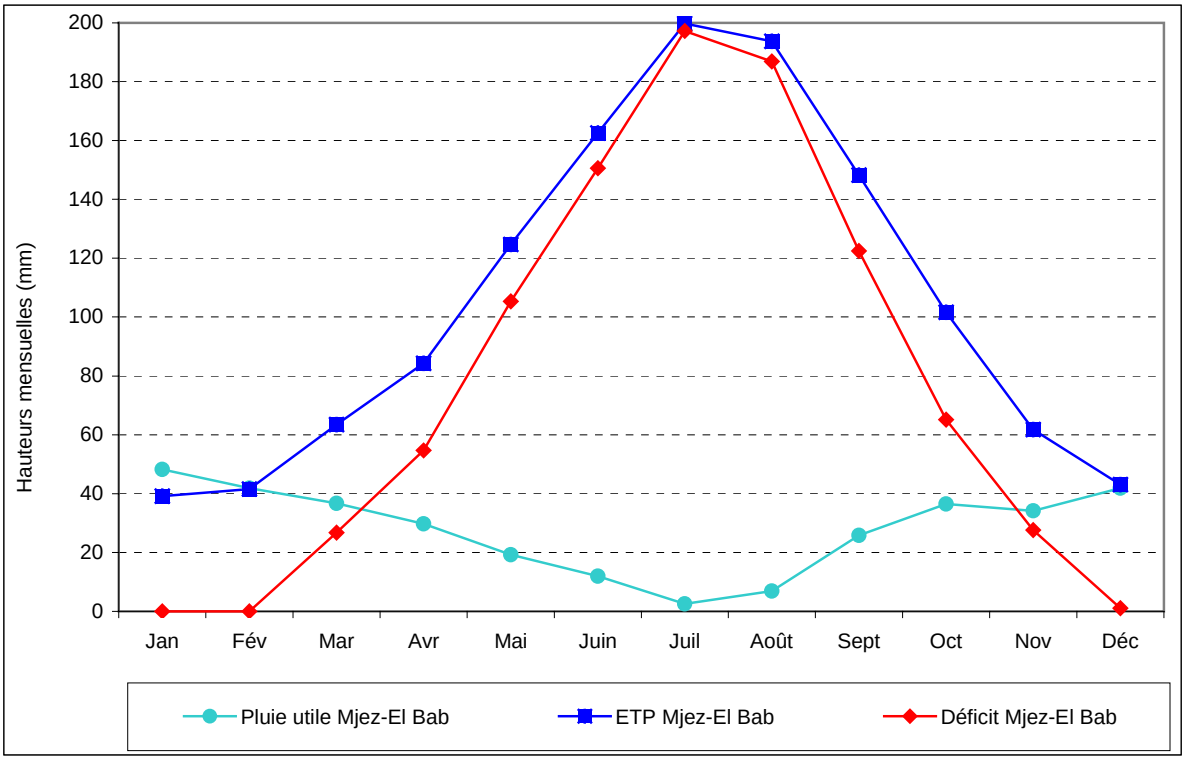


Diagram n°I-2 : Comparison between the useful rain monthly values, the ETP and the hydrous deficits

This **Diagram n°I-2** shows strong concentration of the hydrous deficits between October and April. The seasonal distributions of these hydrous deficits are indicated in **Table n°I-12** below.

Table n°I-12 : The deficits seasonal value in Goubellat

Season / Hydrous Deficits	Winter	Spring	Summer	Autumn	**Year**
Quantity (mm)	26.7	310.6	506.6	93.9	**937.9**
Proportion (%)	2.8%	33.1%	54.0%	10.0%	**100%**

Thus we can note a strong concentration of hydrous deficits between spring and summer, since these seasons have respectively more than the half and a third of the annual average deficit. During these two seasons, the cultivation irrigation is essential to ensure them a good productivity.

e) A TS-P13 Project in coherence with the climatic changes and the recorded hydrous deficits

e.1) Useful rain fall on Fernana and Hammam Bourguiba perimeters

Table n°I-13 on page I-19 presents the results of these calculations from the average values of the rainfall calculated for the two perimeters of the monthly values recorded between 1901 and 1990 on the great close weather station, namely Aïn Draham station. This station is located on the heights whereas Hammam Bourguiba perimeter is located on the north-western slope directly under maritime influence and Fernana perimeter on the south-eastern slope isolated from this influence.

The rainfall map of Tunisia s' North indicates a rainfall of 1,575 mm in Aïn Draham, and 785 mm in Fernana and 1,185 mm in Hammam Bourguiba, **Table n°I-13** below presents total and useful rainfalls recorded on that station and calculated for the two perimeters.

Table n°I-13 : Average useful rainfall calculated for Aïn Draham station between 1901 and 1990

Month / Weather station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct.	Nov.	Dec	**Year**
Aïn Draham													
Rainfall (mm / 84 years)	247.9	202.9	161.1	136.9	79.3	26.7	5.8	13.5	66.7	151.4	197.1	263.3	**1 552.6**
Useful rainfall (mm)	198.3	162.3	128.9	109.5	63.4	21.4	4.6	10.8	53.4	121.1	157.7	210.6	**1 242.1**
Fernana													
Rainfall (mm / 84 years)	123.6	101.1	80.3	68.2	39.5	13.3	2.9	6.7	33.2	75.5	98.2	131.2	**773.7**
Useful rainfall (mm)	98.9	80.9	64.2	54.6	31.6	10.6	2.3	5.4	26.6	60.4	78.6	105.0	**619.0**
Hammam Bourguiba													
Rainfall (mm / 84 years)	186.5	152.7	121.2	103.0	59.7	20.1	4.4	10.2	50.2	113.9	148.3	198.1	**1 168.3**
Useful rainfall (mm)	149.2	122.2	97.0	82.4	47.8	16.1	3.5	8.2	40.2	91.1	118.6	158.5	**934.6**

e.2) Temperatures evolution on Fernana and Hammam Bourguiba perimeters

The air temperature is an important weather element for plants development and water requirements. The air temperature spacial distribution in an area is mainly conditioned by physiographical factors, by name the relief (altitude and exposure), the ground s'nature and coverage, the proximity of large water surfaces and the winds mode.

Table n°I-14 below presents monthly and annual average values of maximum and minimal temperatures and the air temperature daily average, the average thermal amplitude and the values of the absolute maximum and minimal temperatures observed during the period 1901-1990 in Aïn Draham station, located at 739 m altitude. This **Table n°I-14** presents also the data calculated for Fernana and Hammam Bourguiba perimeters located respectively at 260 m and 125 m average altitude, applying the rule of temperature rise by 0,5°C when altitude decreases by 100 m.

Table n°I-14 : Air temperatures values (°C)

Station	Month θ averages (ºC)	Jan	Feb	Mar	Apr	May	June	July	August	Sep	Oct.	Nov	Dec	Year
	Absolute maximum	22.0	24.0	29.0	32.0	35.0	42.0	43.0	43.0	41.0	39.0	29.0	26.0	**43.0**
	Maximum	9.4	10.4	13.8	16.8	20.8	25.7	29.8	31.0	27.3	21.3	15.3	10.6	**19.4**
Aïn Draham	Average	6.6	7.2	9.8	12.3	15.9	20.2	23.7	24.0	21.8	16.9	11.9	7.9	**14.9**
Station	Minimal	3.9	4.0	5.9	7.9	11.0	14.7	17.7	18.5	16.5	12.5	8.4	5.3	**10.5**
	Absolute minimum	-4.0	-5.0	-2.0	0.0	2.0	7.0	9.0	11.0	8.0	4.0	-1.0	-5.0	**-5.0**
	Thermal Amplitude	5.5	6.4	7.9	8.9	9.8	11.0	12.1	12.5	10.8	8.8	6.9	5.3	**8.8**
	Absolute maximum	24.4	26.4	31.4	34.4	37.4	44.4	45.4	45.4	43.4	41.4	31.4	28.4	**45.4**
	Maximum	11.8	12.8	16.2	19.2	23.2	28.1	32.2	33.4	29.7	23.7	17.7	13	**21.8**
Fernana PIP	Average	9.0	9.6	12.2	14.7	18.3	22.6	26.1	26.4	24.2	19.3	14.3	10.3	**17.3**
	Minimal	6.3	6.4	8.3	10.3	13.4	17.1	20.1	20.9	18.9	14.9	10.8	7.7	**12.9**
	Absolute minimum	-1.6	-2.6	0.4	2.4	4.4	9.4	11.4	13.4	10.4	6.4	1.4	-2.6	**-2.6**
	Absolute maximum	25.1	27.1	32.1	35.1	38.1	45.1	46.1	46.1	44.1	42.1	32.1	29.1	**46.1**
Hammam	Maximum	12.5	13.5	16.9	19.9	23.9	28.8	32.9	34.1	30.4	24.4	18.4	13.7	**22.5**
Bourguiba PIP	Average	9.7	10.3	12.9	15.4	19.0	23.3	26.8	27.1	24.9	20.0	15.0	11.0	**18.0**
	Minimal	7.0	7.1	9.0	11.0	14.1	17.8	20.8	21.6	19.6	15.6	11.5	8.4	**13.6**
	Absolute minimum	-0.9	-1.9	1.1	3.1	5.1	10.1	12.1	14.1	11.1	7.1	2.1	-1.9	**-1.9**

We concluded that the monthly values of the air temperature vary with a certain regularity during the year, with a maximum in July-August, and a minimum in January. The weakness of the annual thermal amplitude reflects the maritime influence existing in this station.

The absolute maximum temperatures are higher than 40 ºC for the period June-September in the station and the period June-October on the perimeters, and of the negative absolute minimal temperatures are recorded during the period November-March in the station and the period December-February on the perimeters.

e.3) Potential evapo perspiration in Fernana and Hammam Bourguiba perimeters

Table n°I-15 below presents the evapo perspiration monthly results for the two perimeters calculated regarding the Blanney-Criddle empirical formula.

Table n°I-15 : Calculations of the average ETP in the two perimeters by Blanney-Criddle empirical formula

Average ETP	Altitude (m)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct.	Nov.	Dec	**Year**
Fernana perimeter														
Monthly	260	38.3	40.2	61.8	81.6	120.1	158.4	196.0	192.1	146.9	101.6	61.1	42.0	**1 240.2**
Daily		1.24	1.42	1.99	2.72	3.87	5.28	6.32	6.20	4.90	3.28	2.04	1.36	**3.40**
Hammam Bourguiba perimeter														
Monthly	125	38.3	40.3	62.0	84.8	124.5	163.6	202.8	197.5	149.4	102.7	61.7	42.4	**1 270.0**
Daily		1.23	1.43	2.00	2.83	4.02	5.45	6.54	6.37	4.98	3.31	2.06	1.37	**3.48**

e.4) Monthly hydrous deficits calculated for Fernana and Hamam Bourguiba perimeters

Diagram n°I-3 of page I-21 compares these evapo perspiration and useful rainfall monthly distributions calculated for the two perimeters. It allows to show the monthly distribution of the hydrous deficits, condsidering the average variations between these monthly data.

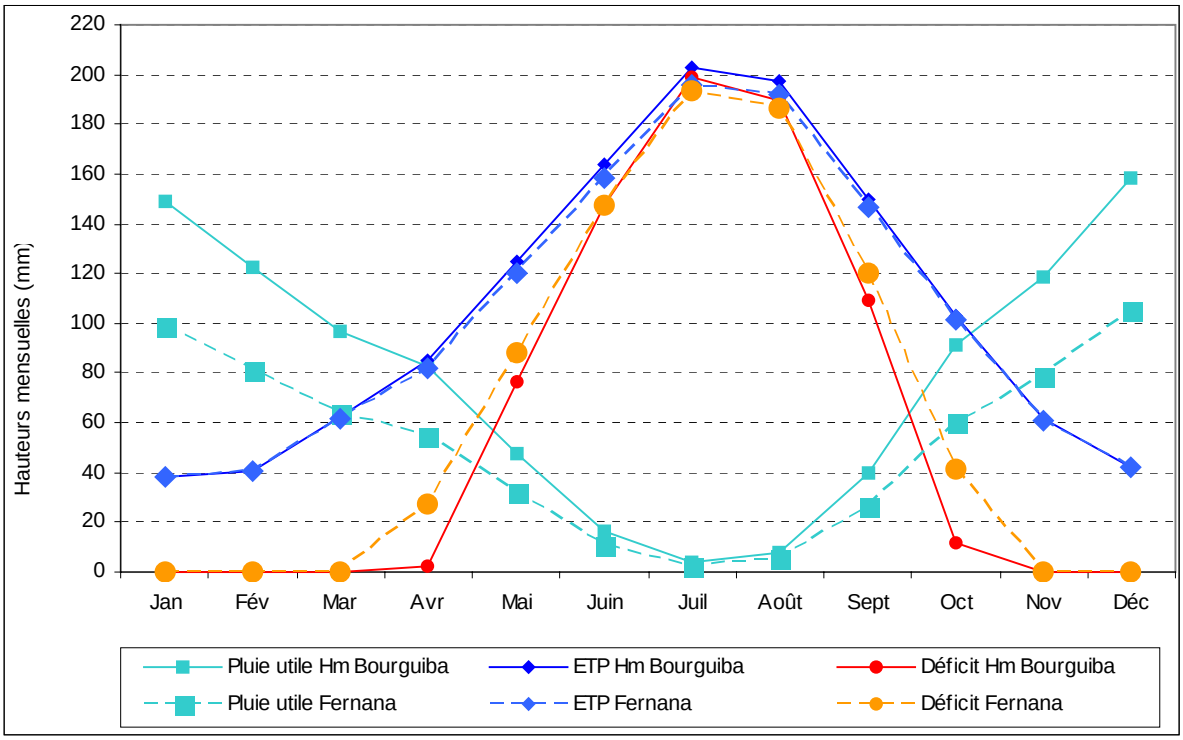


Diagram n°I-3 : Comparison of useful rain, evapo perspiration and hydrous deficits monthly values

This **Diagram n°I-3** allows to note a strong hydrous deficits concentration between October and April. The seasonal distributions of these hydrous deficits are indicated in **Table n°I-16** below.

Table n°I-16 : Seasonal value of the deficits

Station	Season /hydrous Deficits	Winter	Spring	Summer	Autumn	**Year**
Fernana	Quantity (mm)	0.0	261.6	472.9	8.3	**742.8**
	Proportion (%)	0.0%	35.2%	63.7%	1.1%	**100%**
Hammam Bourguiba	Quantity (mm)	0.0	280.3	491.9	25.1	**797.3**
	Proportion (%)	0.0%	35.2%	61.7%	3.1%	**100%**

So one can note a strong hydrous deficits concentration between spring and summer, since these seasons concentrate respectively 2/3 and 1/3 of the annual average deficit. During these two seasons, the cultivation irrigation is essential to ensure them a good productivity.

I.2.2 - Response to drought problems: Program "Eau XXI"

The climatic drought reigning on 90% of Tunisian territory gives the country limited renewable resources, about 4,150 M.m^3 per year. The ratio per inhabitant thus barely exceeds 400 m^3, so according to international standards the country is low in water (ratio < 1,000 m^3) But an ambitious strategy of integrated management of its resources started thirty years ago has allowed Tunisia to satisfy the water demands of the various sectors, even during significant drought periods extending over several years, such 1993-1995 and 1999-2002.

a) Water resources

The exploitable resources of acceptable salinity are considered not very variable, between 2,700 and 3,100 M.m^3. In this regard, the irrigated surfaces have been developed over the past years and must continue to be developed, whereas the rate of drinking water services has already reached 100% in the urban zone, and will achieve this goal in rural zones in the short term, where already it has already largely exceeded 80%.

The water resources are distributed between surface water which is generally not very charged, but which is known to have very strong inter-annual variations, and deep water which is know to have relatively little inter-annual variations, but is generally rather charged in soluble salts.

a.1) Distribution of surface waters

Exploitable surface water resources thus saw a minimum of 780 M.m^3 during the farming year 1993-94 and a maximum of 11,000 M.m^3 during the farming year 1969-70. **Table n°I-17** below distributed by area and quality of water the average resources of 2,700 M.m^3 of which 2,100 M.m^3 can be mobilized by pond works.

Table n°I-17 : Regional distribution of the surface water resources

Areas / Resources	North	Centre	South	**Total**
averages	2,190	320	190	**2,700**
Drinking water (salinity < 1,5 g/l)	1,796	153	6	**1,.955**
	82%	48%	3%	**72%**

Big dams already built currently mobilize 1,340 M.m^3 and the hilly dams mobilize 65 M.m^3, these 1,405 M.m^3 representing 2/3 of the mobilized volume.

a.2) Distribution of subsoil waters

The subsoil water resources are distributed between 719 M.m^3 entirely renewable, coming from ground water, and 1,250 M.m^3, including 600 M.m^3 renewable, coming from the deep water tables. **Table n°I-18** of page I-22 distributes these resources by area.

Table n°I-18 : Regional distribution of the subsoil water resources

Areas / Resources	North	Centre	South	**Total**
Renewable ground water	395	222	102	**719**
Deep water tables	216	306	728	**1,250**
including renewable	*216*	*306*	*78*	**600**
including no-renewable	-	-	*650*	**650**

In these underground resources, the problem of salinity is rather acute since only 57 M.m^3 coming from the ground water and 400 M.m^3 coming from the deep water tablets have a salinity lower than 1,5 g /L.

b) Strategy used

The plan for use of "Northern Waters" identified in the seventies a certain number of actions for the mobilization and transfer of Northern Tunisian waters towards the areas of Greater Tunis, the coastal Sahel, Kairouan, Sfax and Sidi Bouzid. Most mobilized water comes from the Sidi Salem, Joumine, Sejnane and Sidi El Barrak dams, with an interconnection system between all these infrastructures. Thus, the Master plan

of "Northern Waters" includes the construction of pumping stations, hydraulic works and transfer pipes bringing water from Sidi El Barrak dam towards Mejerdah Cape-Bon canal.

The decennial strategy of the country concerning water stock management "Eau XXI" aims to exploit and mobilize the existing supply to satisfy future demand. This strategy is specifically based on:

- the resolution of all problems connected to water sector, taking into account technical, economic and institutional aspects of the management of this resource ;
- the proposal of a pilot project contributing to the follow-up and the improvement of stock management.

c) Established strategy of Eau XXI for irrigated agriculture

As in the majority of countries with arid and semi-arid climates, the sector of irrigated agriculture is the largest consumer of water resources in Tunisia: in 2004, 83% of total distributed volumes are allocated to agriculture. Any efficient water use thus passes by a control, not of supply, but of demand by maintaining the water requirements around 2.800 M.m^3 in 2030.

To this end, a strategy for the control of agricultural water demand has been put into place, which follows several axes.

c.1) Encouragement of irrigation water conservation

The long-term strategy encourages the reinforcement of water saving actions with the principal objective to enhance each cubic meter exploited by various sectors.

The tools allowing water conservation are primarily the improvement of network outputs from the source to consumption areas, sensitizing consumers, the encouragement of water conservation techniques (the State grants subsidies of up to 60 % of the capital cost to encourage farmers to acquire water conserving irrigation materials), and finally a reflected policy of price fixing.

c.2) Choice of adequate varieties

Agriculture should be increasingly directed towards the selection of cultivations which maximize the profit of water use on the level of production and water valorisation through the improvement of post-production services (conditioning, transformation and marketing). So the alteration of the current systems of production into other more efficient systems is possible.

The incentive for the selection of economically profitable cultivations must also take into account the safeguard of the strategic cultivations in order to ensure the food safety of the country and the protection of a certain social class of small farmers in order to maintain a certain social balance.

It is also necessary to take the safeguard of the hydrous resources into account, it is necessary to optimise the use of manures and agrochemical products to the maximum possible level, and to gradually substitute pesticides with biological combat.

c.3) Rationalization of the use of water of irrigation

In the coming years, Tunisia will adopt a water resource allocation policy. The economic sector which best develops this factor will have priority.

The volumes of water allocated for agriculture will drop following the reduction in the volume allocated by hectare. This fall will be due to the reallocation of resources to the most profitable economic sectors.

In order to have a competitive agricultural production on the international markets in the coming years, it is necessary to control the sustainable use of production factors, and of water in particular.

c.4) Creation of the groupings of collective interest or GICs

The future strategy encourages the creation of collective interest associations or specific groupings which ensure their participation in hydraulic project and stock management.

This commitment of farmers will reinforce their feeling of investment in farms and will thus contribute to good management. It will help also farmers to develop their control over production factors, and especially of irrigation water.

d) Established strategy of Eau XXI for drinking water

d.1) Actions carried out by the SONEDE (National Company for Water Exploitation and Supply)

To meet the drinking water requirements for large urban poles from Northern waters, the SONEDE established a plan of action whose objective is to reinforce its water processing and distribution capacities. This program comprises the establishment of treatment and pumping stations, the construction of new tanks, ...

Projects to satisfy the water requirements of greater Tunis using Northern Water consists of:

- the completion of two treatment stations of 2 and 1 m^3 /S to cover the water needs of greater Tunis until a 2010 horizon;
- the completion of a new pumping station of flow equal to 3 m^3 /S.

Projects to satisfy the water requirements for the Sahel, Sidi Bouzid, Kairouan and Sfax using Northern Water is divided into 3 phases: a first phase between 1994-1996, a second phase between 1997 and 2000, and a third phase between 2005 and 2006.

The assessment and schedule of SONEDE works for this program are submitted in the Appendix.

I.2.3 - Irrigated agriculture in Tunisia

From its position on the southern bank of the Mediterranean Sea and its opening onto the Sahara, the climates of Tunisia are all characterized by one period of marked aridity, passing gradually from 12 to 4 months as one travels from the South to the North.

a) The need for recourse to irrigation

Such aridity causes hydrous deficits, which under a rainy system generate production deficiencies. In the Tunisian North, only summer crops are affected by this period of inevitable summer dryness, which systematically resort to irrigation throughout the country in order to produce these crops.

But under a rainy system, winter crops can be affected by the risk of inter annual rainfall, which involves the

succession of defective crops, followed by superabundant production. The auxiliary irrigation thus allows these hydrous deficits to be avoided, appearing during crop years characterized by deficient rainfall, of which the frequency of appearance decreases as one travels from the South to the North. Indeed it goes from a year out of 2 in arid regions, to one out of 5 years in wetlands.

b) Development of irrigated agriculture in Tunisia

In addition to the traditional recourse to irrigation activities in zones where ground water was not very deep and along the rivers, motorization allowed for the development, in the XXth century, of irrigated agriculture in zones where water tablets were deeper. But since Independence, a willing policy to mobilize the renewable hydrous resources has covered the country with dams and major drilling, which has allowed Tunisia to mobilize 80% of its thin surface water resources in fifty years, and to overexploit its subsoil water resources.

These 3,300 M.m^3 are used today at 80% to cultivate using irrigation on 370.000 ha arranged in public or private perimeters. These 4% of the national CES (Water and Ground Preservation) today provide 30% of the total value of the agricultural productions in an average year (and much more during years of dryness), but above all allow for the diversification of the national selection of fruits and vegetables available to Tunisian consumers.

c) Irrigated agriculture in Northern Tunisia

As shown in Map n°I-2 on page I-13, which presents hydro-agricultural installations in the three concerned administrative divisions (governorates), existing installations have until now concerned almost exclusively the Mejerdah valley, which concentrates the principal regional metropolises and thus a large part of the development capacities by the secondary and tertiary sectors.

Moreover, the catchments area of this river is dominated by several geological formations largely represented in the landscape, like Mio-Pliocene and Trias, which constitute significant sources of soluble salts that one finds in surface waters collected in the dams and water infiltrating the ground water, which is then used for irrigation in the Mejerdah valley. In fact, the use of this rather charged water involves a risk of high salinity of the grounds of these irrigated perimeters, which more of less threatens the long term sustainability of these installations.

I.3 - Actions carried out by the JBIC concerning integrated water resources management

Since 1996, the JBIC has financed a Program of integrated Tunisian Northern water management which respects the orientation of the Program "Eau XXI", by privileging the use of the North-Western lightly charged water as the principal drinking water supply for Tunisians, and control of water supplies used to irrigate cultures.

This Program is articulated around three projects which aim at using Extreme-North fresh waters:

- to improve qualitatively and quantitatively drinking water distributed in SONEDE networks;
- to develop irrigated production in several plains of North-Western Tunisia to improve the agricultural income of the owners and to limit the rural migration of the young population towards the coasts.

I.3.1 - TS-P7 Project

The project of doubling the water piping system of North-Western fresh water transfer from the Sejnane dam to the Mejerdah River near Tunis aims at reinforcing the transfer of fresh waters to the drinkable water supply networks feeding the urban zones of the coastal areas of the Northern and Central parts of the country. It thus allows for both the qualitative and quantitative improvement of the drinking water supply, and thereby contributes to the elevation of the standard of living.

In parallel, the installation of two perimeters was envisaged on 4,420 ha for developing irrigation starting from these fresh waters of Sidi El Barrak dam in the immediate vicinity of its pond and along the way of waters transfer towards the pond of Sejnane dam. These hydraulic installations contribute to the increase of about 3,000 farmers' income, that must ensure the economic development of two wedged zones of the North-Western area, the " chateau d'eau" (tower water) of Tunisia, subjected hitherto to the rural migration of their young people to the coast:

- the residual Nefza plain, after the setting in water of the Sidi El Barrak dam, and
- the Sejnane plain, in direction of the pond of the Sejnane dam.

I.3.2 - TS-P11 Project

The use of waters released from the Sidi Salem dam into the Mejerdah River for irrigating crops was envisaged on 2,900 ha in the Goubellat plain. It thus allows the development, in a zone close to Greater Tunis located in a semi-arid climate, of crop irrigation.

This new hydraulic installation will contribute to the increase in income of about 570 beneficiaries and prepare the substitution by this new intensive agricultural area of the traditional near urban agricultural areas, which are currently corroded little by little by urban growth.

I.3.3 - TS-P13 Project

The installation of two perimeters was envisaged on 2,030 ha in the Tunisian North-West for developing irrigation starting from fresh waters of Zouitina dam in the vicinity of its pond downstream (Hammam Bourguiba) and along the route of transfer of its waters towards the pond of Bou Heurtma dam (Fernana).

These hydraulic installations contribute to the increase of about 700 farmers' income, that must ensure the economic development of two wedged zones of the North-Western area, "chateau d'eau " of Tunisia, subjected hitherto to the rural migration of their young people to the coast :

- Hammam Bourguiba plain downstream Zouitina dam, and
- Fernana plain upstream in direction of the pond of Bou Heurtma dam.

I.3.4 - Coherence of this JBIC Program with "Eau XXI" Program

The three projects financed by the JBIC in the Tunisian North thus enter perfectly within the framework of the sustainable rural development policy undertaken by the Tunisian government, which aims at an integrated water resources management through the management of demand, to ensure optimal development of the available physical and human potentials, with the objective of improving the standard of living for the rural populations concerned and to achieve food self-sufficiency for the country.

I.4 - Objective and methodology of the study

I.4.1 - Reasons for this mid-term evaluation mission

a) Planned development of the mission

The mission will control the various activities of the three Projects and identify the technical, economic and social conditions which must be put into place in order to have as much positive impact as possible. Thus the principal objectives of this mission are as follows:

- To carry out a mid-term revision of the projects and to gather basic quantitative and qualitative data about the envisaged impact of the projects, while updating the files of the mid-term evaluation as well as the files of the execution plan;

- To propose realistic and concrete solutions to the proposals of Tunisian persons in charge during three regional and one national workshop for the three principal bottlenecks identified by the Ministry of Agriculture and Hydraulic resources (M/ARH) and the JBIC: weak cultural acceptance of irrigation, a lack of aptitude for management among the farmers and the institutions and finally land problems;

- To integrate the remarks and suggestions of the participants in these four workshops in a final Action Plan transmitted to JBIC at the end of this mission.

The mission's terms of reference demand that the solutions be:

i) integrated in the sense that they meticulously describe the roles which will be played within the framework of " Eau 21 " by all the parties concerned ;
ii) exhaustive in the sense that they cover short, average and long term approaches ;
iii) participative in the sense that the solutions are based on a principle of total engagement of all the parties concerned.

I.4.2 - Methodology used for the mission

a) Levels of analysis

ToRs of the mission required that five levels of analysis have to be distinguished in this evaluation:

- on the level of all the available documents and reports related to the program;
- on the level of the M/ARH, and in particular on the level of the DG/BGTH(General Direction of Dams and Great Hydraulic Works) which is the coordinator of the entire program ;
- on the level of the project unit personnel in each area;
- on the level of the farmers / women who will benefit from this program;
- on the level of the various local and national partners.

b) Methodology of listening to the managers and the populations

The methods of participative approach will be used with the beneficiaries and the other parties concerned and implied in the program. Talks were carried out with the various parties concerned (Ministry of

Agriculture and Hydraulic Resources, Project execution Units, various partners). Two types of tools will be used with farmers and women: group meetings and semi-structured individual talks.

On the basis of collected information during these group meetings, a sample of 20 recipients representative of various existing or potential systems of production was interviewed for each irrigation project. Various questions relating to these current systems of production will be included, regarding: harvests, cattle, labour, markets access, agricultural mechanization, aptitudes for irrigation...

b.1) Open socio-economic talks with checklists with persons in charge of the GICs

The objective of the semi-structured interview is to examine the capacities of the GICs (governing, management and services) in order to register problems and to list possible solutions suggested by the Board of Directors of the GICs.

b.2) Open talks with checklists with the persons in charge of rural development

The objective of the semi-structured interview is to inventory the services of existing support in the zone of the perimeter, the human and material means and the proposals to be used as technical support with new irrigators.

b.3) Open talks with checklists with the technical directors of the GICs

The objective of the semi-structured interview is to examine the capacities of management and services of the GIC through technical directors already recruited to support the GIC.

b.4) Open talks with checklists with the recipients of the Projects

The objective of semi-structured interview is to present the situation without project, the participation of the concerned parties in the project, the will and the capacity to irrigate, and the possible solutions suggested by the recipients.

c) Socioeconomic data gathering

It has been essential to collect a wide range of indicators concerning the intervention area of the three plans, in order to allow the final evaluation mission to compare the situation during its unfolding with 2005.

c.1) Data deficiency

The areas involved in the projects suffer from a lack of detailed informations and statistics required for the construction of sociological indicators. In addition, we notice some unwillingness of some official sources that could prevent from realizing an exhaustive study.

Thus, the only solution is to use national statistics that have been only available in a correctly way since 1997.

c.2) Poverty definition

It is necessary to define the poverty phenomenon in a simple statistic way, even if it's a compound and multidimensional. A household is considered as poor if his income, calculated on the basis of total

consumption expenditure, is lower than a certain level, called poverty line. the latter is defined as the minimum income, a person can ensure his elementary needs.

But this definition is not sufficient if we refer to the the human development paradigm[2].Poverty is defined as « privation of human abilities, of opportunities and of essential choices that are necessary for the individual, household or community well-being».

However, it's worth notice that no survey evaluating households income is available in any delegation. With regard to the local data of the survey 1999 concerning households earning and consumption :

- The north-east survey is meaningless for the delegation of Sejnane, because it doesn't take into account the urban populations of « the high Tunis », Ariana, Ben Arous, Bizerte, Nabeul, Hammamet,…

- Data of the north-west has no meaning for the delegations of Nefza, Goubellat, Fernana and Aïn Draham because it comprises urban populations of Beja, Jendouba, Kef, Siliana, Bou Salem, Ghardimaou, Tabarka, Mjez-El-Bab,…

[2] *Rapport arabe sur le développement humain 2002, Programme des Nations Unies Pour Le Développement, Bureau régional pour les Etats arabes(BREA)*