REPUBLIC OF TUNISIA

MINISTRY OF ENVIRONMENT AND LAND PLANNING

Initial Communication of Tunisia under the United Nations Framework Convention on Climate Change

October 2001

SUMMARY VERSION

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BACKGROUND

Tunisia signed the United Nations Framework Convention on Climate Change (UNFCCC), in Rio in 1992, then ratified it in July 1993. As a Non-annex 1 Party of the Convention , and in accordance with Article 12 of the UNFCCC, Tunisia shall submit to the Conference of Parties (COP) a communication describing the efforts made, in order to contribute to address Climate Change.

This document is a summary of the Initial Tunisian Communication to the UNFCCC, which includes, as stipulated by the Convention, and in accordance with the framework recommended by the decision 10/CP.2, the main information to be transmitted to the COP. This information includes, as summarized in this document, an inventory of greenhouse gases (GHG) for the year 1994, an assessment of the vulnerability of Tunisia to sea level rise due to global warming, and an assessment of the Tunisian potential for abating GHG emissions. The last section of this summary also includes a presentation of the Tunisian needs to enhance its capacity in view of a significant contribution of the country to the world effort aimed at mitigating Climate Change and fighting against its adverse effects, as related to its commitments under the UNFCCC.

GEOGRAPHICAL SITUATION AND CLIMATIC CHARACTERISTICS

Tunisia is located in North Africa, between longitudes 7° and 12° East and latitudes 32° and 38° North. It is at the junction of the West and East Mediterranean, and covers a 164.000 km^2 surface.

Due to its geographical position and general orientation of the main relief, Tunisia is influenced in the North by the Mediterranean, the South being under the influence of the Sahara. The Center is under the joint effect of these two elements.

Thus, the North of the Tunisian Dorsal benefits from a Mediterranean climate, characterized by:

- A hot and dry summer;
- A mild and relatively rainy winter.

The Center as well as the Gulf of Gabes have a semi-arid climate, characterized by:

- Relatively high temperatures ;
- Modest rainfall; between 200 and 400 mm/year.

The rest of the country witnesses a desert arid climate characterized by:

- High temperatures as well as important amplitudes ;
- Disparate rainfall rarely exceeding 100 mm.

It shall be noted that the key position of Tunisia between the tempered regions of the Northern Hemisphere and the inter-tropical regions grant its climate a special variability. Such a characteristic makes Tunisia a country particularly vulnerable to Climate Change.

ECONOMIC CIRCUMSTANCES

After a period characterized by an economic growth of 2.9% at constant prices (81-86), Tunisia has since engaged in a vast structural adjustment program, involving important economic, social and technological transformations. As a result, the economic growth reached 4.8% between 1987 and 1993, and exceeded 6% in 1999.

Along with the economic reforms, Tunisia also engaged in economic liberalization, global economy opening and integration. Thus, as early as 1991, Tunisia became a member of the GATT, and signed a free trade agreement with the European Union, which states a progressive lifting of customs barriers on the imports of goods and services from the countries of the Union, until their total removal at the end of 2007.

In the same line, in preparation for its integration into globalization, Tunisia launched a "**Program of Mise à Niveau"**,[1] since 1996, which should allow Tunisian industries to acquire the capacities and to adapt to the rules of free trade, and to compete on an equal footing with the imported products.

Table 1: Summary Table of National Circumstances

Parameter	**1994**
Population (million of inhabitants).....	8.8
Urban population (%).....	61%
Population in a situation of absolute poverty in 1995 (%).....	6.2%
Life expectancy at birth (number of years).....	71.2
Rate of Alphabetization in % (regarding the population aged 10 years and above).....	68%
Surface (km^2)	164,000
Gross Domestic Product for the year 1994(*) • In current values (billions $US)..... • In constant values (billions $US of 1990).....	 15.8 12.8
Gross Domestic Product per capita for the year 1994 : • In current values ($US)..... • In constant values ($US of 1990).....	 1,795 1,455
Share of the informal sector in the economy in 1995 (% of GDP).....	20%
Share of the Industry in the GDP (%).....	34%
Share of Services in the GDP (%).....	50%
Share of Agriculture in the GDP (%).....	16%
Useful farming lands (km^2).....	53,000
Surfaces annually cultivated (km^2).....	41,000
Cattle activities (1000 heads) • Bovines..... • Ovine and Goats ..... • Other large ruminants (camels, horses, etc.)..... • Poultry	 662 7,500 246 53,000
Forest Surfaces (km^2).....	8,307

(*) Average Exchange rate in 1994 : 1 Tunisian Dinar = 1 US$

[1] Programs aimed at upgrading the general efficiency standards of the whole economy.

INVENTORY OF GREENHOUSE GASES IN TUNISIA

The inventory of GHG (greenhouse gases) for 1994 shows a **relatively limited contribution by Tunisia** to the of the greenhouse effect, in comparison with other Nations. In fact, the **net** anthropogenic GHG emissions of Tunisia are **23.4 million** tons CO_2 equivalent (TE-CO_2), which represent 2.66 TE-CO_2 per capita or 1.8 TE-CO_2 per thousand US$ of GDP.[2]

The analysis per type of gas show a domination of CO_2 which represent 66% of the **net** national emissions, followed by N_2O with 18% and of CH_4 with 16%.

On the other hand, in **gross** terms (without taking into account the carbon sequestration), Tunisian emissions totaled **28.9 million** TE-CO_2 in 1994, meaning 3.3 TE-CO_2 per capita. The GHG absorption totaled 5.5 million tons of CO_2 in 1994, meaning 0.6 tons of CO_2 per capita.

The analysis of the **gross** Tunisian emissions by source show, the preponderance of energy in the emission balance. In fact, with 15.3 million TE-CO_2, energy uses represent more than half the gross national emissions, followed by agriculture, which represents with 6 million TE-CO_2, 21% of gross emissions. Next come forests and industrial processes with respectively 3.7 millions TE-CO_2 (13%) and 2.8 millions TE-CO_2 (10%) of gross national emissions. Wastes remain a relatively weak source of emissions, with only 1 million TE-CO_2, representing hardly 4% of gross Tunisian emissions.

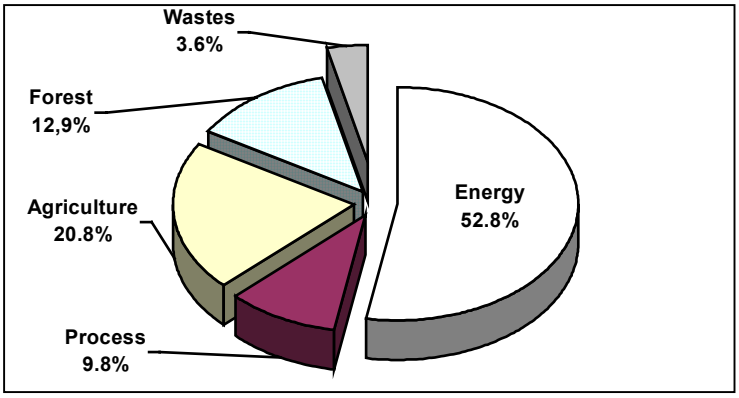


Figure 1 : Repartition of Gross Tunisian Emissions of GHG for 1994 (%)

[2] Expressed in constant prices of 1990.

Table 2: Summary of net and gross emissions of GHG in Tunisian in 1994 (1000 TE-CO2)[3]

	Emissions of CO_2	Absorptions of CO_2	CH_4	N_2O	Total Gross Emissions	Total Net Emissions
National Total of emissions/absorptions	**20 827.2**	**-5 503.5**	**3 783.5**	**4 260.4**	**28 870**	**23 367**
1 – Energy	14 257.4		925.2	68.6	15 251	15 251
2 – Industrial Processes	2 839.0			0.5	2 840	2 840
3 – Solvents						
4 – Agriculture			1 996.6	4 021.6	6 018	6 018
5 – Land Use and Forestry	3 730.8	-5 503.5			3 731	- 1 773
6 – Waste			861.6	169.7	1 031	1 031
Repartition per gas (%)						
• Gross Emissions	72%		13%	15%	100%	
• Net Emissions	66%		16%	18%	100%	
International Bunkers (*)			**0.151**	**6.620**	**776.4**	

(*) *In accordance with the IPCC's methodology, emissions due to international Bunkers (supply in fuel of planes or ships operating on international routes) are not accounted for in the Tunisian emissions.*

In addition, the GHG inventory emissions also estimated the emissions of ozone precursor gases (CO, NO_x and COVNM), which have an indirect radiating effect, as well as SO_2.[4] The table 3 presents the results of the estimates of emissions of these gases for 1994.

Table 3: Emissions of gases precursors of ozone and of SO_2 in Tunisia in 1994 (1000 tons)

	CO	NO_x	COVNM	SO_2
National Total of emissions	**68.445**	**370.059**	**110.645**	**77.855**
1 – Energy	67.861	355.641	64.387	76.357
2 - Industrial Processes	0.039	0.084	34.903	1.498
3 – Solvents			11.355	
4 – Agriculture	0.545	14.334		
5 – Land Use and Land Use Change				
6 – Waste				
International Fuel Compartments(*)	**3.745**	**1.440**	**0.605**	**0.720**

(*) *Emissions non-accounted in the total of Tunisian emissions.*

[3] Emissions calculated on the basis of a Global Warming Potential (GWP), over 100 years integration period of, equal to: (i) 1 for CO_2 ; (ii) 21 for CH_4; and (iii) 310 for N_2O. In original units (tons), the emissions of CH_4 and of N_2O respectively reach 180.000 tons and 13.700 tons.

[4] According to IPCC recommendations, SO_2 has been incorporated into the GHG inventory , although it is not really a greenhouse gas. In fact, it rather has a "cooling" effect. .

Table 4 : Synthetic results of GHG emissions by gas and by source (Gg) [5]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals (Gg)	**20 827,2**	**-5 503,5**	**180,151**	**13,744**	**72,619**	**373,565**	**111,345**	**77,855**
1 - Energy	**14 257,4**	**0,0**	**44,043**	**0,221**	**72,035**	**359,147**	**65,087**	**76,357**
A- Fuel Combustion Activities (Sectoral Approach)	**13 694,2**	**0,0**	**14,497**	**0,221**	**72,035**	**359,147**	**65,087**	**76,357**
1 - Energy Industries	3 998,0		3,122	0,014	10,908	22,398	17,152	18,463
2 - Manufacturing Industries and Construction	3 324,4		0,166	0,026	8,828	0,751	0,238	30,892
3 - Transport	3 391,7		0,414	0,026	34,093	137,147	25,988	5,142
4 - Other Sectors	2 980,2		10,795	0,156	18,206	198,852	21,709	21,860
5 - Other								
B- Fugitive Emissions from Fuels	**563,2**	**0,0**	**29,546**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
1 - Solid Fuels								
2 - Oil and Natural Gas	563,2		29,546					
2 - Industrial Processes	**2 839,0**	**0,0**	**0,0000**	**0,0015**	**0,0389**	**0,0836**	**34,903**	**1,498**
A- Mineral Products	2 546,9						27,589	1,383
B- Chemical Industry				0,0015	0,0016			0,018
C- Metal Production	292,1				0,0193	0,0164	0,009	0,014
D- Other Production					0,0180	0,0672	7,305	0,084
E- Production of Halocarbons and Sulphur Hexafluoride								
F- Consumption of Halocarbons and Sulphur Hexafluoride								
G- Other								
3 - Solvent and Other Product Use							**11,355**	
4 - Agriculture			**95,078**	**12,973**	**0,545**	**14,334**		
A- Enteric Fermentation			83,670					
B- Manure Management			10,725	0,592				
C- Rice Cultivation								
D- Agricultural Soils				12,365				
E- Prescribed Burning of Savannas								
F- Field Burning of Agricultural Residues			0,683	0,015	0,545	14,334		
G- Other								
5 - Land-Use Change and Forestry	**3 730,8**	**-5 503,5**						
A- Changes in Forest and Other Woody Biomass Stock	3 686,8	-5 503,5						
B- Forest and Grassland Conversion	0,0							
C- Abandonment of Managed Lands	0,0							
D- CO2 Emissions and Removals from Soils	44,0							
E- Other	0,0							
6 - Waste	**0,0**	**0,0**	**41,030**	**0,55**	**0,0**	**0,0**	**0,0**	**0,0**
A- Solid Waste Disposal on Land			31,865					
B- Wastewater Handling			9,164					
C- Waste Incineration								
D- Other (Human Sewage)				0,55				
7 - Other								
Memo Items :								
International Bunkers	**776,4**		**0,0072**	**0,021**	**3,745**	**1,440**	**0,605**	**0,720**
Aviation	747,6		0,0053	0,021	3,168	1,056	0,528	0,236
Marine	28,8		0,0019	0,0002	0,576	0,384	0,077	0,484
CO2 Emissions from Biomass	**3 500,9**							

[5] Gigagram (or 1000 tons).

VULNERABILITY OF TUNISIA TO SEA LEVEL ELEVATION DUE TO CLIMATE CHANGE.

With opening on the Mediterranean Sea on the North and East, and a long coastline of 1300 km, Tunisia undoubtedly benefits from important economic and ecological assets. All the civilizations that succeeded each other made good use of this geographical advantage, and largely favored the concentration of economic activities on the coast and thus encouraged the development of human settlements in these areas.

Today more than ever, with the opening on the outside world and globalization, these asset will be determinant for a favorable economic positioning of Tunisia, and for a highly competitive capacities. Therefore, the sea will undoubtedly remain among the major basis for the future economic development of Tunisia. Consequently, any damage to the coastal balance of the country, either from an anthropic or a natural origin will represent a direct threat to a very important part of the economy and to the Tunisian human settlements.

It is understood that, due to its geographical location and its climatic characteristics, Tunisia will certainly be very sensitive to the direct adverse effect of Climate Change[6]. In addition, faced with the threats caused by the accelerated sea level rise (ASLR), Tunisia is at risk to be more exposed and thus more vulnerable. In fact, the ASLR can have important harmful consequences on various economic sectors related to the sea or the coast line, as well as on the physical and biological coastal environment and on human settlements.

According to the simulations made by climate specialists on the basis of the IPCC 6 scenarios, it is foreseeable that at the 2100 horizon, a potential increase of the temperature from 1.3 to 2.5 degrees C, and an elevation of the sea levels from 38 cm to 55 cm will occur. Transposed on an equal scale to the Mediterranean scale, these same assumptions of climate warming and sea level elevations could deeply affect the natural and fitted systems, and in particular those of Tunisia which disposes of 1300 km of coast.

According to indications given by archeological traces, the sea level rise, recorded during the historical times would reach 20 to 40 cm. Besides, the first treatments made on the tidal recordings of Sfax Port show notably a tidal elevation at a rhythm worth 3 to 4 times the world average, and this since the beginning of the century.

The tidal level elevation in Tunisia has been at the origin of modifications, sometimes important in the shore position and in the coast morphology. Some spaces were lost by erosion or submersion, by the continent in favor of the sea, and some soils were deteriorated by salinization with the ASLR. Such a progress should likely continue and even speed up.

- ***Water Resources***

Water resources constitute the most precious economic and environmental "capital" for countries affected by aridity, in particular those of the Maghreb, who already face a hydrous stress[7] situation. Regarding future projections, they are even more pessimistic since according to the forecast, after 2025, these countries will be in situation of water shortage (less than 500 m^3/inhabitant/year). This situation is even more alarming for Tunisia which has the lowest level of water resources in the region, and which is already very close to this fateful average.[8]

[6] Perturbation of hydrological cycles, elevation of temperatures, etc.
[7] Less than 1000 m^3/capita/year.
[8] 528 m^3/capita for the year 1995.

The geographical position of Tunisia interlinking the tempered regions of the northern hemisphere and the inter tropical regions, confers to its climate an important variability. That's how the rainfall have always been marked by dry episodes, associated with raining sequences, sometimes disastrous, and in any case, very unlikely leading to an efficient water mobilization.

The resources in water in general, and the surface waters in particular, are largely dependent of the climate variability and the rainfall. So the average surface water volume available annually in Tunisia is of 2700 millions cubic meters (Mm^3/year). However, this availability is highly modulated according to rainfalls, enabling a big place to extreme cases. In this way:

- Water availability is less than 2230Mm3/year, **one year over two**;
- Water availability is less than 1500 Mm3/year, **one year over five**,
- Water availability is less than 1250 Mm3/year, **one year over ten**.

According to the international usual standards, Tunisia is in a hydrous stress situation close to a shortage, sharpened by a high anthropic pressure. So minor they be, the Climate Changes can so, result in harmful consequences on water resources , on ecosystems depending of water, and on the different economic activities that need large quantities of water such as agriculture and tourism.

By modifying the evaporation and precipitation rate, the global warming will probably affect the hydrous climate balance and therefore the Tunisian water resources. In this way, if the intensification of the evaporation can lead to a possible important increase of the rain falls, it might not be sufficient to offset the decrease of the sweet water resources. Moreover, due to the global warming, the rain situation can be characterized by a bigger frequency of rains resulting from torrential storms and downpours, disappearing generally in streaming waters rather than be absorbed by the soils.

The coastal resources in water will get direct effects due to climate warming, and indirect effects following the sea level rise. The resources in water of the coastal regions will so, have the maximum of risk. In particular, the sea level rise would damage the aquifer coastal formations and other underground sweet water reserves by intrusion of sea waters, especially that the anthropic pressure on these underground water slicks is very high.

Natural ecosystems:

In general, the ASLR has **no significant impact on the humid places in continental zone**, with the single exception of the Lac d'Ichkeul, which surrounding areas, sometimes very low, could turn out to be sensitive to the ASLR.

Contrary to the humid continental zones, the humid littoral places will be particularly vulnerable to the ASLR, being close to the littoral. In general, for the case of Tunisia, the most vulnerable humid places will be the lagoons, the sebkhas, the lowest coastal marshes, which will be in majority annexed to the sea domain.

As long as the Sea Level Rise is progressing, the resulting impacts will be more and more significant. The extreme part of these humid places (interface sea-lake surface) will be eroded and we will eventually register a migration of the internal part of these humid places (interface lake surface-land).

Concerning the littoral forests, they seem relatively less vulnerable to ASLR, except the coastal oasis where ASLR could result in a retreat of the coastal line and an increased salinization of the littoral ground water, detrimental to the palms good growth.

The agricultural sector would be among the sectors most affected by ASLR. Indeed, there are many littoral agricultural speculations (citrus fruit, irrigated cultures, etc…) with important covered surfaces, and ASLR can lead to important losses of these grounds by erosion or salinization. ASLR would also affect the agricultural infrastructures (drainage and irrigation pipes).

- ***Tourism***

Tourism, which is among the main strategic lines of the development of Tunisia, could suffer as a consequence of ASLR. In fact, the aesthetics and extent of the beaches which are among the main appeal of the three major tourist poles of the country [9] could be highly affected by ASLR. In addition, the infrastructures, notably those very close to the coast, will be particularly threatened.

- ***Regional development and infrastructure***

The Tunisian coast line concentrates 2/3 of the total population, more than 70% of the economic activities, 90% of the tourists accommodation total capacity, and a great part of the irrigated agriculture. This high anthropic pressure has already made this area fragile.

Consequently, any vulnerability of the coastal zones caused by ASLR would modify the usual principles of regional development, leading therefore to important social and economic costs.

- ***Major ASLR sensitive zones***

The sea level rise impact will be perceptible on the whole region. However, these impacts will be more or less determinant according to the back country geology.

Their geographical division already shows that the most risky coastal segments belong to the city of Bizerte and its lakeside system, to the northern and central parts of the Gulf of Tunis, to the oriental coast of the Cap Bon peninsula, to different segments of the Gulf of Gabes, and to the low islands of the country oriental coast.

On the northern coast, the beaches are most often less sensitive to erosion problems and have, sometimes a rather excess sedimentary budget in the case of the beaches occupying the oueds mouths. However, weakness signs, balance break threats and sometimes even preoccupying erosion problems exist in developed segments notably those belonging to important agglomerations zones.

The coast of the Gulf of Tunis, shows many forms of weakness caused by natural factors and also by the conjunction of numerous anthropogenic interventions throughout a relatively long history.

Moreover, the coasts configuration, and the importance of the lower level areas make different sectors of this zone very vulnerable to ASLR, especially that it hosts the most important urban and industrial concentration of the country.

The beaches represent the most frequent forms of the Gulf of Hammamet and of the Sahel. In general, the weaknesses are as evident as the coastal segment is anthropic. In this way, the sea sector erosion problems are raised in the tourist sector of Hammamet where some hotels have even lost an important part of their sandy beaches.

In addition, starting from El Kantaoui port, going toward Sousse, the beach erosion affects the sector where the tourist regions have been established.

[9] Hammamet, The Sahel and Jerba.

After Sousse, the beach of Skanes is still large in front of many hotels. But erosion signs started to appear for some years especially in the occidental part of the tourist area.

The Monastir town beach, impoverished since it is not fed by a coastal drift, now stopped by the barriers of the new port. Besides, the front sea boulevard had to be protected. The remaining sandy coasts, extending from Mahdia are also in degradation. Therefore some breakwaters have been set up on both sides of the root of the Africa cap.

On the coastal section of the Gulf of Gabes and its southern surrounding areas, under the effect of ASLR, the cliffs will be subject to more and more rapid erosion. Concerning the sandy beaches, they will likely migrate the interior of the lands or disappear. Concerning beaches bordered by constructions, always less thick and lacking in important bordering dunes, they could disappear even with the less pessimistic ASLR scenario.

- ***Islands and small islands***

In Tunisia, islands with accused relief will be less affected by the sea elevation. Whereas the flat islands will certainly be highly affected by ASLR, with more or less important consequences.

Thus, the Kerkenna islands, which are especially characterized by their weak topography, made by a succession of flat lands, occupied by some sabkhas, and by small back of lands often at a very regular surface, appears like one of the places most threatened by ASLR.

According to the accelerated sea rise scenario, the erosion of the Kerkenna islands risks to become more and more important and to speed up, and the salinization will continue to gain lands.

But the most important impact for this archipelago, will be recorded in the maritime tides and the sebkhas. Therefore, the sea level rise, even of some decimeters could result in their permanent annexing, to the sea. With the ASLR scenarios, of 0.50 and 0.55 m, in the 2100 horizon, the archipelago risks even to be transformed in a great number of small islands.

The beaches of Kerkenna are even more vulnerable. Many of them are loosing their substance. Their fragility has been sometimes accentuated by developments of sea fronts, especially in the tourist area. The elevation of the sea level, the subsidence of the archipelago ground and the absence of important watercourse likely to supply the coast in sediments are the major natural factors.

The Jerba island cliffs are sometimes subject to severe erosion and they are moving backwards at an important speed. That's what suggests for example, the state in which antique ruins or even more recent construction, which have been affected by the retreat of the cliff and which started to loose part of their external walls, find themselves.

The beaches of Jerba have a great importance for the economy and constitute a major element for the island's environment, but they are at the same time very fragile and many of them are seriously threatened. Therefore, many tourist areas are highly affected by the sea advance. For instance, many hotels have already lost part of their beaches, and some had damages to their external walls by the seawater intrusion. Besides, the advance of the sea led to the erosion of a great part of the ancient coast way, and the destruction of some of the closest constructions to the coastline.

The threat will be even more serious for the regions that are close to the shore. Considering the over coasts, the sea level exceeds with the different scenarios, the 2 m value. In this case, the water can even advance to the hotel inside. A coastline of 25 km and equipped with hotels, is at risk to become devoid of natural beaches.

TUNISIAN INITIATIVES HAVING HAD A CONTRIBUTION TO THE MITIGATION OF GREENHOUSE GAS EMISSION GROWTH

For two decades, Tunisian Development policy has been geared towards the application of the sustainable development percepts, and has been strengthened by the implementation of the Agenda 21, which clearly introduces an integrated approach of the development-environment issue in Tunisia. This policy was materialized by the implementation of institutional, regulatory and financial measures, aiming at concretizing such percepts in all the economic activity sectors, and which results contribute directly or indirectly to mitigating climate change.

Institutionally, environment protection in Tunisia is based on a central structure, the Ministry of Environment and Regional Development), and some more specialized structures, comprising institutions such as the Environment Protection National Agency, the Drainage National Office, the International Center of Environment Technology of Tunis, the Coasts Development and Protection Agency, the Tunisian Observatory of the Environment and the Development, and the National Agency of the Renewable Technologies.

The intervention of these environment protection actors are based on many intervention priority lines, among which: strike against industrial pollution and special wastes management, drainage, solid home wastes treatment, energy conservation, protection against petrol pollution, Nature and Biodiversity preservation.

Beside the specialized structures in the environment sector, other intervening parties also play an important role in the local environment preservation, and contribute to the mitigation of the atmosphere damages.

In particular, the General Department of Forestry, which is under Ministry of Environment supervision, has the prerogative to protect and develop the forestry sector so that it appropriately plays its ecological and economic role.

Moreover, the general development philosophy of the agricultural sector is also guided by the sustainable development precepts, implying the implementation of adequate instruments by the Ministry of Agriculture. These precepts are realized through the following lines: (i) Improvement of the agricultural exploitation systems thanks to a more adequate perception of the agricultural intensification related stakes; (ii) Rationalization of the lands use taking better in consideration their proper characteristics; (iii) Preservation and regeneration of the lands, implementing an adequate rehabilitation and a concrete Landownership policy; (iv) improvement of the hydrous resources management systems; (v) accurate participation of the population and better underlining and mobilization of the competences in the development of a viable agriculture.

Equally, climate variability and changes, as well as aridity, are the center of the agricultural administration concerns. Therefore, beside the agricultural systems management policy, Tunisia has launched for many years, an adequate policy of struggle against desertification, realized by the ratification of the desertification convention. This policy has been translated by the implementation of parade strategies, comprising notably an effective mobilization of the populations in the lightening of the land pressure, and the knowledge development and the evaluation of the desertification process. Tunisia has also developed a concerted approach with neighboring countries, and with the international community for the implementation of the program aimed at struggling against desertification.

THE TUNISIAN FUTURE POTENTIAL FOR THE MITIGATION OF THE GREENHOUSE GAS EMISSION GROWTH.

Having been resolutely engaged in sustainable development path, Tunisia has already set a frame allowing her to have an effective contribution to the local and global environment protection, while pursuing its economic and social development objectives.

The Tunisian development strategy could already be considered as corresponding to a greenhouse gas mitigation policy. In fact, the economic transformations that have been engaged for more than a decade, having led to a less energy intensive industrial structure, and an increasing domination of the tertiary sector, have resulted in a significant mitigation of the greenhouse gas emission growth.

Moreover, the past Tunisian policy, concerning the energy conservation, natural resources regeneration and protection,[10] the struggle against any pollution type, has already significantly contributed to the greenhouse gas emission mitigation.

The natural gas option, for instance, allowed to avoid to emit more than 900.000 $TECO_2$ per year, and the encouragement to the energy conservation measures, have contributed to avoid emiting around 250 000 $TECO_2$ per year.

It is certain that with the incresing risks of the global warming, the efforts that should be undertaken by the countries should be even more important. As a Non-Annex 1 Party, Tunisia obviously gives the national development related concerns full priority. However, she also has an important greenhouse gas mitigation potential, that she could mobilize while filling her development priorities.

- ***Expected future emissions according to the business as usual scenario (reference)***

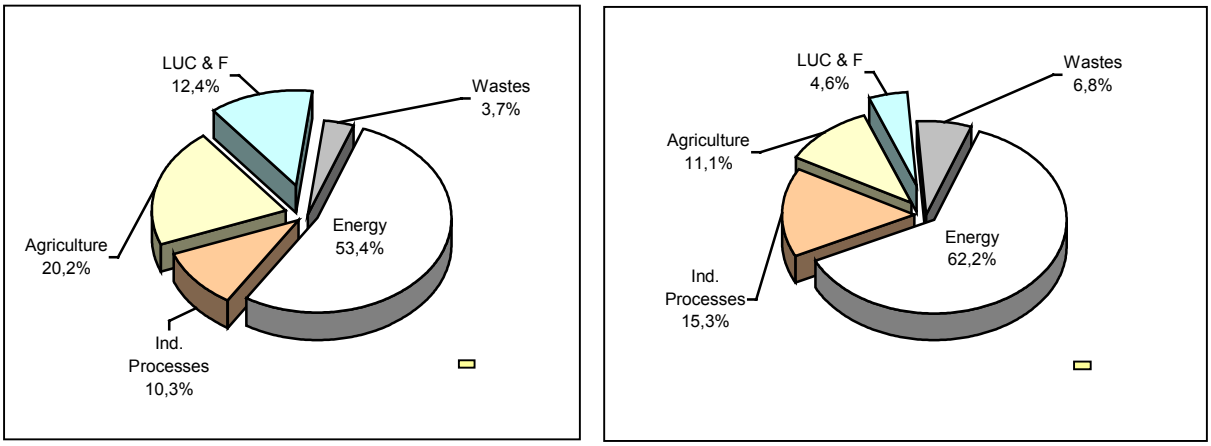
The greenhouse emission simulation results, at the 2010 and 2020 horizons, for the reference scenario, are presented in table 5. They show a GHG gross emissions reaching 79 millions of TE-CO_2 which represents more than the emission doublings between 1997 and 2020. As regards to Net emissions,[11] they rose from 25 millions of TECO2 in 1997 to 62 millions $TECO_2$ in 2020, which represents an annual growth exceeding 4% within the period 1997-2020.

It is to note the more and more important part of the energy in the greenhouse gas emission balance. Indeed, while this source represented only 53% in 1997, it would represent 62% of the emission balance in 2020. A similar emission growth profile and equally registered by the industrial ways which go from 10% in 1997 to 15%in 2020, and by the wastes which part goes from 4% to 7%. On the contrary, the agricultural sector shows an important decrease of its part in the emission balance, passing from 20% in 1997 to 11 % in 2020. It is so for Land-use Change and Forestry, which share in the gross emission balance dropped from 12% to 5%, and which absorption capacity would increase twofold between 1997 and 2020.

[10] Forest development, reforestation policy, fight against desertification, etc.
[11] Net emissions count, in addition to emissions, carbon absorption by plants.

Table 5 : Anticipated GHG emissions in Tunisia- Reference Scenario (1000 TE-CO_2)

	1997	2010	2020
Energy	17 010	31 636	48 993
Industrial Processes	3 265	7 409	12 068
Agriculture	6 440	7 522	8 746
Land-Use Change and Forestry (LUC&F)	-2 744	- 7209	- 12 785
Emissions due to LUC & F	3 952	3 917	3 596
Absorptions due LUC & F	-6 696	- 11 126	- 16 381
Wastes	1 182	4 678	5 338
TOTAL gross emissions	**31 849**	**55 162**	**78 741**
TOTAL net emissions	**25 153**	**44 036**	**62 360**



Figures 2 : Compared structures of GHG emissions by source in 1997 and 2020 (%)

- ***Impacts of mitigation options on the growth of GHG emissions in Tunisia***

Total mitigation potential

The Action Plan for GHG emissions growth mitigation shall globally include 47 different Abatement options, the majority of which (33 options, i.e. 70%) in the energy sector. Besides, the Land Use Change and Forestry include 6 mitigation options, while agriculture and wastes share, equally, the remaining 8 options.

The analyses of the anticipated results shows that the implementation of these 47 options would enable avoiding the cumulated emission of 190 million TE-CO_2 over the whole 2001-2020 period, on one hand, and to absorb about 50 million TE-CO_2, on the other hand (table 6). Thus, the net result of the program would reach about 240 million TE-CO_2, that would be potentially removed from the atmosphere, thanks to the implementation of the program.

It shall be noted that energy plays a major role in the mitigation plan, contributing for 60% of the identified cumulated GHG mitigation potential . The forests come in second rank, with 21% of the mitigation potential, and the wastes come third with 11%, while agriculture contributes for 8% of the identified GHG mitigation potential.

Table 6: Impact of the implementation of the mitigation options by source of emission (1000 TE-CO_2)

	Number of options	2010 Horizon	2020 Horizon	Aggregate total Period 2001-2020	Share (%)
Energy*	33	7.8	13.4	145.2	60%
Agriculture	4	0	1.8	18.0	8%
Land Use Change and Forestry**	6	0.7	3.6	50.3	21%
Wastes	4	1.6	2.2	26.7	11%
TOTAL	**47**	**10.1**	**21.0**	**240.2**	**100%**

(*) Includes the options related to biomass-energy as well as the option for the valorization of methane emitted by solid wastes landfills.

(**) The figures mentioned in this category are absorptions.

Energy

Even though appreciable results have already been achieved in Tunisia, important margins still exist for energy efficiency in Tunisia. However, any additional effort would require the mobilization of important human, technical and financial resources, that exceed, in the current state of development priorities, the possibilities of Tunisia.

Within the framework of GHG Abatement Plan,, possibly to be supported by the funding mechanisms associated with the United Nations Framework Convention on Climate Change (CCUNCC), it has been possible to identify a group of 33 mitigation options in the energy sector, that can be implemented in Tunisia. These options are divided in three categories: (i) 18 Demand Side Management options; (ii) 10 Supply Side Management options; and (iii) 5 cross-cutting options.

The implementation of such program would lead to aggregate savings of primary energy amounting to 2.4 million toe for horizon 2010 and 4.2 million toe for horizon 2020, as shown by table 7:

Besides, in aggregated terms, primary energy savings would amount to 45 million toe over the period 2001-2020, which represents more than 11 years of oil production in Tunisia.

Table 7: Summary of primary energy savings realizable thanks to all mitigation options for horizons 2010 and 2020

	2010 Horizon	**2020 Horizon**	**Aggregate Energy Savings 2001-2020**
Demand Side Management Options	1 307	2 690	26 054
Supply Side Management Options	546	700	9 096
Cross-cutting options	584	792	10 295
TOTAL	**2 437**	**4 182**	**45 445**

Table 8 recapitulates the **aggregated emissions** avoided over the 2001-2020 period, of all GHG Mitigation options deriving from energy. Thus the mitigation plan would allow avoiding the emission of 145 million TE-CO_2 over the period 2001-2020. It shall be noted that, in the energy sector, there is a significant concentration of the mitigation potential on a limited number of options. Thus, the ten most important options, totalize as much as 63% of the aggregated

mitigation potential, and the fifteen most important options, enable 78% of the aggregated mitigation potential.

In addition, with 55% of the avoided emissions, the demand Side Management share the most important GHG mitigation potential for.

Table 8: Total GHG emissions avoided thanks to mitigation options related to the energy sector over the period 2001-2020 (1000 TE-CO_2)

	1000 TE-CO_2 avoided
Demand Side Management	**79 423**
Residential and tertiary	35 268
The Transport Sector	19 192
Industrial sector	24 961
Supply Side Management	**33 993**
Centralized electricity production	15 225
Promotion of alternative Energy Supply Systems	18 769
Cross-Cutting options	**31 738**
GENERAL TOTAL	**145 154**

NB : it is to be noted that the options aiming biomass-energy have been integrated in this Table. Of course, and in order to keep the consistency of the GHG inventories, the results of such options should be re-affected in the Forestry GHG Table.

Agriculture

As regards to **cattle farming,** in the current state of knowledge, the perspectives of CH_4 emission reduction remain limited, and are rather in the research stage. However, works carried out in this field in the past few year, in many industrialized countries, have allowed to analyze the processes of methanogenesis as well as to identify a number of techniques, capable of being used to reduce emissions in Tunisia, through a number of applied researches. These techniques especially concern:

- The modification of the diet of animals;
- The improvement of the productivities of animals, especially for dairy production via more rigorous selections;
- The improvement of the management of farm manure.

Regarding the **soils**, the N_2O emission reduction could especially be under the form of agronomical solutions which would be aimed at reducing nitrification and de-nitrification reactions in the soil: reduction of the excess nitrogen by fractioning of the supplies, spreading of the availability of nitric nitrogen for vegetal, maintaining the porosity of the soil high in order to limit the state of anoxia, etc…

As for methane, the solutions are more into the field of research, and depend widely on the types of soil, the control of the use of nitrogenous fertilizers and generally speaking on the conditions specific to each type of agriculture.

There is also a rather considerable potential for the mitigation of the emissions of carbon from soils, which are mainly due to the mineralization of the organic materials of the soil and which is the result of both cultivation and soil-use practices. The mitigation of carbon emissions would mean insuring a better protection of lands against various erosion phenomenon, which would imply a rational use of lands and a sustainable management of natural resources, in general, and maybe even a certain soil re-allocation.

Table 9 presents an approximation of the most probable mitigation rates of the concerned GHG. However, the mitigation potentials will only be integrated in the mitigation scenario after 2010, because their realization remains conditioned by the outcome of the research which should be developed.

Table 9 : Potentials for foreseeable mitigation of the emissions of methane and Nitrous oxide in the agricultural sector

	Source d'émissions	Rate of Mitigation of CH_4	Rate of Mitigation of N_2O	Aggregated emissions avoided for the period 2001-2020 (1000 TE-CO_2)
Measures a, b et c	• Dairy cattle	50%	-	8 247
	• Non dairy cattle	20%	-	
Measure d	• Agricultural Soils	-	10 to 15%	9 793
	TOTAL	-		18 040

Land Use, Land Use Change and Forestry (LULUCF) :

In Tunisia, the **Land Use change** constitute one of the major areas that offer an interesting potential for carbon sequestration in the soils. In fact, the current use of the lands, especially in the arid and semi-arid areas, contributes to the weakening of the soils and to speed up the carbon losses.

In this mind set, the conversion of marginal lands sown with cereal crops into other crops, better able to insure a permanent cover of the soils, would offer interesting solutions to fight the various forms of erosion, while presenting other economic and environmental benefits. We can mainly name three options which offer an interesting potential:

1. The **planting of olive trees** constitutes a near perfect example of the conversion of marginal lands, and constitutes an alternative which is very beneficial on all levels, especially on steep hills, crusted lands and this on a wide variety of soils.

   Like olive trees, the Tunisian **hardy fruit tree** varieties also offer an important potential on all levels, which can be developed, each according to the climatic requirements, on marginal lands, especially on hilly lands and in the mountainous areas of the Dorsal.
2. Regarding **semi-forest trees,**[12] they offer interesting development and land protection potentials, especially in the mountainous and forest areas of the North West.
3. Finally, **grasslands should be set up in a permanent manner** (10-15 years) and/or **temporary** (2 years) on marginal lands and on calcareous soils in the humid and sub-humid areas which are currently cultivated with cereal.

In the **forestry** domains , we can consider four main options, which are capable of creating an increase in the capacities of the Tunisian eco-systems for carbon sequestration:

1. **Reforestation**: this is the reforestation of degraded forest areas by the plantation of appropriate varieties according to the environment. With time, this reforestations shall meet four main objectives, namely: (i) the reconstitution of deteriorated natural species, (ii) the protection of the river basins of dams, (iii) the production of usable wood and (iv) the storage of carbon.

[12] Walnut tree, pecan tree, chestnut tree, etc.

2. **Pastoral Plantations and the improvement of courses** also constitute interesting mitigation options. This action should be made of the development of degraded cultivation lands which are sometimes cultivated with cereal crops in the Centre-South or in a continuous manner in the North. This development would also affect the pasture lands, in order to restore their production potential and to increase the production of fodder biomass for the cattle. On the other hand, we could consider the plantation of feed bushes and trees in the steppe areas and in the semi-arid areas in general.
3. **Forest developments**: it is a case of combining a certain number of actions, aimed at restoring the production potential of forests, and ensuring Optimum and sustainable valorization of the resources. These actions should be implemented in a participatory and integrated way as to increase e the contribution of the forest resources, thus managed, to the socio-economic development of the forest populations.
4. The improvement and management of courses should follow a similar process. In fact, the major part of the collective courses being under the responsibility of the public authorities, they should be managed within the same framework and protocols as mentioned above for the forestry sector.

Table 10 presents the anticipated results of the options aimed at carbon sequestration, aggregated over the full period 2001-2020. It shows the important contribution of the fruit tree growing as a carbon sequestration source, totalizing ¾ of the mitigation potential of the LUC & Forestry sector.

Table 10 : Aggregated GHG sequestration potential resulting from mitigation options in the Land Use Change and Forestry over the period 2001-2020 (1000 TE-CO_2)

	1000 TE-CO_2 absorbées
a - Plantations arboricoles	38 576
b - Aménagement des prairies	123
c - Reboisements forestiers	718
d - Plantations pastorales	10 373
e - Aménagements forestiers	354
f -Amélioration et aménagement des parcours.	194
Total	**50 338**

Waste

In the **solid waste** sector, three main actions can be proposed. The composting option is upstream of the chain, and the other two are downstream: the electric valorization of CH_4 and the flaring of gas.

Composting allows a considerable reduction of the quantity of biodegradable wastes in the landfills, and thus of the CH_4 emissions. The development of composting stations for organic waste requires, before hand, the set up of appropriate selective collection process at the source. It also requires, the development of a market for compost, that is close to the composting stations, as to ensure the financial viability of the composting facilities.

The **Methane recovery** from landfills could be considered in the highly urbanized areas. Two options are possible for this mode of operation:

- The electric valorization of CH_4, to be considered in the large sized landfills. The generated electricity could be used for the landfill's own use, but most of it would be injected in the electric network.
- The flaring, to be chosen in the small sized landfills, is technically easier and costs less in terms of investment than electric valorization. The technique constitutes in methane recovery and burning in a flare, which reduces the risks of accidental fires and explosions in landfills, while converting CH_4 to CO_2, which is less harmful to the atmosphere.

In the field of **used wastewater treatment,** two options can be proposed depending on the treatment process :

- In the case of **anaerobic digestion,** the most advantageous option is that of energy valorization of the biogas, for thermal and electric uses;
- In the case of stations with aerobic process (generally small and medium sized), the proposed option is that of a second aerobic treatment. Despite constraints of cost and space, this option allows a reduction by half of the CH_4 emissions.

Table 11 summarizes the total emissions avoided during the period 2001-2020, of all GHG mitigation options due to wastes.

Table 11 : Impact of the implementation of the mitigation options in the waste sector (1000 TE-CO2 avoided)

	2010 Horizon	2020 Horizon	Aggregated total 2001-2020
Composting of solid waste	222	274	3 491
Recovery and flaring of methane from solid waste landfills	1 162	1 535	19 409
Recovery and electric valorization of methane from solid waste landfills	443	585	7 286
Recovery and electric valorization of methane from wastewater treatment plants	106	129	1 821
Aerobic treatment in wastewater treatment plants.	81	222	1 985
TOTAL	**2 014**	**2 745**	**33 992**

NB: it should be recalled that option 3 is presented here just in order to group all the options based on the valorization of waste, it had already been included in the energy section .

- ***Aggregated emissions –mitigation scenario***

The aggregated results of emissions according to the mitigation scenario are presented in table 12. It shows the total gross GHG emissions reaching 61 millions TE-CO_2, which represents a doubling of emissions between 1997 and 2020, while during the same period the GDP was nearly multiplied by a factor 4. Net emissions, went from 25 millions of TE-CO_2 in 1997 to 41 millions of TE-CO_2, which represents an annual growth of 2.2% over the period 1997-2020, while it was over 4% in the reference scenario.

We shall note that, as in the reference scenario, energy plays an ever important role in the GHG emission balance . In fact, it would represent as much as 59% of the emission total in 2020. An even more important growth profile of emissions is witnessed by industrial processes, which go from 10% in 1997 to 20% in 2020, while agriculture represents a total opposite profile, going from 19% to 11% of the total emission balance , and that forests witnessed an important decrease of its contributions to the emission share , going from 12% to less than 5%.

Table 12 : Anticipated GHG emissions according to Mitigation scenario (1000 TE-CO_2)

	1997	2010	2020
Energy	17 010	24 245	36 151
Industrial Processes	3 265	7 409	12 068
Agriculture	6 440	7 522	6 913
LUC & Forest	-2 744	-8 321	-16 864
Forest-emissions	3 952	3 523	3 043
Forest-absorptions	-6 696	-11 844	-19 907
Waste	1 182	3 107	3 178
TOTAL gross emissions	**31 849**	**45 806**	**61 353**
TOTAL net emissions	**25 153**	**33 962**	**41 446**

The following figure shows the results reached thanks to the implementation of the GHG mitigation program:

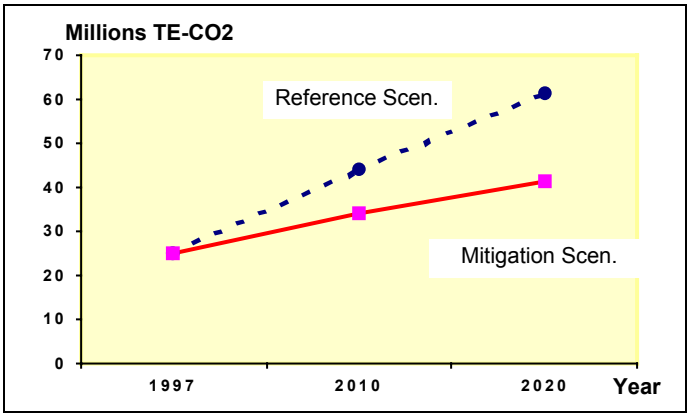
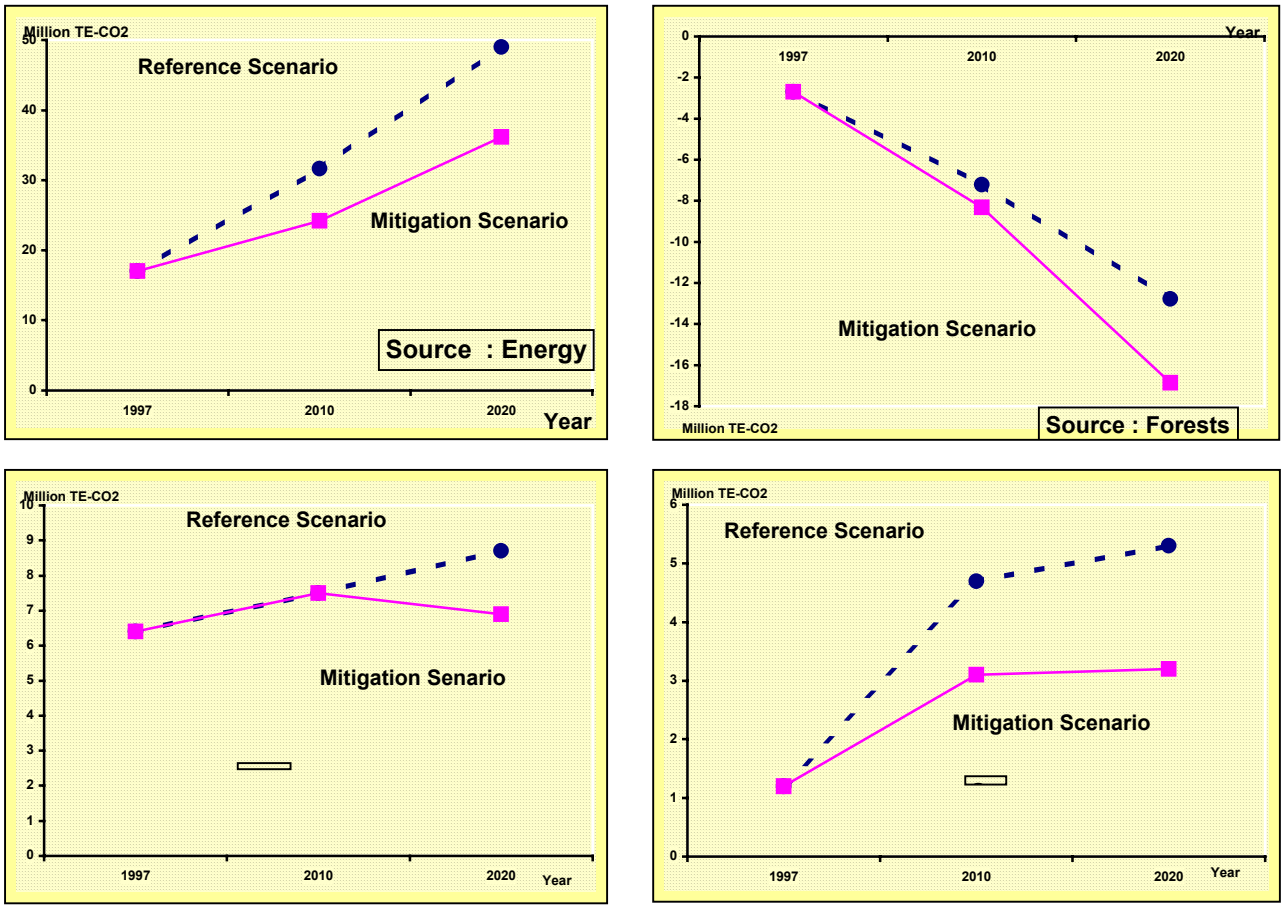


Figure 3 : Comparative national GHG emissions in reference and mitigation scenarios (millions TE-CO_2)

The following figures show the compared sector tendencies of the evolution of emissions according to the reference and mitigation scenarios.



Figures 4 : Comparative sectorial GHG emissions in Reference and Mitigation scenarios (Million TE-CO_2)

C CAPACITY ENHANCEMENT IN TUNISIA IN VIEW OF A SUSTAINED CONTRIBUTION TO THE IMPLEMENTATION OF THE UNFCCC

As a Non-Annex 1 Party, Tunisia has the right to insure favorable conditions to its development, which inevitably require a GHG emissions growth.

However, Tunisia is also conscious of the fact that the global environment must be preserved, and that all efforts must be made to avoid endangering the survival of future generations, especially that development models to be adopted, can perfectly be associated with environmental concerns. As such, Tunisia is willing to contribute to the world effort to fight climate change,[13] according to the principle of common but differentiated responsibilities, as stipulated, and rightly so, by the Convention.

In order to maintain this contribution at a sufficient level, while guaranteeing the realization of its development priorities, Tunisia would need to have the possibility to significantly reinforce its expertise in the field of Climate Change as well as its institutional and technological capacities. In addition, it is understood that the set up of such a program for the reinforcement of capacities and realization of a climate change action plan, shall require the mobilization of important financial

[13] Especially by a regular updating of the National Communication, and its transmission to the Conference of Parties, according to a frequency to be agreed upon by the COP.

resources, to be requested from the financial mechanisms of the Convention, according to the modalities defined by the Conference of Parties.

- ***Training and capacity enhancement needs in connection with the implementation of the UNFCCC***

The acquisition of knowledge, thanks to a permanent and sustained training process, and to a better involvement of the various players of the development, in the field of climate change, would have concrete results on the expertise abilities of the country, and on their capacities to master the crucial topics, related to climate change. In order to achieve an appropriate level of expertise in the field, the training needs, in Tunisia's case, should be centered on the following main themes:

- The study of the variability of the climate, its foreseeable nature and its possible changes;
- Consequences of the integration of climate change related concerns on the national development, and the implications on Tunisia, of a strict application of the UNFCCC internationally;
- Direct aspects related to climate change, to the action plan and to the national communication: vulnerability and adaptation; climatic modeling and regional impacts of global climate change; economic, technological and institutional analysis of the mitigation options; prospective scenarios of GHG emissions; permanent training on the inventory;
- Ecological, economic and social impacts of climate change ;
- Mastery of the financial mechanisms aimed at climate change mitigation (GEF, CDM, etc.) and initiation to the project preparation and submission to these mechanisms;
- Reinforcement of the negotiation capacities of the countries, through training but also through the participation of Tunisian representatives to the various regional and international events, both technical as well as policy and negotiation related ones.

In addition, besides the training needs, it would be appropriate to set up an efficient information, awareness and basic training process on climate change aimed at political leaders on one hand and at the general public on the other hand.

- ***Needs for Institutional Strengthening***

In order to succeed in integrating the issues related to climate change, during the preparation of the sectorial development strategies and the implementation of development projects, a number of institutional support measures are necessary. Among these measures, the most determining would consist of the Consolidation of the National Climate Change Committee (NCCC). In order to achieve such a goal, this committee needs to be officialized, and its should be enlarged to the other structures interested in the issue of climate change.

In support of the NCCC, it would be necessary to create a permanent national unit working on climate change. Such a structure could in particular:

- Play the role of a Permanent Secretariat to the NCCC;
- insure a permanent follow-up of the climate change process at the national and international levels, including the implementation and follow-up of the commitments associated with UNFCCC;
- Play an information role, especially for the distribution of periodic publications;
- Follow-up and monitor the implementation of the national climate change action plan, and especially the adaptation and mitigation projects;
- Possibly insure the follow-up and the accounting of the CDM projects, according to the rules agreed upon by the Conference of Parties.

- ***Technological needs***

Given the level of development reached so far by Tunisia, the immediate technological needs of the country would mostly relate to immaterial needs. As for material needs, they are linked to the financial resources which can be mobilized by the financing mechanisms of the Convention.

The first need concerns the reinforcement of capacities specifically in the field of the assessment of technological needs, the criteria for the selection of these technologies and the analysis of the adequacy of these technologies to the country circumstances, as well as the most appropriate modalities and speed for their introduction.

The main requirement in technology transfer is **quick access** to information, training and methods for the acquisition of these technologies. In fact, the efficiency of a technology is also measured in terms of its capacity to offer a technical "plus", but also economic, to the company or country acquiring it. This quick access to the most efficient technology leads to a stimulation of competition, and thus to create a sustained dynamic of improvement of performances, and as a result a decrease in the threatening to the environment.

The other vital imperative for Tunisia is to have **access to the most recent knowledge**, or even participate in the research, in the field of technology development or environment-friendly technology management practices,. Such an imperative can be satisfied through a permanent program of acquisition of knowledge, thanks to the participation in training sessions and international events, as well as the exchange of information, experiences, and data via the most modern methods such as the internet.

In the same way, it would be imperative that Tunisia have the possibility **to acquire a perfect mastery** of the technologies which must be adopted, at an acceptable transaction cost. This mastery involves all the aspects of the transfer of technology, and requires a reinforcement of the capacities of: consulting and advice, the implementation of appropriate institutional and financial mechanisms, management of these technologies, adaptation of the technologies to the local conditions, and maintenance of these technologies, or even their reproduction.

Finally, the last imperative for Tunisia would be to have access to **attractive financial modalities** for technologies, processes, transfer of know-how, permanent access to international networks, and for the enhancement of the technological information framework in Tunisia.

Funding needs

Up to now, the assessment of the costs for the implementation of all the mitigation options and the set up of costs curves, as well as the evaluation of adaptation costs to Sea Level Rise have not been completed yet. The results of these works will be published by the end of 2001.

However, already, some important information emerges from the first results obtained from the GHG mitigation studies. In fact, for the majority of the mitigation measures, the net costs are below 30 Dinars/TE-CO_2 avoided.[14] In addition, more than 3/4 of the energy related measures have a « negative » net cost, which makes them « no regret » actions.

[14] Over 80% of the energy sector measures, and the totality of the Forestry and Waste measures have a Net Costs below this level.

As for the vulnerability, apart from the impact of Sea Level Rise, no study has been conducted, to this date, on the vulnerability of forests and continental agriculture to Climate Change, and on the identification of adaptation measures. Resources should be mobilized, on these aspects, in the future, in order to complete the vulnerability study.

As for the needs related to the communication of information to the Conference of Parties, they have been partly expressed in the above paragraph, related to the establishment of a climate change unit (Institutional Strengthening).

However, additional financial resources would be required to ensure the continuity of works aiming at the preparation of the national communication to the COP, and the implementation of the action plans. It is possible, in particular to mention the following funding needs :

- Improve the accuracy of the GHG inventory by carrying out some specific research aimed at the improvement of emission factors and activity data;
- Facilitate access to the prospective models used, mainly in the energy field and in the climatology;
- Conduct more complete vulnerability and adaptation studies and assessements ;
- Allow Tunisians experts, in charge of the climate change process, to have update knowledge, as regards to analysis and assessment methodologies related to the three above aspects;
- Prepare project proposals on the main areas of interest for the country, i.e. GHG mitigation and Climate Change Adaptation;
- Create a permanent follow-up process of technological developments at international level, in relation with Climate Change questions, of assessment of Tunisian technological needs, and definition of most adequate modalities for their acquisition.