

# GHG EMISSIONS IN TUNISIA AND THEIR IMPACTS

Mounir BELLOUMI

University of Sousse

## BACKGROUND

Tunisia signed the United Nations Framework Convention on Climate Change (UNFCCC), in Rio in 1992, then ratified it in July 1993. Tunisia is a Non-annex 1 Party of the Convention. This poster is a summary description of 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.

## GEOGRAPHICAL SITUATION AND CLIMATIC CHARACTERISTICS

Tunisia is located in North Africa. It is at the junction of the West and East Mediterranean, and covers a 164.000 km<sup>2</sup> 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 mild and relatively rainy winter;  
A hot and dry summer;  
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" 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.

## INVENTORY OF GREENHOUSE GASES IN TUNISIA

The inventory of GHG (greenhouse gases) for 1994 shows a relatively limited contribution by Tunisia to the greenhouse effect, in comparison with other Nations. In fact, the net anthropogenic GHG emissions of Tunisia are 23.4 million tons of CO<sub>2</sub> equivalent (TE-CO<sub>2</sub>), which represent 2.66 TE-CO<sub>2</sub> per capita or 1.8 TE-CO<sub>2</sub> per thousand US\$ of GDP. The analysis per type of gas show a domination of CO<sub>2</sub> which represent 66% of the net national emissions, followed by N<sub>2</sub>O with 18% and of CH<sub>4</sub> with 16% (Figure 1). On the other hand, in gross terms (without taking into account the carbon sequestration), Tunisian emissions totaled 28.9 million TE-CO<sub>2</sub> in 1994, meaning 3.3 TE-CO<sub>2</sub> per capita. The GHG absorption totaled 5.5 million tons of CO<sub>2</sub> in 1994, meaning 0.6 tons of CO<sub>2</sub> 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<sub>2</sub>, energy uses represent more than half the gross national emissions, followed by agriculture, which represents with 6 million TE-CO<sub>2</sub>, 21% of gross emissions. Next come forests and industrial processes with respectively 3.7 millions TE-CO<sub>2</sub> (13%) and 2.8 millions TE-CO<sub>2</sub> (10%) of gross national emissions. Wastes remain a relatively weak source of emissions, with only 1 million TE-CO<sub>2</sub>, representing hardly 4% of gross Tunisian emissions (Figure 2). In addition, the GHG inventory emissions also estimated the emissions of ozone precursor gases (CO, NO<sub>x</sub> and COVNM), which have an indirect radiating effect, as well as SO<sub>2</sub>. The table 3 presents the results of the estimates of emissions of these gases for 1994.

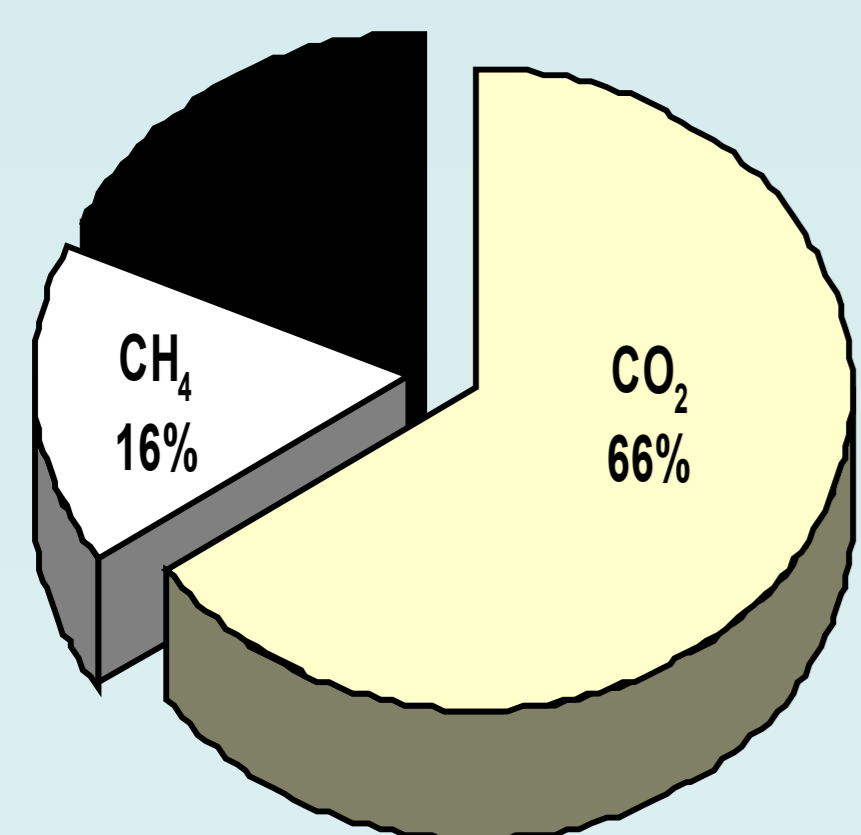


Figure 1: Repartition of Net Tunisian Emissions of GHG for 1994 per type of gas (%)

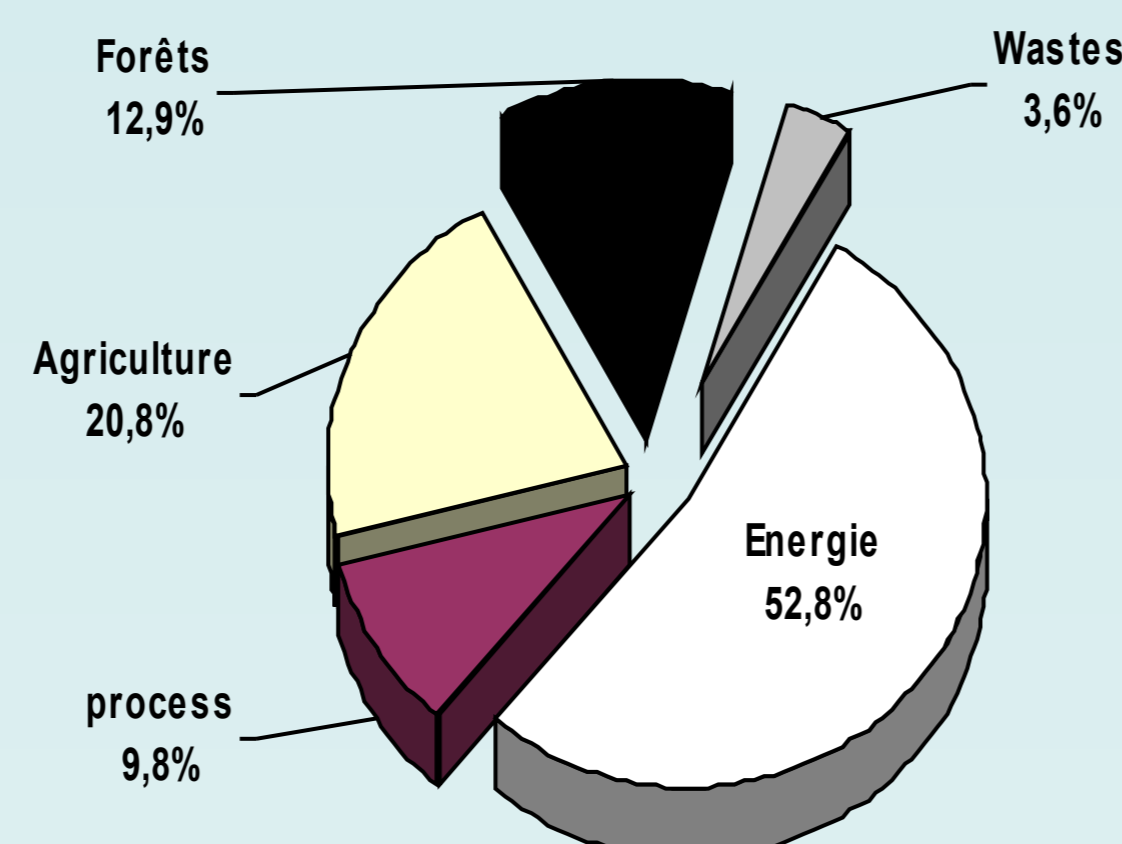


Figure 2: Repartition of Gross Tunisian Emissions of GHG for 1994 (%)

Tableau 1: Summary of net and gross emissions of GHG in Tunisia in 1994 (1000 TE-CO<sub>2</sub>)

	Emissions of CO <sub>2</sub>	Absorptions of CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	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 - Solvants						
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 (%)	72%		13%	15%	100%	
•Gross Emissions	66%		16%	18%	100%	
•Net Emissions						
International Bunkers			0,151	6,620	776,4	

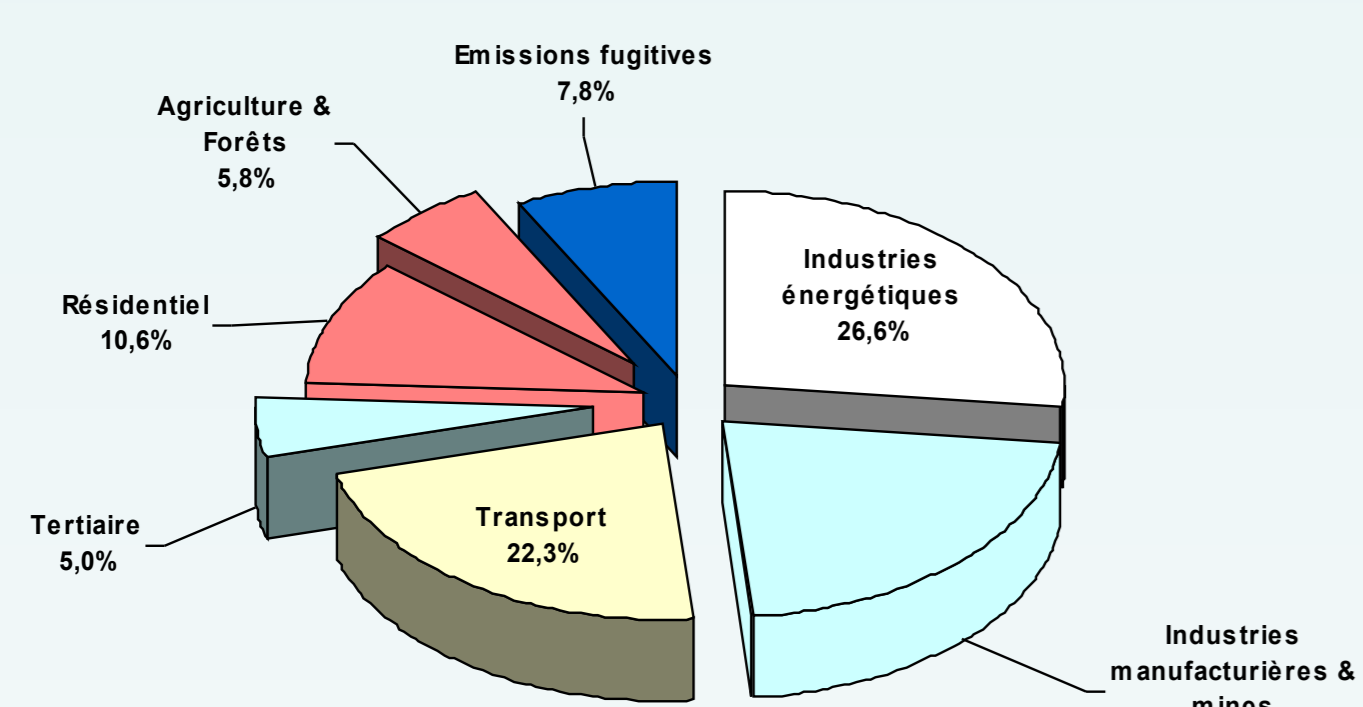


Figure 3: Distribution of the emissions of GES due to the energy uses (%)

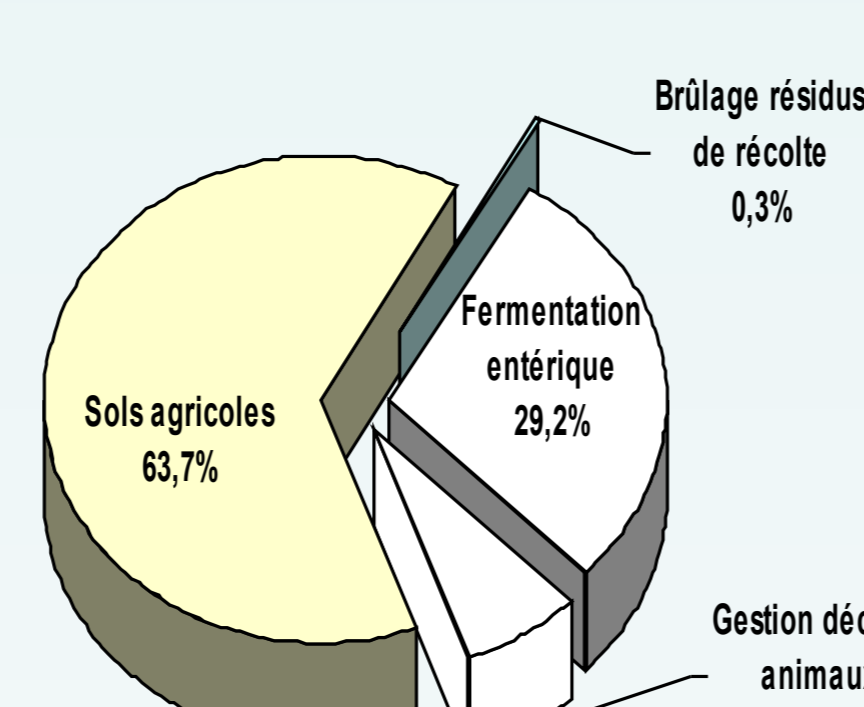


Figure 4: Distribution of the emissions of GES due to the agriculture uses (%)

## 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. 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 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 incapallt for countries affected by aridity, in particular those of the Maghreb, who already face a hydrous stress 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<sup>3</sup>/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. 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<sup>3</sup>/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 2230Mm<sup>3</sup>/year, one year over two;

Water availability is less than 1500 Mm<sup>3</sup>/year, one year over five,

Water availability is less than 1250 Mm<sup>3</sup>/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 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.

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.

## 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 precepts, 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 precepts 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 tightening 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.