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Climate Change in Algeria: Vulnerability and Strategy of Mitigation and Adaptation

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Abstract

Due to its geographical position and climatic characteristics, Algeria is highly vulnerable to climate change. Even a small rise in temperature would lead to various socio-economic problems that hinder the development of the country. The models predict that rainfall events are less frequent but more intense, while droughts are more common and longer. The spatial and temporal distribution of rainfall will also change. The analysis of climate data from 1931 to 1990 in northern Algeria reveals a rise in temperature of 0.5 °C would reach an increase of 1 °C by 2020. A temperature rise of 2 °C is expected by 2050. The decrease of water resources, declining agricultural yields, encroaching desert, the challenge of planning and the energy consumption for air conditioning are only the initial impacts to which Algeria must find answers supportable economically and socially. Thus although the contribution of Algeria on global warming is minimal (less than 0.5% of global GHG emissions), the country is very vulnerable and should integrate adaptation into its development policy.

We present in this study an analysis of the current situation with regard to support sustainable development and climate change issues, footprint of Algeria, trends in emissions of CO₂ in Algeria, mitigation and adaptation strategy Algeria, national climate plan and especially what the impact of the new national plan for promoting renewable energy adopted in 2011 and expects to produce 40% of electricity needs from solar. Avenues of consideration that are able to mitigate the impacts induced by medium-term climate change will also be presented.

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1. Introduction

The issue of climate change is in Algeria an important and new challenge. A large part of Algeria belongs to the Mediterranean basin which is a "hot spot" of climate change and should therefore be protected. Algeria, ratified in April 1993, the United Nations Framework Convention on Climate Change (UNFCCC), and fully subscribes to commitments relating to the stabilizing emissions of greenhouse gases to prevent anthropogenic interference with the climate system.

By adhering to the Kyoto Protocol in 2005, Algeria has shown its determination to participate in the international effort against climate change and its potential impacts on water resources, natural ecosystems and the sustainability of economic development. All socio-economic sectors and institutions are gradually incorporating aspects related to climate change, particularly in the search for ways of adaptation and mitigation. With no historical responsibility for climate change, any national effort of mitigation should not be economically restrictive or menacing the right of Algeria to development.

Algeria has developed an initial strategy against climate change and developed numerous projects for adaptation and mitigation of changes climate. The national strategy is based primarily on four areas: institutional strengthening, adaptation to climate change, mitigation of emissions of GHG and human capacity building [1]. Its implementation mainly concerns the sectors of energy, industry, transport, waste, water resources, agriculture and forests. In this context, there was creation in 2007 of the National Agency for climate change and inventories of greenhouse gas (GHG) emission are carried out periodically.

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This paper presents the evolution of CO₂ emissions and an analysis of the current situation in terms of support for sustainable development and the issue of climate change. We discuss energy strategy to 2030 (Algerian Solar Plan), the national climate plan and the challenges the country faces. Avenues of consideration that are able to mitigate the effects induced in the medium term by climate change will also be presented.

Nomenclature

UNFCCC	United Nations Framework Convention on Climate Change
MATE	Ministère de l'Aménagement du territoire et de l'Environnement
GHG	greenhouse gas
GAW	Global atmosphere watch
PPP	Purchasing power parity
GDP	Gross Domestic Product
GFN	Global Footprint Network
IPCC	Intergovernmental Panel on Climate Change
UNDP	United Nations Development Programme
NACC	National Agency on Climate Change
LPG	Liquid petroleum gas
CNG:	Compressed natural gas
SWH	Solar water heater

2. Evolution of GHG and climate in Algeria

2.1. Evolution of GHG

Since 1950, the CO₂ continues to grow. In the Global Atmosphere Watch (GAW) Program of the World that helps to improve the understanding of interactions between the atmosphere, the oceans and the biosphere, the CO₂ measured at the GAW station of Assekrem (altitude: 2710 m), Tamanrasset, Algeria, is growing steadily from 360 ppm in 1995 to 385 ppm in 2008, representing an annual increase of about 2 ppm / year (figure 1) [2, 3] and we measure today no less than 392 ppm.

Algeria has conducted two national emission inventories of greenhouse gas (GHG) emissions for the years 1994 and 2000. The inventory covered the direct six greenhouse gases (CO₂, CH₄, N₂O, SF₆ and CFCs) and indirect greenhouse gas precursors (NO_x, CO, NMVOC and SO₂). The share of emissions of each greenhouse gas is illustrated in figure 2 [4]. In 2008, the overall GHG emissions totaling 121.31 MT eq.CO₂. Per capita emissions are 4.1 T eq. CO₂/inhab/an. It was 3.1 in year 1990.

By comparing the emission per habitant, Algeria is among important emitters from developing countries (Figure 3). In comparison, the average annual global emission of CO₂ is 4.7 T /inhab., Qatar 55.4 T /inhab., UAE 31.1 T / inhab., U.S. \$ 19.8 T / inhab , France 6.1 T / inhab., Lebanon 20.3 T / inhab, Tunisia 2.4 T / inhab. Morocco 1.5 T / inhab. and India 1.4 T / inhab. [5].

By activity, the energy sector (production and consumption) which is the source of highest emissions, about $\frac{3}{4}$ of the total (Figure 4) and this sector has the most important potential for mitigation measures [4].

The annual average growth of 2.0% seems to be in line with the increase of the average annual consumption of energy during this period. Thus, with this growth, emissions will increase by 2020 of 40% over the year 2000. In these emissions, the production of electricity increased since 1997 by about 6% / year, accounting for 40% of CO₂ emissions.

In 2008, for one \$ PPP (purchasing power parity) of GDP, Algeria emitted 0.41 Kg CO₂ [6]. There is generally a good correlation between living standards and CO₂ emissions. This rate shows that the Algerian economy use fossil energies in the process of production and consumption. For example, France uses nuclear energy, the rate rises to 0.2. It also follows that for a tonne of CO₂, the wealth generated is two to three times lower than in developed countries. It is also a result of the delocalization of heavy polluting industries to developing countries [6].

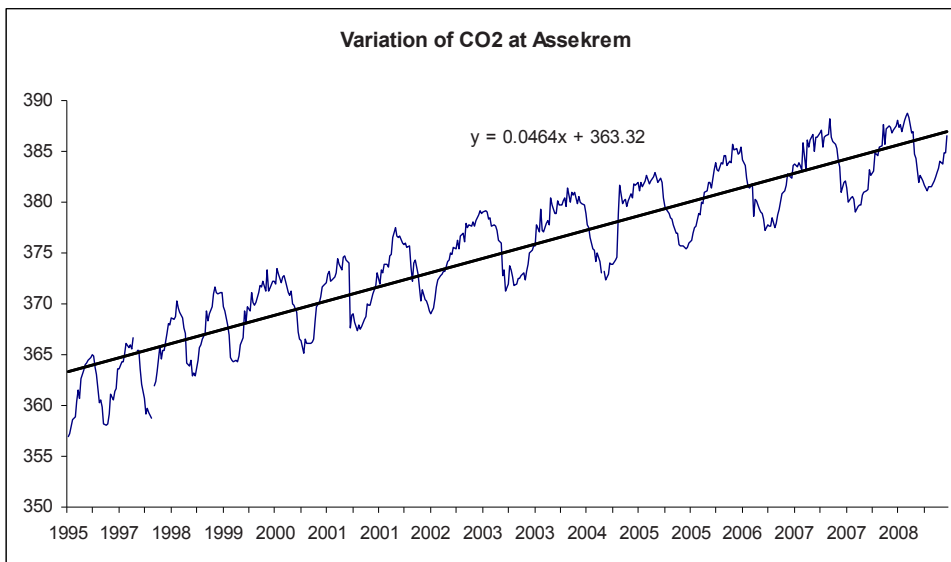


Figure 1. Evolution of CO₂ at the Assekrem Station [2]

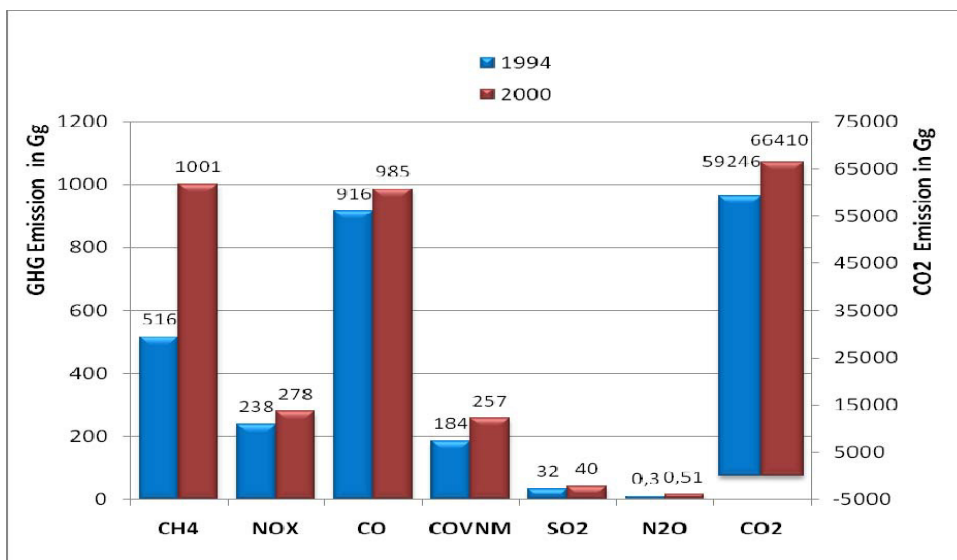


Figure 2: GHG emissions from the energy sector in 1994 and 2000 [4]

In All sectors, energy use in 2008 amounted to 23.2 million Toe. Taking into account the current socio-economic trends and without mitigation actions, the estimates we conducted show that Algeria consumes 50.02 million Toe to 2030 (average annual growth rate of 4% energy) which corresponds emissions in the order of 180 MT CO₂ per year by the energy sector (power plants to natural gas).

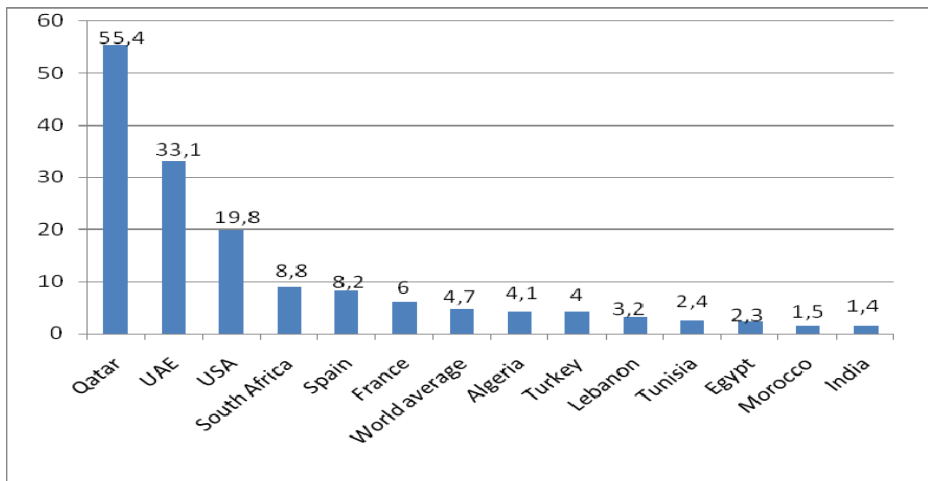


Figure 3. Comparison of CO₂ emissions per capita among other countries [5]

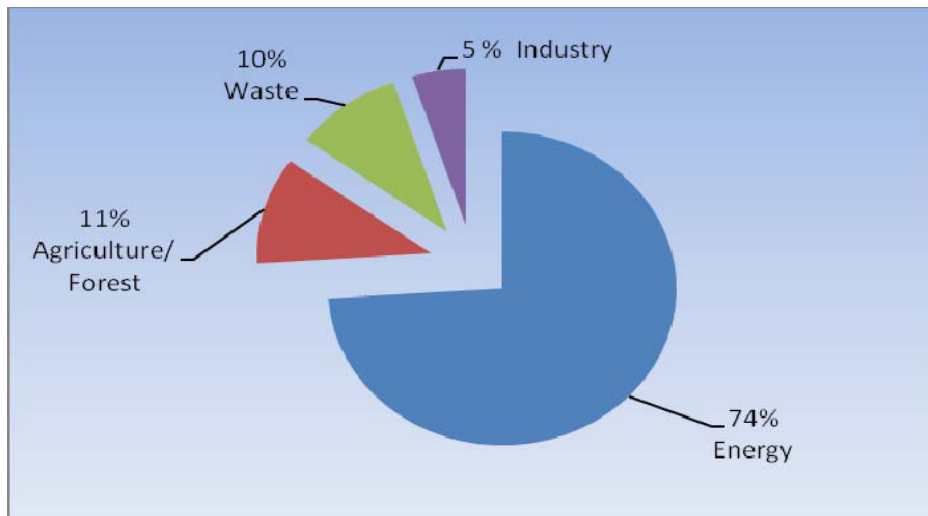


Figure 4. Total GHG emissions by sector in Algeria [4]

2.2 The ecological footprint of Algeria

The ecological footprint created by the Global Footprint Network (GFN) characterizes the process of depletion of natural resources of the planet or a country. It consists in comparing the amount of available resources (biocapacity) to the actual consumption of a country. It is expressed in global hectares / capita (gha / capita). [7]. In 2008, the world average per capita ecological footprint is about 2.7. The world average biocapacity is 1.8 gha / capita. The main responsible for the deficit are CO₂ emissions, they constitute 55% of the global ecological footprint. The rest goes to the exploitation of natural environments. The process of depletion of natural resources is accelerating. In 2012, the world has consumed during the first 234 days all natural resources than the earth can produce over the year. The "Global Overshoot Day" was reached August 22. Thus, one planet is not enough to provide for us needs and to absorb our waste. The extreme case is given by the Qatar which with a consumption of 11.68 gha / hab. needs five planets only to absorb his CO₂ production. In the Mediterranean region, in 2008, the GFN reports for Algeria 1.6 gha, France 4.9 gha, Spain 4.7 gha and Morocco 1.3 gha [8].

For 2011, our estimates lead to an ecological footprint of 1.85 gha. This value shows that Algeria has no deficit; consumption is in equilibrium with the available biocapacity. A review of living (GDP), GHG emissions and ecological footprint suggests that Algeria is generally in a sustainable development process it will be necessary to preserve.

2.3. Climate Change

In its 2007 report, the IPCC has combined 25 global climate models to assess the impacts of climate change in 2050 and 2100. In the Mediterranean region, there provided a temperature rise of 2-3 ° C by 2050, and 3-5 ° C by 2100. The rain events are less frequent but more intense, while droughts are more common and longer. The spatial and temporal distribution of precipitation would change, which directly affect agriculture and water resources. Regional models with the IPCC scenarios applied to Algeria for the period 1990-2020 forecast growth of the average temperature of 0.8°C to 1.1°C, and reduced precipitation 10% (Figures 5, 6) with an increase in the sea level of 5 to 10 cm. Increased evaporation and decreased precipitation will accentuate the decrease of water mobilized in dams and groundwater

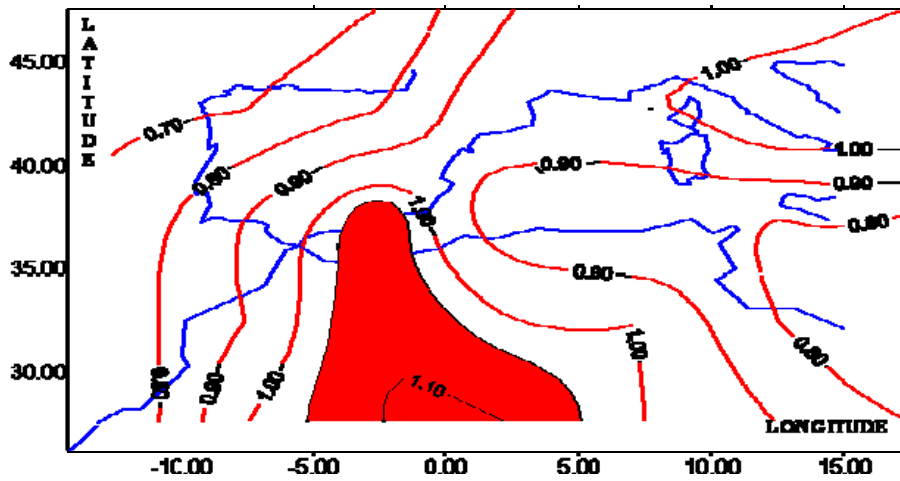


Figure 5: Projected Temperature (° C) to 2020 (winter)

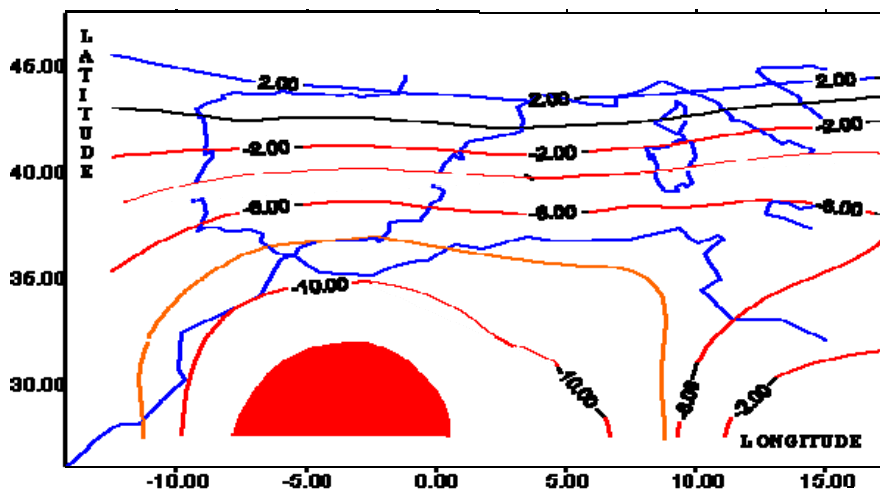


Figure 6: Change in precipitation (%) to 2020

3. Vulnerability

The major vulnerability of the country is observed in the areas of water and agriculture. Algeria is a semi arid to arid north to south. Water availability per capita is 600 m³/hab./an, placing Algeria in the category of poor countries in water resources under the shortage threshold set by the UNDP or the scarcity set by the World Bank in 1000 m³/hab./year. With 71 dams of a capacity of 7.1 billion m³, Algeria has almost reached the mobilizable water potential. The rate of groundwater exploitation in the north of the country reached about 90%, nearly 2 billion m³/year. Some aquifers are already overexploited. To ensure that consumption needs, the country of use in recent years desalination of sea water with a production capacity of about 2 million m³/day.

Land used by agriculture, which occupy nearly 21% of the total land area, are estimated at 49 million ha distributed as follows: 8.4 million ha of agricultural area, 33 million ha used as routes, 6.6 million ha of forests and steppes of Alfa. Irrigated land accounts for 11% of the agricultural area, an area of 929.000 ha. Algeria therefore has only 3.5% of the total area of the country as arable land and irrigated. The ratio "availability / capita" agricultural land rose from 0.75 ha / cap in 1962 to 0.24 ha / cap in 2008. This enormous loss of farmland is not only the result of human pressures (industrial, construction, pollution ...) but also the result of desertification, soil erosion, the vegetation cover loss. Climate change will degrade biodiversity and contribute to the weakening of the soil and reduced vegetation cover resulting in a gradual desertification. In the steppe, the effect of climate change is reflected by the change in the cyclical nature of drought from one year to three years in the 60 to two years out of five in the 70s and 80s for seven out of ten years now.

Vulnerability to climate change is a vital issue for the protection of natural resources and human health and the environment protection, developing the strategic development of the country.

4. Strategy

The national strategy against the climate change is essentially based on components: climate change adaptation, mitigation of GHG emissions, institutional strengthening for mainstreaming of climate change at all levels and in all sectors such as the energy, industry, transport, waste, water resources, agriculture and forests. For this purpose, a legal and regulatory framework is developed to ensure the implementation of this strategy. In the industrial sector and energy legislation is reinforced by texts of laws on energy conservation, development land, waste management, electricity and gas distribution, protection of the environment in the context of sustainable development of renewable energy, water, energy efficient audits. A national fund for renewable energy is created for the promotion of renewable energy through the diversification of energy resources within the country. Many industrial initiatives are developed to either mitigate or adapt to climate change. The analysis of the current state with a future projection highlights some strength of the actions undertaken to date and the barriers that stand against the outcome of this strategy (Table 1). However, despite all these measures already taken, it appears the need for coordination at the national level and especially inter-sectoral lacking to date. The creation of the National Agency on Climate Change (NACC) could achieve this coordination at the national level and capitalize on the experiences and replicate best practices across the country. It will also run multi-sectoral projects ensuring proper

Table 1: Benefits and Barriers of the strategy

Benefits	Barriers
Legislative and regulatory framework well-developed.	Low technical inter-sectoral coordination
Comprehensive strategy to promote renewable energy.	Weakness of new technologies transfer
Availability of financial resources (funds, budgets).	Insufficient technological mastery
Start promoting research and development related to climate change	Insufficient qualified human resources and limited availability of national expertise
	Low ownership of areas of climate change local and regional

coordination and reconciliation of areas around the theme of climate change. The agency has not a great development in spite of the strategic role it is supposed to play in this area in the country.

The implementation of the government strategy should be based in part on such an agency for successful policy and action plans provided. It is urgent to analyze the course of this agency in order to propel to the forefront and allow it to play its role at a time when this problem is growing both at the domestic level and worldwide

5. Mitigation

When looking at the national inventory of greenhouse gas emissions, one can observe that the sectors most emitters are: the energy industry, transport and housing. These sectors are a major source for mitigation.

The main mitigation measures implemented or being implemented to reduce emissions of pollutants and greenhouse gases are:

- Recovery of associated gas from oil wells (95% in 2020)
- The widespread use of gas in oil refineries
- The widespread use of natural gas for domestic
- The renewal of power plants by introducing the combined cycle
- Development of hybrid plants (natural gas-solar)
- The development of the use of LPG and CNG as vehicle fuel,
- The reduction of gas flaring in energy industries,
- Introduction of energy efficiency in buildings,
- Solar energy development

6. Program for renewable energy and energy efficiency

However all these measures do not allow substantially reduction of the current level of GHG emissions. The estimated reduction impacted by these measures account for 10 to 12%. The new development plan for renewable energy announced in early 2011 provides for the production of

22,000 MW of electricity from solar by 2030, half of which is for the local market and the other part will be exported to other markets in Europe. This project will impact on GHG mitigation in Algeria and Europe.

The first stage (2011-2013) of the program will focus on pilot projects to test different technologies available, the second (2014-2015) is the beginning of its deployment and the last (2016-2020) is that of deployment large scale. The first hybrid solar-gas plant was put into operation in 2011. With this program renewable energy electricity production will be 40% of solar origin to 2030. The program will contribute gradually to satisfaction in term of national electricity needs, but beyond that, it is designed as a vector for industrial development with its realization through national and added value. Whether occurring in the DESERTEC project or another, Algeria wants a real transfer of technology. The "Energy Efficiency" program includes measures to the rationalization and energy conservation. The purpose of energy efficiency is to produce the same goods or services but using the least energy possible. This program contains actions that favor the use of forms of energy best adapted to different uses and require behavior change and improvement of equipment.

The actions selected are primarily the housing sector that is very energy intensive, more than 40% of the electricity consumption. The proposed shares of energy efficiency include the introduction of the thermal insulation of buildings that will reduce about 50% the energy consumption for heating and air conditioning and use of energy efficient equipment. A pilot project of 600 high performance energy units distributed over several Wiley is underway.

The program is as follows:

- Construction of 20,000 high energy performance apartments to 2020
- The development of solar water heater (SWH): 100,000 m² for the individual (SWH 50,000) and 50,000 m² for the collective to 2020
- The spread of low consumption lamps: distribution of 10 millions lamps to 2015 and 35 million to 2020
- Labeling and promotion of household electrical equipment with low energy consumption.
- Progressive development of solar cooling

We estimated that these actions energy conservation will avoid about 40 MT CO₂ to 2025.

Other energy efficiency projects will be dedicated to industry in particular in cement factories.

This ambitious program of renewable energy and energy efficiency and all activities mitigations will reduce over 40% of CO₂ emissions.

7. The national climate plan

The National Climate Plan (NCP), which is in final discussion before being finally adopted by the authorities, outlines the various vulnerabilities of Algeria. The NCP is part of the vision of Rio + 20 and contributes to the global effort against climate change and sustainable development of the country. It defines the outlines of the overall strategy to be adopted taking into account the reality of the country and its priorities. The NCP offers among others:

- To identify the impacts of climate change on the economy and society.
- To propose a strategy to address against the CC and decline this strategy into a coherent set of actions and measures for adaptation and mitigation priority will be translated at operational level, indicators and achievements and that into action plans for fields and periods.
- To identify the terms and conditions of their implementation as well as monitoring and evaluation.
- To improve access to public and private international finance and promote technological and financial foreign partnership

In the operational part, NCP offers a coherent set of actions in the short, medium and long term that are based on existing sectoral policies and on international best practices and ensure the integration of the problem of climate change in the Algerian economy and society.

As key actions whose implementation is inexpensive and does not require significant delay implementation, are :

- Reuse of treated wastewater for agricultural adaptation to climate
- Water- Economy
- Adaptation agricultural calendars to climate change
- Selection of varieties and seeds adapted to the arid climate
- Strengthening local participation in planning, implementation and monitoring of actions relating to mitigation and adaptation to climate
- Implementation of the monitoring mechanism and early warning extreme weather
- Strengthening the capacity of institutions involved in climate change
- Adaptation of the institutional and regulatory framework and implementation program of fight against climate-sensitive diseases
- Promotion of renewable energy and energy efficiency in the building
- Integration of climate change in development studies and impact hazards and environmental audits and energy
- Adaptation of climate change in the fight against desertification and land degradation
- Enhanced protection against extreme rainfall events
- Adaptation of urban and interurban public transport

The NCP will be revised periodically in response to changing climate

8. Conclusion

Algeria, which is part of Mediterranean hot spot, is very vulnerable to climate change. Experts predict at the medium term an increase in temperature of 2 °C, a decrease in rainfall of 10 to 15% and more frequent droughts and more intensive. Facing this situation, and to ensure the availability of water resources, curbing soil erosion and sustainable development, the country has implemented a strategy for adapting to climate and GHG mitigation. It covers all sectors, especially the energy sector which is responsible for the largest share of GHG emissions (74%). Much progress has been made in the mobilization of water resources for drinking and irrigation, and much remains to be done in agriculture. Regarding to ecological footprint, CO₂ emissions and GDP, Algeria is among the countries that are committed to sustainable development and should preserve this position.

In the field of energy, the final development plan for renewable energy is undoubtedly a big challenge for the country. Overall this strategy will reduce up to 60% of GHG emissions. Algeria has a good chance of a successful struggle

against the change climate, if certain conditions are met such as the formation of qualified human capabilities, the integration of all the possibilities, good coordination and good governance.

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