

## The Impact of Climate Change on Economic Growth in Developing Countries Case of Morocco

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## **The Impact of Climate Change on Economic Growth in Developing Countries Case of Morocco**

### **Abstract**

Today, climate change is one of the major challenges that face the world, it is a considerable threat to mankind and also to its economic activities, the macro-economic impacts of climate change and low-carbon transition policies on the planet would be moderate overall a relative few hundredth of a percent of world GDP on an annual basis.

Understanding what constitutes dangerous climate change is of critical importance for future concerted action (Schneider, 2001, 2002).

Developing countries, such as Morocco, consider themselves to be the most vulnerable to the effects of climate change. In contrast to low-income countries, rich countries that have very high greenhouse gas emissions can mitigate and adapt to the impact of climate change.

The awareness of this vulnerability was confirmed during the many years of drought that hit the country at the end of the last century and heavily affected the national economy.

It is important to have the most recent information on this subject in order to take it into account in the vulnerability assessment and adaptation planning processes.

In this work, we purpose a review of the literature on the impact of climate change on economic growth, particularly in Morocco. theoretical analysis of the environmental/economic analysis and the possibility of its application to the Moroccan situation

The study finds a significant negative effect on climate change debt on economic growth in Morocco in the short-run and the long-run. It also finds the necessity of implementing an economy to have more ideas about the unknown climate/economic situation in Morocco.

**Keywords:** Climate change; Economic Growth; DICE Model; Innovation; Morocco

**JEL Classification:** Q44, Q54

**Paper type:** Theoretical Research

## Introduction

Today, climate change is one of the major challenges that face the world, it is a considerable threat to mankind and also to its economic activities.

Since the birth of the earth, the climate has constantly undergone so-called natural changes due to volcanoes, floods, drought, deterioration of the ozone layer, natural emission of carbon dioxide ...

These changes have been aggravated since the appearance of man, drawing more and more on natural resources, especially since the industrial era.

Nowadays, the world is witnessing a strong increase in temperature and record levels in this matter are recorded. The average global temperature on the continents has broken a record with the warming of + 1.89°C. In fact, the 20th century was the warmest century and among the ten warmest years.

The IPCC predicts that by 2100 the average temperature in the world will have increased by 1.8°C to 4°C, and in the worst case 6.4°C. The international community had already recognized the reality of the danger at the Rio de Janeiro summit in 1992, the report of the British economist Nicolas Stern, made a big noise.

This report evokes future consequences of climate change of great magnitude comparable to those of the first and second world wars, and the 1929 crisis combined, and estimates the costs of these changes to 5500 billion euros and 5% of future GDP in the world if nothing is done.

Developing countries, such as Morocco, consider themselves to be the most vulnerable to the effects of climate change (World Bank, 2010). In contrast to low-income countries, rich countries that have very high greenhouse gas emissions can mitigate and adapt to the impact of climate change.

In the macroeconomic literature, work on the environmental issue only appeared after the oil crisis. Prior to the oil crisis, the environment was not a primary concern of economists; the work that has been done on this issue has not been practically considered in economic policies. It was only after the oil crisis of the 1970s that economists began to integrate the environmental variable into their writings, notably in the Club of Rome's research, in their writings on "zero growth," and in their work on the impacts of commodity price fluctuations.

The main reasons for Morocco's vulnerability to the effects of climate change are, firstly, the country's economic situation based on sectors that are very sensitive to the effects of climate change - such as agriculture, which represents 14% of Morocco's GDP (ET-TOUILE & ARIB, 2018), and the fishing sector, which represents 2.3% of national GDP (Doukkali Mohammed Rachid, 2018). The second reason for this vulnerability is Morocco's geographical location, with a very high physical exposure, which generates a very high-temperature threshold. Finally, the low capacity to adapt and mitigate against the effects of climate change is directly dependent on several economic factors, such as technical progress, school enrollment, the efficiency of public policies, and the development of the country's financial sector.

The scientific literature on climate change and its impacts in Morocco is relatively abundant. The topics covered are numerous: changes in average climate, extreme weather events, impacts on surface and deep-water resources, agriculture, health, ecosystems, tourism and energy.

In this work, we purpose a review of the literature on the impact of climate change on economic growth, particularly in Morocco.

To answer this research question, we will begin by presenting a review of the literature on climate change and its impact on economic growth. Then in the second section we will present the impact on economic growth, and in the last section we will review the literature on the impact of climate change on economic growth, particularly in Morocco.

## **1. Literature review of climate change**

The issue of climate change has been at the forefront of the environmental debate for several years now. The recent awarding of the Nobel Peace Prize to Mr. Al Gore and the Intergovernmental Panel on Climate Change (IPCC) is further evidence of the importance given to this issue. The increase in greenhouse gases (GHG) may indeed lead to a change in climate conditions that will have significant impacts on several sectors of activity and several natural systems (IPCC, 2007).

Climate change is a global phenomenon that refers to the set of variations in climatic characteristics characterized by a general increase in average temperatures at a given location over time.

Climate change is a result of the greenhouse effect. The atmosphere containing greenhouse gases absorb the infrared part of the planet's emission spectrum. The surface temperature of the planet then increases until the amount of energy escaping to space becomes equal to that received by the Sun.

According to the United Nations Framework Convention on Climate Change (definitions), "Climate change is a change of climate which is attributed directly or indirectly to any human activity that alters the composition of the Earth's atmosphere and which is in addition to natural climate variability observed over comparable periods."

For the IPCC The Intergovernmental Panel on Climate Change, on a global scale, a 0.8°C increase in average temperature has a high impact on a local scale, both on ecological and economic balances and also on our societies.

Climate change can affect the planet on several levels that affect economic activity at the same time, such as: Meteorological disturbances: Climate change can be one of the causes of meteorological disturbances, where we can have long periods of drought or long periods of rainfall. Global warming can also lead to a great increase and aggravation of extreme weather phenomena: cyclones, storms, hurricanes (Doukkali Mohammed Rachid, 2018)... Global warming is leading to a rise in sea levels and ocean acidification. Increasing temperatures, climate, and seasonal disturbances disrupting ecosystems, changing conditions of animal and plant biodiversity, and plant reproduction cycles.

The Earth's climate system is defined as a complex system of interactions between five components: the atmosphere, the hydrosphere, the cryosphere, the biosphere and the lithosphere. Each component evolves on its own time scale and interacts with the others on different time scales, defining the state of the system.

The atmosphere is the gaseous envelope that surrounds the planet, half of whose mass is located below 5,500 meters of altitude. The hydrosphere is mainly represented by the oceans which cover 70% of the earth's surface, but also by rivers, lakes and groundwater. The cryosphere includes glaciers, ice caps, sea ice, snow-covered surfaces and permafrost. The biosphere is composed of the fauna and flora, both continental and oceanic.

These components play an important role in the climate system through energy exchange, carbon and water cycles.

Finally, the lithosphere is defined by the crust and the upper part of the Earth's mantle. It is integrated into the climate system on long time scales corresponding to plate tectonics, relief formation and sinking of the bedrock under the ice caps. Of the bedrock under the ice caps.

According to the IPCC, greenhouse gases that are the main cause of climate change (GHGs) are gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at given wavelengths of the spectrum of terrestrial radiation emitted by the Earth's surface, atmosphere and clouds.

It is this property that is at the origin of the greenhouse effect are water vapor (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and ozone (O<sub>3</sub>) are the main greenhouse gases in the Earth's atmosphere. There are also greenhouse gases resulting solely from human

activities, such as halogenated hydrocarbons and other substances containing chlorine and bromine, which are covered by the Montreal Protocol. In addition to CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>, the Kyoto Protocol addresses other greenhouse gases such as sulfur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). Hydrocarbons (PFCs). The Earth receives its energy from the sun: part of the solar radiation is absorbed by the Earth, the Earth releases the energy received in the form of infrared radiation emitted back into space, the greenhouse gases (GHGs), present in the atmosphere, have the property of intercepting part of this infrared radiation and re-emitting it, particularly towards the Earth. This natural phenomenon, called the greenhouse effect, modifies the Earth's radiation balance and allows the Earth's surface to reach an average temperature of 15°C, whereas without it, the temperature would be without it the temperature would be -18 °C.

## **2. Impact of climate change on the economy**

### **2.1. Impact of climate change on the economy's sector of activity**

In economic theory, Allan Fisher, Colin Clark, and Jean Fourastié developed the three-sector theory, which divides the economy into three sectors.

The primary sector includes activities related to the exploitation of natural resources: agriculture, forestry, fishing, and mining activities (Insee, 2020). The primary sector includes all activities that produce unprocessed raw materials.

The secondary sector includes activities related to the processing of raw materials from the primary sector (manufacturing industry, construction) (Insee, 2020)

The third sector is the tertiary sector, which brings together and defines by complementarity the activities of the primary and secondary sectors respectively. This sector is composed of market activities such as tourism, insurance, as well as non-market activities such as education and health.

Climate change has consequences on mankind and on the different sectors of the world economy, which has an impact on social (Godard, 2010) and economic balances (Gérard, Piketty, & Boussard).

The primary sector, which is the sector most threatened and sensitive to the effects of climate change on activities such as agriculture, is directly impacted by the consequences of biodiversity, which changes the functioning of ecosystems and reduces crop yields. Drought and rainfall shocks also have great effects on this productivity, as well as higher temperatures than decrease useful agricultural productivity while leading to an increase in dangerous grasses and pests. We can also mention the Fisheries Sector, where climate change can have very serious effects on the fisheries and aquaculture sector. The oceans absorb 30 percent of the anthropogenic emissions of carbon dioxide, this absorption increases the surface temperature which causes a decrease in oxygen in the oceans, which in turn disrupts its biodiversity and the fishing sector. This is what we call ocean warming (Durand, 2011).

In general, climate change has negative impacts on the primary sector that threatens global food security.

Not only the primary sector, but the secondary sector is also affected by the effects of climate change on many aspects of exploration and extraction, as well as on the production of industrial raw materials. With the increase in climate-induced extreme weather events, resources become less available, increasing the costs of operating and transporting these resources. Climate change will eventually cause the volume of the surface and groundwater to decrease in most regions, which will cause competition for water in the sector. Besides, climate change may also reduce labor productivity, particularly for manual labor in hot and humid climates.

In the tertiary sector, climate change is not a threat that will occur in the distant future, because different impacts are likely to occur in different parts of the world. For example, in the tourism sector, global warming is already having an impact on decision-making. The impacts of climate change on this sector are clear at the moment, with the rise of the sea level.

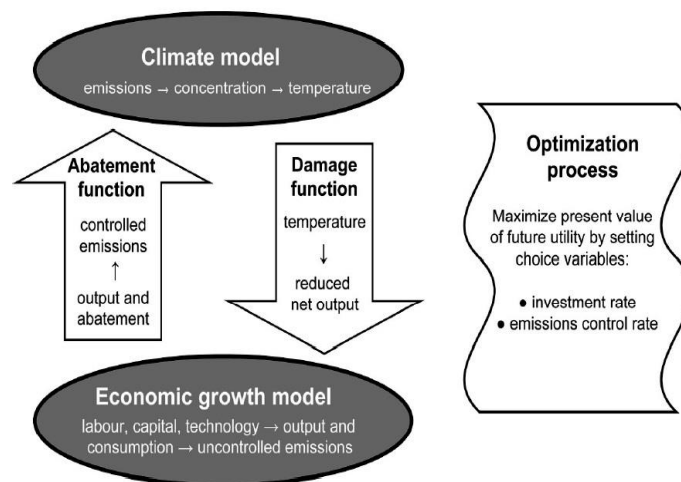
Several summer tourist sites in the world are affected by this consequence of climate change. The increase in temperature also has an impact on the melting of ice in the mountains which impacts winter tourist sites. On the other hand, climate change also has impacts on the health sector, with the increase in temperature, many important diseases become sensitive to changes in temperature and precipitation patterns. In addition, the insurance sector is also impacted by extreme weather events, with an increase in the frequency and intensity of natural hazards. The education sector is also directly affected, first of all, the health of teachers and learners, as well as problems of access to schools, especially in rural areas (Morenoa & Becken, 2008).

## 2.2. The impact of climate change on the macroeconomic balance.

In economic theory, many types of macroeconomic and microeconomic models are used to analyze the impact of climate change on the economy. The microeconomic analysis focuses on individual behavior, so micro models are used to analyze the behavior of economic agents. In contrast, the macroeconomic analysis focuses on aggregate quantities. Macroeconomic analysis is generally done on the level of income, investment, consumption, unemployment, inflation, etc. Today we are talking about the integration of the environmental variable in macroeconomic analysis, in particular, the "climate change" variable.

Since the 1990s, an empirical literature has been analyzing the effects of climate change and low-carbon transition policies on economic growth.

**Figure 1: Inside the integrated assessment models: Four issues in climate economics -**



**Source: ELIZABETH A. STANTON\*, FRANK ACKERMAN and SIVAN KARTHA**

Over the last 20 years or so, it has provided researchers with the opportunity to develop new tools in the form of models linking climate and macroeconomics: the Integrated Assessment Models (IAM).

The main value of IAM is to provide a global view of the interactions between the many different aspects, sectors and issues related to climate change and related policies.

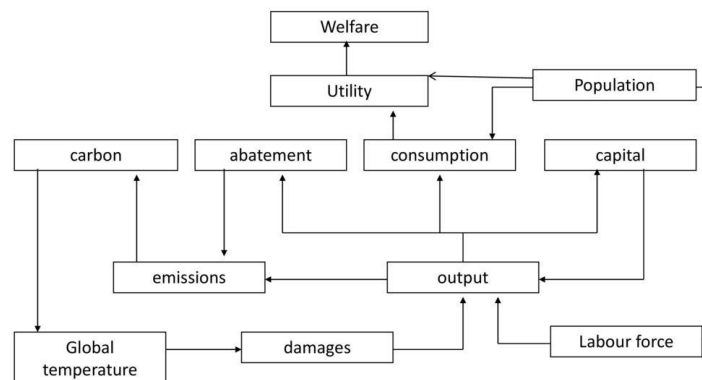
Several subfamilies of IAM can be distinguished. Models of university origin were the pioneers in the 1990s, at Yale (with W. Nordhaus and his DICE and then RICE models), at Stanford (Energy Modeling Forum) or at the Paul Scherrer Institute.

In 2018, the 50th Nobel Prize in Economics was awarded to the two economists William Nordhaus and Paul Romer, who have worked on the relationship between climate change and macroeconomics.

The first, William Nordhaus, a professor at Yale University in the United States, is renowned for his work "integrating climate change into long-term macroeconomic analysis. The second, Paul Romer, affirmed the relationship between innovation and economic growth with his work "integrating technological innovations into long-term macroeconomic analysis.

*Figure 2: DICE (2007) Model architecture*

### DICE (2007): model architecture



*Source: Carsten Vogt (2013)*

In the 1970s, as public awareness of the dangers of pollution began to rise, Nordhaus developed macroeconomic approaches to global warming - the DICE for Dynamic Integrated model of Climate and the Economy - which linked climate change to economic growth.

The DICE Model brings together the factors that impact on economic growth, CO2 emissions, the carbon cycle, climate change, climate damage, and climate policy (Nordhaus, 2017).

The DICE and RICE models (the 2010 version of the model) have widely attracted the attention of economists studying the economic consequences of climate change. They are among the most widely used models for analyzing the impact of climate change on economic growth.

According to William Nordhaus, the solution to climate change is simply a carbon tax, this economic policy of carbon tax is very simple. In a speech on CBC's as It Happens, Nordhaus said, "If you simply commit to a tax on the use of fuels that directly or indirectly emit greenhouse gases and raise that tax gradually in the future, people will see that there is a big benefit in finding ways to provide energy where they can do so without paying tax.

Concerning Paul Romer, this economist, who has reversed the classic analysis of Solow's model, puts forward the hypothesis that returns are increasing (thanks to positive externalities) and considers that technical progress is endogenous, that is, it depends on the behavior of economic agents.

Paul Romer emphasizes research and development, that is, the accumulation and increase of technological capital. To innovate, a researcher uses the knowledge that is available in his or her time; by innovating, he or she increases the knowledge available not only to himself or herself but also to other researchers, especially those of future generations. Consequently, the R&D expenditures made by a firm enable it to increase its productivity and innovate; thanks to positive externalities, they also benefit other firms. Thus, a virtuous circle is at work: "by innovating, a firm which enables other firms to innovate, which in turn leads to economic growth (Romer, 1994)

For Paul Romer, innovation and technical progress are the solutions to climate change, meaning that innovation and investment in green energy can adapt and mitigate the effects of climate change.

With contributions from Paul Romer and William Nordhaus, the two economists were awarded the Nobel Prize in Economics in 2018 for their work on the question of the importance of innovation in growth and the economics of climate change.

### **3. Climate change in Morocco**

Global warming is a reality throughout Morocco, higher average and extreme temperatures; longer, more extensive, and frequent heat waves; lower annual rainfall, disruption of the seasonal distribution of rainfall ... climate change is a reality in Morocco as in the world. Both the underlying trends and extreme evolution prove it.

The Moroccan climate is relatively contrasted, influenced by the Atlantic Ocean, the Mediterranean Sea and the Sahara. The distribution of rainfall is marked by great heterogeneity, with annual accumulations of less than 200 mm in the south and east of the country but more than 600 mm in the north. The Rif and Atlas concentrate on the most important rainfall, with accumulations exceeding 1000 mm / year in some areas. This orographic barrier marks the transition between the West, under the influence of the humid Atlantic, and the East, under the influence of the Sahara.

According to data from the Secretary of State for Sustainable Development, during the period 1961-2008, the warming varies between +0.1°C per decade in the extreme North, 0.3°C per decade in the Atlantic region, except for Essaouira (a microclimate influenced by cold ocean currents in the region) and 0.4°C per decade in the mountains in the southern Atlas region (Departement of the environment Morocco, n.d.) .

This result correlates with the upward trend in temperatures observed internationally. The latest special report of the Intergovernmental Panel on Climate Change (IPCC) noted that human activities have increased the average global surface temperature by 0.8 to 1.2°C since pre-industrial times, with +0.2°C warming every 10 years.

In the special report of the IPCC (Intergovernmental Panel on Climate Change) of 2018, Morocco is a low greenhouse gas-emitting country, it remains vulnerable to the effects of climate change due to the specificities of its geographical position and the diversity of its ecosystems. Climate change has a major impact on the country's economic growth, especially with an economy based largely on the primary economic sector, which is the most sensitive to the effects of climate change.

#### **3.1. The impact of climate change on the ecological, social, and economic balance in Morocco**

Climate change has major impacts on ecological, social, and economic balance:

On the ecological level, degradation of ecosystems and a loss of biodiversity, due to climate change, particularly with the decrease in rainfall and the lengthening and frequency of drought would be likely to reduce the productivity of ecosystems. We are also talking about significant declines in available water resources. The main cause of this decrease is the decrease in rainfall, especially with the rise in temperatures. Droughts are now more frequent and longer. "Between 1940 and 1979, there were 5 droughts, this number doubled between 1980 and 2002 (Mohamed & Abdelaziz, 2016). It is expected that droughts will be prolonged by more than 5 days by 2100". It is the same for floods. In the Souss Massa region, for example, there has been a sharp increase in the number of floods: between 1982 and 2007, there have been 4 floods in 25 years while between 2008 and 2015, there are 7. The rise in sea level on the Mediterranean coast of Morocco is of the order of 0.6 mm/year for the period 1945 to 2000. While on the Atlantic Coast, a rise

between 1.6 and 2 mm/year is observed for the period 1955-2003 (3rd National Communication on Climate).

On the social level, climate change is causing increasing mobility of populations, with floods and drought motivating population movements from one region to another or from rural to urban space. Climate change also affects the health of populations. As climate change increases the scale of migration, these migratory movements will occur in areas where the margins of adaptation of populations would be exhausted.

On the economic level, climate change is a major challenge for the Moroccan economy and growth, due to the great importance of the primary sector, particularly in the agricultural sector, in the national economy (15% of GDP) and employment (40%). Regarding the secondary sector, Morocco has a low capacity in the secondary sector, which has a strong growth in urban areas, which generates problems in creating new jobs, and difficulties in absorbing surplus labor from rural areas.

Also, at the level of the Moroccan economy, Morocco's key economic sectors (Textile, Tourism, Agribusiness) are vulnerable to climate change.

The textile sector is particularly vulnerable to climate change. Negative effects on the textile sector include: reduced availability of raw materials (agricultural products such as cotton and jute), energy and water shortages, damage to premises and machinery. Floods can have a significant impact on the deterioration of communication and transportation systems, electricity supply, and damaged infrastructure. Besides, these types of sectors have a production process that presents significant pollution risks, for example. Water pollution will soon be subject to stricter government regulations (Mohamed, RAJEL, & ESSAFI, 2019).

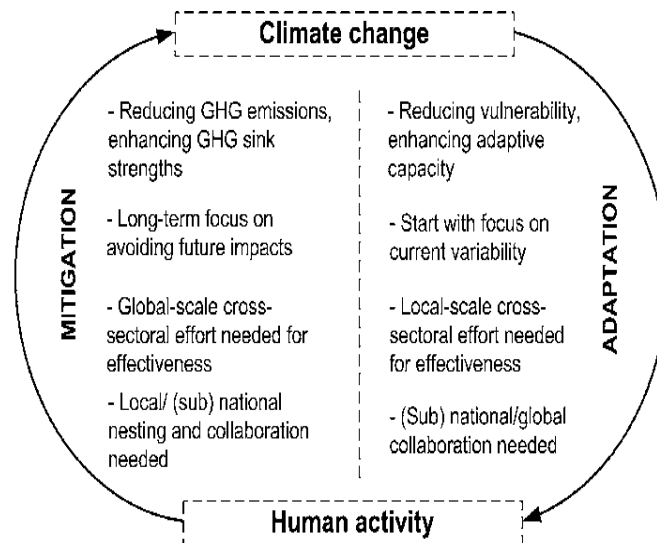
The tourism sector, which is highly dependent on its external environment, is a sector particularly vulnerable to climate change and is itself exerting strong pressures on ecosystems. Hotels, restaurants, tourist operators, and indirectly the tourists themselves are the main actors affected. Negative effects on the tourism sector include damage to hotels and restaurants especially those located on the coast, shortage of water to supply water-intensive services such as swimming pools and golf courses, deterioration of biodiversity and ecosystems, and health risks for tourists. Floods can have a significant impact on the deterioration of premises, communication, transportation, food, and electricity supply systems. One of the most important impacts remains the negative effect on Morocco's highly diversified natural heritage (sea, mountains, and countryside). Rising temperatures and more frequent extreme weather events could reduce the country's tourist attractiveness. Climate change also presents opportunities for ecotourism, which is on the rise and is a government priority.

The agro-industrial sector that is entirely dependent on agriculture is one of the sectors most affected by climate change. Negative effects on the sector include: agricultural production being impacted by changes in rainfall and droughts, infrastructure and machinery damaged by floods and heavy rains, supply, communication, and distribution networks cut off. Changes in the length of seasons require different approaches to planning. A disruption in the supply of fresh produce from agriculture can slow food processing and export industries.

### **3.2. Morocco's strategy on climate change.**

Aware of the fragile situation against the effects of climate change, Morocco has voluntarily committed itself to the fight against global warming. Indeed, since it participated in the Rio Conference in 1992, Morocco has stopped implementing strategies and projects to contribute to the international effort for sustainable development and the fight against the effects of climate change.

**Figure 3: Duguma, Lalisa & Minang, Peter & Van Noordwijk, Meine. (2014). Climate Change Mitigation and Adaptation in the Land Use Sector:**



*Source: Duguma, L. A., Minang, P. A., & van Noordwijk, M. (2014).*

Faced with the effects of climate change, Morocco has put in place adaptation strategies that aim to prepare its entire population and economic actors to face these vulnerabilities and mitigation strategies that contribute to its overall development, including through the introduction of clean technologies. These strategies have been put in place to preserve its territory and civilization, as well as to decouple the growth of its economy from its greenhouse gas emissions.

The IPCC defines adaptation to climate change as "the process of adjusting to current or expected climate and its consequences. For human systems, this means mitigating or avoiding adverse effects and exploiting beneficial effects. For some natural systems, human intervention can facilitate adaptation to the expected climate as well as its consequences."

Mitigation of climate change, again according to the IPCC, is "human intervention to reduce the sources or enhance the sinks of greenhouse gases". Adaptation and mitigation of climate change must be complementary

### **Example of Moroccan Adaptation Strategies:**

**Green Morocco Plan:** Launched in April 2008, is a strategy that aims to make the Moroccan agricultural sector a real lever of socio-economic development in Morocco, through accelerated growth, poverty reduction, and consolidation of the integration of agriculture in national and international markets (Departement of the environment Morocco, n.d.).

**Water strategy:** this is a strategy that aims at integrated and decentralized management of water resources based on consultation and the effective participation of all stakeholders, especially users, in decision-making at both local and national levels. It constitutes the fundamental axis of the new water policy adopted by Morocco.

**Strengthening programs to combat climate-related diseases:** The national health and environment program aim to identify priority health risks related to environmental degradation, to strengthen actions to control and prevent these environmental risks at the national, regional, and local levels, and to promote the integration of environmental health promotion in sectoral development policies.

**National Biodiversity Strategy and Action Plan:** This strategy aims to improve the status of biological diversity by safeguarding ecosystems, species, and genetic diversity through the development of a national system of protected areas, ensure a favorable conservation status of migratory species and the ecological connectivity and resilience of their habitats, take

conservation measures to improve or maintain the conservation status of water species and ensure sustainable management of hunting and fish resources.

In order to deal with the expected impacts of climate change, two complementary strategies by public decision makers:

Mitigating climate change: this involves limiting warming by reducing greenhouse gas emissions and increasing carbon storage

Adapting to climate change: preparing for the inevitable impacts of climate change in order to increase climate change in order to increase the resilience of sectors and territories.

### **Example of Moroccan Mitigation Strategies:**

Morocco's Energy Strategy (Energy Efficiency and Renewable Energies...): since 2009 an energy strategy taking into account Morocco's challenges and based mainly on the rise of renewable energies, the development of energy efficiency, and regional capacity building. This strategy aims to reduce the Kingdom's energy dependency, programs have been put in place to further increase the capacity of electricity production from renewable sources by about 10,100 MW by 2030.

Energy Efficiency Program in Building: Energy efficiency, along with the development of renewable energy, is a major priority in the national energy strategy, this strategy has a target of 15% in 2030 of energy consumption. In this perspective, energy efficiency action plans have been put in place in all key sectors including transport, industry, building, and also agriculture. The Debasement Master Plan: The Master Plan is a waste management planning tool at the provincial level, it provides proposals for the disposal of the province's waste through the implementation of a system of sorting, energy recovery, composting, and landfilling. And recommends the most appropriate variant in terms of cost effectiveness and cost-benefit to the province, looking 20 years ahead.

### **3.3. Climate change and economic growth: What answer for tomorrow's Morocco?**

Fighting the effects of climate change means above all taking action to reduce our greenhouse gas emissions. This is logical since it is these emissions that cause global warming. Less CO<sub>2</sub> emissions mean less global warming. It is therefore the main means used by scientists to find a solution to this problem.

#### **3.3.1 Taxing CO<sub>2</sub>, a solution to the climate and the economy of Morocco**

One of the solutions proposed by economist William Nordhaus and the carbon tax, for him the tax is the most effective solution to the problems caused by greenhouse gas emissions. He therefore, proposes a global system of carbon taxes that would be uniformly imposed on all countries.

To limit climate change and its consequences, some countries have defined policies to control greenhouse gas (GHG) emissions. These policies are inspired by the principle "The polluter pays" such as the carbon tax.

The carbon tax is a tax added to the selling price of goods or services according to the quantity of greenhouse gases, such as carbon dioxide (CO<sub>2</sub>, carbon dioxide), emitted during their use (Berahab, 2017).

For an application in Morocco, the carbon tax must be integrated into energy taxes, depending on the amount of greenhouse gases emitted by a product expressed in dhs per ton of CO<sub>2</sub>, it is paid by individuals and companies, and integrated into the final price of gasoline, diesel, fuel oil, or natural gas. It is also subject to value-added tax. The objective of this tax is to give a price signal, encouraging the reduction of the use of fossil fuels.

For the implementation of this tax at the level of Morocco, it is first necessary to set up a GHG emission allowance trading system market, based on the polluter-pays principle. Emitters must

buy shares on the carbon market to pay the cost of their climate nuisance, which would encourage them to reduce their emissions.

The role of the carbon market is to allow the implementation of the carbon tax, to define the cost of carbon dioxide emissions based on quotas and ceilings, these ceilings are designated by the quantity emitted by the public authority, i.e. each company must buy its pollution rights.

The implementation of a carbon tax will allow Morocco, first of all, to reduce energy consumption, and therefore greenhouse gas emissions, an opportunity for economic development for sustainable sectors of activity to encourage companies to innovate in green projects, concerning the state, it could make savings by limiting its energy imports, especially in the case of Morocco which has a high energy dependence.

Currently, Morocco is in the process of preparing to launch a carbon market. This decision was made in 2017 by the Secretary of State for Sustainable Development in partnership with the World Bank to involve the territories in the energy transition. But the question now is how to speed up this carbon market to reduce greenhouse gas emissions, on the one hand, and to comply with the Paris agreement on the other to slow climate change.

### **3.3.2 Green Innovation in the face of climate change in Morocco**

Faced with the threat of climate change, innovation is one of the main levers for reducing greenhouse gas emissions. Beyond environmental considerations, the deployment of low-carbon technologies is now a major economic challenge, associated with opportunities for growth, new production, and job creation. The ability to develop and master these technologies has become an important parameter in the competitiveness of nations.

Green innovation concerns several fields, products, processes, and methods of communication, organizations, and institutions, and frequently relies on the introduction of new technologies (Arib, 2014).

For the establishment of a policy based on the encouragement of innovation aimed at reducing greenhouse gas emissions in Morocco, it is necessary to support the implementation of R & D spending in each sector. That is to say, it is necessary to maintain a wide range of research avenues for techniques to reduce CO<sub>2</sub> emissions, to explore all possible technological options and thus increase the likelihood of new solutions emerging. As well as ensuring that public financial support for the development of technologies to reduce CO<sub>2</sub> emissions includes subsidies for studies on citizen involvement.

In the energy sector, Morocco's energy strategy aims at three strategic orientations, the mobilization of national resources through the rise of renewable energies (RE), energy efficiency, and the promotion of measures in favor of transition management to combat climate change using innovative green technologies such as the Nour project, for example. For the time being, we need to present an inventory and an evaluation report of the strategy, especially after we finish the first phase of the project which is the 30% energy mix (Stratégie énergétique national, 2020).

In the building sector, in Morocco, we have the Program of Energy Efficiency in Building. As the energy strategy, first of all, it is necessary to carry out a follow-up study of the state of the program. Besides, it is also necessary to encourage innovation by facilitating the experimentation of new technical solutions by establishing specific insurance mechanisms to cover the first implementations of innovations.

In the agricultural sector, the Green, Morocco, Plan was established in Morocco to make agriculture a real lever of socio-economic development in Morocco by relying on two pillars, the social pillar which aims to support small farmers to increase their yields, the second pillar is the economy which aims to make Moroccan products more competitive in international trade. After the end of the Green, Morocco, Plan in 2020, a new program was implemented in February 2020 under the name of "Green Generation". Innovation is essential to improve

agricultural productivity, to improve its sustainability as well, and to adapt to the effects of climate change. At the level of the agricultural sector, innovations must be green innovations that aim to protect the environment and increase the productivity of Moroccan agriculture. International partnerships are also needed to advance water recovery and treatment, and desalination.

Concerning the transport sector, we must, first of all, give priority to supporting research and innovation and give advantages to ecological vehicles on public highways, freeways, and in parking lots as a means of reducing costs, priority access, etc. We must also set more restrictive obligations in terms of consumption and CO<sub>2</sub> or particle emissions while supporting the effort to develop ever more efficient technologies in this respect.

#### **4. Conclusion**

Under the effect of greenhouse gas emissions, climate change is expected to involve very profound physical upheavals: increase in average and maximum temperatures, precipitation regimes, an increase in the number and intensity of extreme weather events, a rise in extreme weather events, sea-level rise, etc. These physical phenomena would have different implications differentiated according to the regions of the world, but would constitute a systemic issue on the economic and political, economic and political stability.

It is mainly human activity that causes an increase in greenhouse gases in the atmosphere and therefore contributes to increasing the greenhouse effect and global warming, so it is the role of mankind to find a solution to reduce the impacts of climate change.

Man must act quickly to avoid an irreversible situation and thus avoid the catastrophic scenarios presented by the IPCC reports. Consequently, if humans continue their lives as usual, without worrying about the release of greenhouse gases into the atmosphere, then warming will reach the most pessimistic forecasts for the 21st century and it will no longer be possible to control it.

The economic analysis of the impacts of climate change is a particularly complex exercise, which explains the many uncertainties in this field. On the one hand, the duration of the events to be studied does not lend itself well to the use of economic analysis. Indeed, the time scale of observation of climate change is of the order of a century, whereas economic analysis generally carries out cost evaluations on a scale of only a few decades. While the analyses that have been conducted have used a comparative statistical approach by applying anticipated temperature differences to current economic values, it is difficult to predict how demographic, economic, trade, and technological changes will affect production levels and the values of goods produced beyond a few years.

On the other side, the use of a discount rate to calculate the net present value of projects with different cost-benefit time profiles in climate change economic impact assessment may be open to criticism given that many of the impacts will occur decades from now and that even the use of a very low discount rate will tend to minimize the value of the long-term impacts.

All in all, the quantitative results obtained today by the IAM on the economic effects of climate change are weak and above all uncertain. The economic policy implication of this result is not that no decisions should be made.

In general, this literature suggests that the economic benefits of adaptation actions materialize earlier than those of actions to combat global warming (adaptation vs. mitigation).

if we control these emissions, we will avoid a strong increase in greenhouse gases, and therefore in temperatures, rising water levels, melting glaciers, etc.

In a fragile economy such as Morocco, policies are needed that focus on adaptation and mitigation to the effects of climate change, thus ensuring sustainable economic growth.

One of the solutions proposed to combat the effects of climate change is the carbon tax and innovation proposed by the two Nobel prize-winning economists Paul Romer and William Nordhaus.

From this theoretical study, we can conclude the need to have an empirical study that will calculate and respond to these impacts of climate change on economic growth in a quantitative way.

## References

- (1) Arib, F. (2014). Les services dans l'économie verte au Maroc. Opportunités de création d'emplois et défis d'innovation. *SERMED 2014 Conference Papers*, (p. 29).
- (2) Berahab, R. (2017). Découplage entre croissance économique et émissions de dioxyde de carbone dans le monde.
- (3) *Department of the environment Morocco*. (s.d.). Récupéré sur <http://www.minenv.gov.ma/index.php/fr/>
- (4) Doukkali Mohammed Rachid, K. A. (2018). Système marocain de production halieutique et sa dépendance du reste du monde.
- (5) Durand, B. (2011). Captage et stockage du gaz carbonique (CSC). *The International Nuclear Information System*.
- (6) ET-TOUILE, H., & ARIB, F. (2018). Econometric Study of the Impacts of Climate Change on Food Security in Morocco. *Institut Marocain de l'Information Scientifique et Technique*, Arican scientific journal.
- (7) Gérard, F., Piketty, M.-G., & Boussard, J.-M. (s.d.). Modèle macro-économique à dominante agricole pour l'analyse de l'impact du changement climatique et des effets des politiques en termes d'efficacité et d'équité.
- (8) Godard, O. (2010). Cette ambiguë adaptation au changement climatique. *Natures Sciences Sociétés*, 287 - 297.
- (9) *Insee*. (2020, 05 14). Récupéré sur L'Institut national de la statistique et des études économiques : <https://www.insee.fr/fr/metadonnees/definition/c1736>
- (10) Mohamed, A., RAJEL, R., & ESSAFI, R. (2019). Impact des phénomènes climatiques extrêmes sur les ressources en eau et l'agriculture au Maroc. *Revue Marocaine des Sciences Agronomiques et Vétérinaires*, 223-232.
- (11) Mohamed, E. G., Hanane, R., & Abdelghani, Q. (2019). Changements climatiques et mobilités forcées au Maroc : Un enjeu d'avenir.
- (12) Mohamed, S., & Abdelaziz, B. (2016). Impact du changement climatique sur le climat et les ressources en eau du Maroc aux horizons 2020, 2050 et 2080 et mesures d'adaptation. 32-39.
- (13) Morenoa, A., & Becken, S. (2008). A climate change vulnerability assessment methodology for coastal tourism.
- (14) Nordhaus, W. (2017). DICE/RICE models. *Yale Economics*.
- (15) Romer, P. M. (1994). The Origins of Endogenous Growth. *Journal of Economic Perspectives—Volume 8*, 3–22.
- (16) (2020). *Stratégie énergétique nationale*.
- (17) World Bank. (2010). *The World Bank Annual Report 2010 : Year in Review*. Washington: World Bank Annual Report. .