(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 10, Issue1, 2021

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

A CGE analysis of the impact of climate change on sustainable development: the case of High Plateaux region, Algeria

TOUITOU Mohammed[1]

[1] Faculty of Economics and Business, University of Algiers 3,

Road Ahmed Oueked, Dely Brahim, Algiers, Algeria.16000

Abstract. *The paper aims to assess the impact of climate change on sustainable development in the case of the High Plateaux region of Algeria. A baseline "climate change" scenario and an "adaptation" scenario were assessed as part of our work. The methodological approach implemented is broken down into three interconnected evaluation phases, pre-modelling phase, modelling phase and post-modelling phase. The work has shown that these complex ex-ante evaluation approaches are adaptable and applicable in the context of Algeria. Our findings indicate that climate change would have a significant impact on economic aggregates on a regional scale. It also highlighted that the calculation of a single index of the impact of environmental policies on the sustainability of arid regions confirms the hypothesis of gaining sustainability by working towards a strategy of adaptation to climate change.*

Keywords: Integrated assessment, climate change, DPSIR approach, computable general equilibrium, multi-criteria analysis

JEL Codes: Q54, D58

How to cite: MOHAMMED, T. (2021). A CGE analysis of the impact of climate change on sustainable development: the case of High Plateaux region, Algeria. *Journal of Economic Development, Environment and People, 10*(1), 11-25. doi: http://dx.doi.org/10.26458/jedep.v10i1.684

Introduction

Welcome to JEDEP, Issue nr.1. The journal's coverage is: general economics, sustainable development, eco-development, distribution of wealth, household behaviour and family economics, human resources, incomes distribution, human development, migration, business management, marketing, consumer behaviour It also provides a friendly platform for academic and application professionals from crossing fields to communication together.

Climate change is a global externality in its causes and consequences, and which; also carries the major risk of irreversibility [1]. The physical phenomena associated with climate change would a priori have an impact on economic dynamics in two ways: directly through the damage, they will cause and indirectly through the anticipations of agents on the future climate, which influence their economic behaviour [2].

A growing body of evidence shows that changes in the climate system contribute to a range of biophysical and economic impacts that are already affecting the economy (see, for example, the latest reports from the Intergovernmental Panel on climate change: [3] and [4]; see also [5] and [6]. Besides, it is expected that future impacts will be much greater [4]. A certain amount of climate change is already inevitable, but beyond that, a great many uncertainties with uncertain consequences remain, in particular through the contribution to future greenhouse gas emissions and their consequences on the climate or their biophysical and socio-economic impacts. We can therefore reasonably wonder about the interest for decision-makers in a modelling analysis of the economic consequences of climate change on a global scale. Indeed, all these uncertainties, combined with the simplifications necessary for any representation of the world economy by modelling, risk mortgaging any aggregate result. It is the direction of these changes and the interactions they induce in the economic system, rather than their magnitude, that are most instructive.

Climate change has significant effects on economic activities, the well-being of the population, and ecosystems [7]. Human-induced warming reached approximately 1 °C (likely between 0.8 °C and 1.2 °C) above preindustrial levels in 2017, increasing at 0.2 °C per decade [8] and the impact of climate change may continue to intensify in the future. The available evidence also shows the presence of a fundamental asymmetric condition that characterizes the climate change phenomenon: The countries with the greatest historical contribution to greenhouse gas emissions are not the ones that receive the greatest impacts and costs of climate change; This is a consequence of its geographical location, its economic structure and its availability of resources, among other factors. On the contrary, it is common to observe that countries with a lower historical contribution to climate change are those that receive the most relevant impacts on their economic activities, their social conditions, and their ecosystems.

Authors in several fields, notably in agriculture with [9] or [10]; on human health [11] or forestry tackle the problem of climate change. Many works have been published on the economic consequences of climate change (for example:[12-17] and on the modeling of the costs of action public (see in particular [18, 19]). In-depth regional studies have also been devoted to the consequences of climate change, such as the Garnaut Review for Australia [20, 21], the Risky Business study for the United States (Risky Business Project, 2014), the project Peseta for the European Union [22, 23] and the COIN study for Austria [24]. Some studies have also attempted to quantify the costs of inaction and the benefits of public action in the area of climate change. Note in particular the Stern report (2007), which concludes that climate change could reduce well-being by a proportion equivalent to a permanent reduction in per capita consumption of between 5% and 20%. Most of this work starts from a simplified and aggregated representation of the economy. Typical modelling studies focusing on projections of climate change impacts over time include highly aggregated integrated assessment models, in which damage caused by climate change in different sectors is aggregated and used to reassess well-being in a climate change situation. It is difficult to compare such

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 10, Issue1, 2021

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

models, as each generally includes different impact categories, but it is evident that their projections of the overall macroeconomic consequences of particular impacts vary widely (see, for example, US Interagency Working Group, 2010, 2013). Much less research has used computable general equilibrium (CGE) models to examine the economic implications of climate change impacts in specific sectors, often using a comparative static approach (for example, [11, 25]).

CGEM s make it possible to estimate the impact of climate change by the difference between the results given by the model calibrated on the trend scenario and the results given by the model whose parameters have been re-estimated according to a given warming scenario. (See Annex 2 for examples of impacts modeled using a CGEM in the framework of the [26]). Most of the work based on CGEM distinguishes between direct effects and indirect effects via the effects of adjustments between sectors or between countries. The direct effects can appear in two ways in these models [27]: • a productivity shock, as in the agricultural sector for example, where climate change would imply a reduction in the productivity of certain types of crops; • destruction of capital, with, for example, an increase in the frequency of natural disasters or the rise in ocean levels that risk damaging physical capital (buildings and transport infrastructure in particular).

More recently, the EGC models have also been used to study the consequences of climate change on the whole economy in a dynamic environment (see [26-28]). Modern CGE models are now (at least potentially) truly global with as many as 140 interactive regional economies [29-31] and can be solved over a long time horizon in a recursive (e.g., [32,33] or intertemporal framework (e.g., [34,35].

However, it is also necessary to take into account how the nature and extent of the impacts on natural and human systems vary according to the regions, as well as the shocks they cause through different economic variables, which affect certain activities or some sectors harder than others [36]. [27] Use the recursive ENVISAGE model to simulate the economic impact of climate change via a range of impact channels.

Hence, the interest in developing newly integrated and multisectoral approaches and tools for ex-ante evaluation of the impacts of sustainable development policies [37] and decision support [38]. [38] Defined the integrated assessment approach for sustainable development policies as a multidisciplinary and participatory process, which aims at combining, interpreting, and interchanging knowledge from various scientific disciplines to allow a better understanding of complex phenomena.

The current economic modelling may seriously underestimate the impacts of potentially catastrophic climate change and emphasize the need for a new generation of models that give a more accurate picture of damages [39-41].

Algeria's vulnerability to climate change is accentuated by its socio-economic context marked by strong demographic pressure, increasing urbanization, the precarious situation of large segments of the population, the overexploitation of natural resources on which economic systems and the fragility of ecosystems are highly dependent, the concentration of industrial and tourist activities in coastal areas, the

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 9, Issue 2, 2019

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

lack of infrastructure and limited institutional, technical and financial capacities. Although current information and data are insufficient to fully assess the socio-economic impact of climate change and the costs associated with it, many studies and studies have highlighted the close links between climate change and development sustainable.

This article synthesizes the methodological approach based on the analytical approach, which served us as an integrated and multidisciplinary tool for the ex-ante evaluation of the impact of climate change on sustainable development on a regional scale in Algeria. The methodological approach implemented is broken down into three interconnected evaluation phases, pre-modelling phase, modelling phase, and post-modelling phase.

1. Material and Methods

1.1. Pre-modelling

This phase resulted in the identification of the problem, the spatial delimitation of the study area, the determination of the driving forces as well as the land-use policies to be assessed. It also made it possible to undertake the choice of scenarios and impact indicators. In this regard, the participatory approach DPSIR (Driving force (D), Pressure (P), Impact (I), State and Response (R)) served us as a tool to analyze the causal chain within the regional economic system.

The DPSIR approach is an adaptation of the Pressure / State / Response (PSR) analytical framework developed by the European Environment Agency (EEA). This analytical framework admits that "Human activities exert pressures on the environment (Pressure) and affect the quality and quantity of natural resources (State); society responds to these changes by adopting environmental, economic and sectoral policies, by becoming aware of the changes that have occurred and by adapting its behavior (Response) ”[42]. In our case study, climate change represents the central driving force that affects the system studied. Human activities exert pressure, particularly on natural resources. As a result, the status of environmental compartments (air, water, soil, habitats, and species) and the socio-economic conditions of the local population are affected. Downstream, these state changes induce impacts on resource systems, as well as economic impacts. By considering the profile of these different categories and particularly that of impacts, a corrective response from society is developed and implemented. These responses, whether regulatory, economic, or voluntary, in turn, influence the configurations of the system. As a response to the critical situation, the climate change adaptation strategy was implemented (response).

To identify the different impacts of climate change on the three dimensions of sustainable development, the concept of Land Use Function (LUF) was adopted [43].LUF s are defined as "goods and services" provided by the different land uses, which describe their economic, social, and environmental functions on a well-defined, scale [43]. As part of this work, nine-(9) land use functions (LUF) distributed according to the three dimensions of sustainable development were taken into account. For the impact assessment of policies, each LUF is represented by a set of indicators. The representativeness, significance,

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 10, Issue1, 2021

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

and relevance of the proposed indicators have been widely discussed on several occasions with political decision-makers and development actors [44].

Given that climate change is a phenomenon that affects all sectors of the economy, the Computable General Equilibrium Model (CGEM) seems to be one of the appropriate tools to quantify their impact and assess the performance of the adaptation strategy. The CGEM takes into account the interactions between the markets, the possible substitutions between the factors of production, and the inter-temporal and inter-sectoral reallocation of resources. The advantage of a general equilibrium approach is that it offers a coherent framework for quantifying the economic magnitudes, which are established after the convergence of the system to a new state of equilibrium following exogenous shocks. Knowing that CGEMs require an important source of data which are generally organized in the form of a social accounting matrix (SAM), the theoretical framing of the social accounting matrix as well as the procedures for building such a tool have made subject to in-depth analysis.

1.2. Modelization

The general calculable equilibrium model (CGEM) adopted faithfully presented the different uses of natural resources (land, water resources) within the regional economy as being a factor of production (agriculture, industry, and tourism) and as being well consumption (drinking water and building land).

The production technologies incorporating the factors of production have been modeled by a more or less complex combination of CES (Constant Elasticity of Substitution) production functions and linear Leontief functions. The utility function of consumers is of the Stone-Geary type. These functions have the advantage of presenting realistically the behavior of producers, consumers, and different economic transactions. The methodological structure of the CGEM requires a large number of parameters and quantities that must be estimated and/or collected.

The implementation of the CGEM required going through a phase of data collection and calibration in the form of a Social Accounting Matrix (SAM). The SAM is part of the big family of economic tables (ET) and constitutes a generalization of the table "input-output" of Leontief. The SAM provides a coherent framework for presenting transactions within an economy, be it a country, a region, or a set of countries or regions [45]. The SAM puts in matrix form the interrelations between the accounts of the supply-use tables and those of the institutional sectors. The SAM was used to present the flows in value (quantities multiplied by prices) between the different accounts of the economy, jobs being represented in line, and resources in columns. General equilibrium is achieved when each of the row totals is equal to its column counterpart [46].

The development of scenarios forms the basis of ex-ante assessments of the impacts of development policies. This step is crucial since we must clearly define the political scenarios and options, the base year, and the horizon of our projection. In our case, the scenarios were designed to facilitate the

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 9, Issue 2, 2019

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

climate change impact assessment process and the effects of the adaptation strategy on a regional scale. The horizon 2035 has been set as the projection year; the base year 2013 is dictated by the availability of data for the development of a social accounting matrix (SAM). A baseline "climate change" scenario and an "adaptation" scenario were assessed as part of our work.

• **Reference state:** it translates the current state at the scale of the governorate of High Plateaux as described by the DPSIR approach (availability of natural resources, economic structure etc.)

• **Scenario 1:** it takes into account the effect of climate change on the factors of production of water and agricultural land following the forecasts of the national strategy for adapting the agricultural sector to climate change

• **Scenario 2:** it translates the adaptation strategy on a regional scale conceived by the national strategy of adaptation of the agricultural sector to climate change

1.3. Post-Modelling

The post-modeling phase consists of calculating, by using the analysis method of multi-criteria (AMC), a regional sustainability index (RSI) to assess the impact of climate change and the effects of the adaptation strategy. The regional sustainability index RSI is an aggregated and synthetic index of the various impact indicators. The indicators are linked to the LUF and the three dimensions of sustainable development (Table 1).

Table 1. Choice of Land Use Functions and Indicators

Dimensions	**Land Use Fonctions (LUF)**	**Indicators**
Social	work	Use of the work factor
	Quality of life	price index for consumption
	Food security	Agricultural production
Economic	Industries	Industrial sector production
	Tourism	Tourism sector production
	Agriculture	Agricultural sector production
Environmental	Abiotic resources	Use of the water factor
	Biotic resources	Use of rangelands
	Conservation of Ecosystem	Natural land

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 10, Issue1, 2021

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

The dimensions, land use functions (LUFs), and indicators that make up the synthetic regional sustainability index. Thus, the process of calculating the synthetic sustainable development index can be reduced to a multi-criteria or multi-attribute decision problem.

A sensitivity analysis consisting of varying the weights of the three pillars of sustainable development has been carried out; the aim is to test the robustness of the results in the event of a change in political strategies to favor one or the other of the pillars of sustainability.

2. Results and discussion

Impact of climate change on macroeconomic quantities

What emerges from a global reading of the results of the first simulation (scenario 1) is that climate change will have a more or less significant impact on economic aggregates on a regional scale. There is a -1.95% drop in Regional Gross Domestic Product (RGDP) by 2035, a -1.66% drop in domestic production, a -1.32% drop in private consumption, a drop of - 5.57% in investment, a drop of - 1.20% regional exports and an increase in the general price index by 0.21%.

The results of the model showed that the adaptation actions concerning the rehabilitation of degraded land and the mobilization of water resources would have a positive effect on the regional economy. The decline in economic aggregates at the regional level will be much smaller with the inclusion of adaptation strategies (Table 2). Regional GDP will decrease by 0.37% instead of 1.95%, the investment will drop by 1.34% instead of 5.57% and private production will drop by 0.51% instead of 1.66 %.

Table 2. Variation in economic magnitudes at the regional level

Indicators	Value (Million DZA)			Variation from the reference State (%)	
	Reference state	S1	S2	S1	S2
regional GDP	904800	887459	901456	-1,95	-0,37
Domestic production	1325453	1303785	1318666	-1,66	-0,51
Private consumption	115566,77	114058	115258	-1,32	-0,27
General price index for consumption	1			0.21	0.12
Use of production factors by sector	850512	845963	848753	-0,54	-0,20
Investment	119141	112850	117569	- 5,57	-1,34
Exportation	48400	47824	48150	-1,20	-0,52

(Source: Author calculation)

Impact of climate change on sustainable development

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 9, Issue 2, 2019

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

Sustainability index at the regional level

It should be noted that all the indicator values are outputs from the regional computable general equilibrium model. Criterium Decision-plus3 software was used to calculate the regional sustainability index (RSI) via the simple multi-attribute rating technique (SMART).

Index evaluation

Overall, the current state appears to be the most favorable in terms of sustainability. The regional sustainability index (RSI) is around 0.645 (Figure 1).On the horizon of 2035, with the assumption of no adaptation measures (scenario 1), this composite index will be around 0.430. Based on the classic analysis of production in which the product flows result from the mobilization of factors of production, the decline in natural capital stocks, caused by climate change, can explain this loss in terms of sustainability.

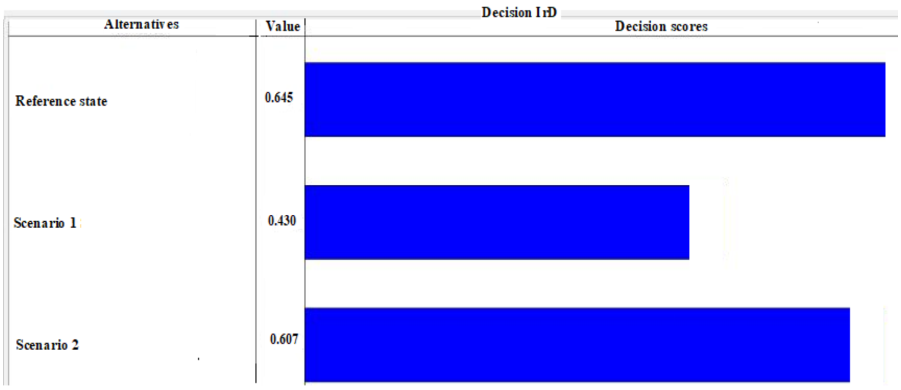

Figure 1. Regional sustainability index for the three scenarios.

Also, the results showed that the adaptation scenario (scenario 2) will have positive effects on almost all of the land use functions (Figure 3). Thus, the adaptation scenario outperforms the first scenario in terms of sustainability (0.607 against 0.430). Despite this improvement, taking into account adaptation measures will not establish the baseline situation. As a result, the adaptation strategy it must be strengthened and political decision-makers must improve production technologies, especially in the agricultural sector, to offset the decline in natural capital caused by climate change. Climate change would tend to increase the variability of agricultural yields over time [47], due to increased variability in temperature and precipitation [48].

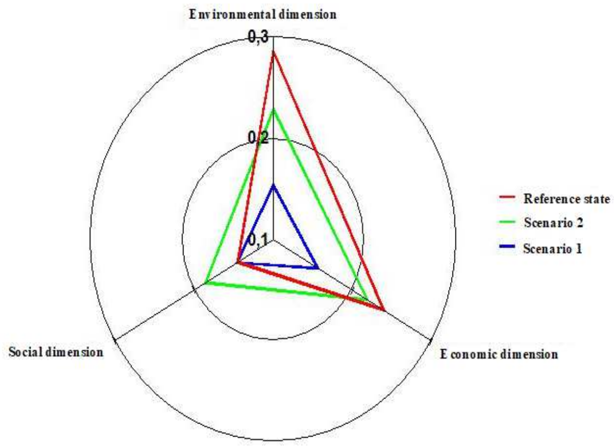

Figure 2. Contribution of the dimensions of sustainable development to the sustainability index

Figure 2 shows that the environmental dimension loses importance in the first and second scenarios compared to the reference state. This can be explained by the direct effect of climate change on the stock of natural capital (water and land). The economic dimension, which ranks second in the formation of the regional sustainability index as it stands, outperforms the environmental dimension in the second scenario. This is explained by the maintenance of a similar level of investment despite the decline in other economic indicators. The social dimension, which ranks third in the current state, becomes more important in the adaptation scenario. This gain in interest is due to the rise in the level of employment as a factor of production substitutable for natural resources.

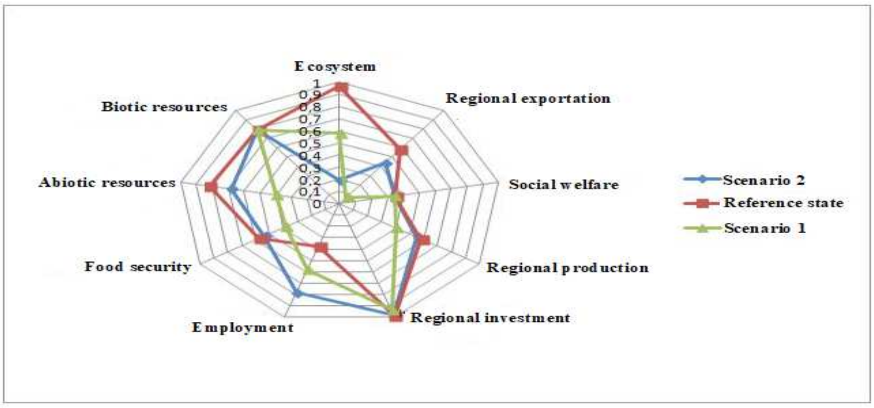

Figure 3. Impact of scenarios on sustainable development indicators

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 9, Issue 2, 2019

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

Sensitivity analysis

The sensitivity analysis reflects the stability of the results taking into account variations in the value of criteria, weights, or thresholds. It can understand a multi-criteria situation through different sets of weights. In our case study, to simplify the analysis, we chose to assign the same weight (preference) for the different dimensions of sustainable development and to the indicators.

In what follows, we will present the impact of a preference game, which corresponds to the variation in the weights of each pillar of sustainable development (environmental, social, and economic) on the regional sustainability index.

As shown in Figure 4, beyond the weight of 0.17 for the environmental pillar, the results confirm the superiority of the reference state in terms of sustainability to the detriment of the two scenarios. For a weight, less than 0.17, the first scenario (climate change) keeps the last rank in terms of sustainability but the second scenario (adaptation scenario) outperforms the reference state. Thus, despite the reduction in the weight of the environmental pillar in the formation of the regional sustainability index, the effects of the decrease in natural capital by climate change remain high and the baseline scenario retains its superiority. This is in fact due to the presence of natural capital as a factor of production and the indirect effects induced by the decline in productivity in the agricultural sector. The possibility of reducing the impacts in order to stay within the limits of environmental sustainability depends on regional or even local conditions, in particular the agreement between technology and the environment. Thus lies the importance of the adoption of new technologies especially in the agricultural sector to be more efficient in the use of natural inputs.

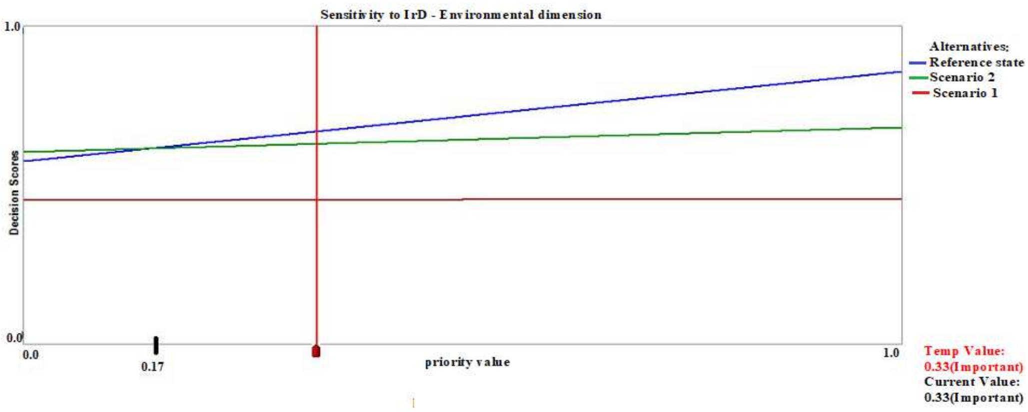

Figure 4. Sensitivity analysis on the environmental dimension

Figure 5 shows that the reference state outperforms the two scenarios for a weight less than 0.51 assigned to the social dimension. Beyond a weight of 0.51, the adaptation scenario ranks first, whatever the weight of the environmental dimension, the climate change scenario ranks last. This can be explained mainly by the substitutability between natural capital and labor as mentioned above.

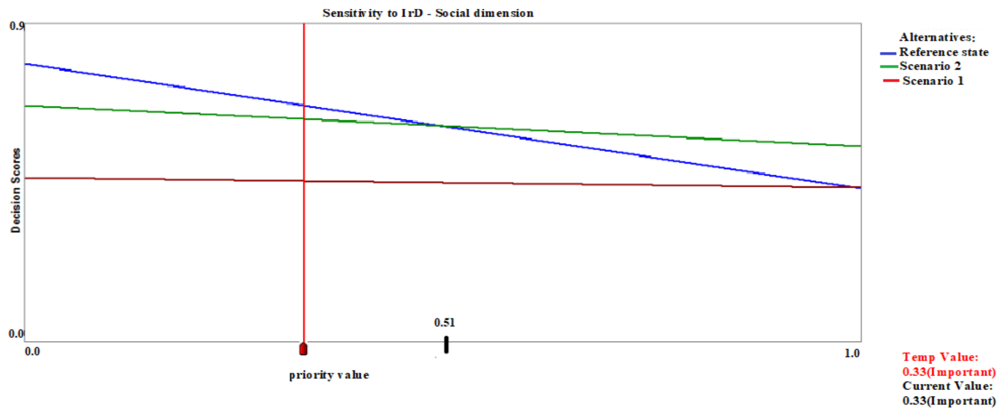

Figure 5. Sensitivity analysis on the social dimension

Whatever the weight assigned to the economic dimension, the result remains stable (Figure 5) and the reference state retains its superiority to the detriment of the first and second scenario. The rigidity of the result is explained by the large difference between the value of the "regional export" LUF in the reference state and its value in the other two scenarios (Figure 6).

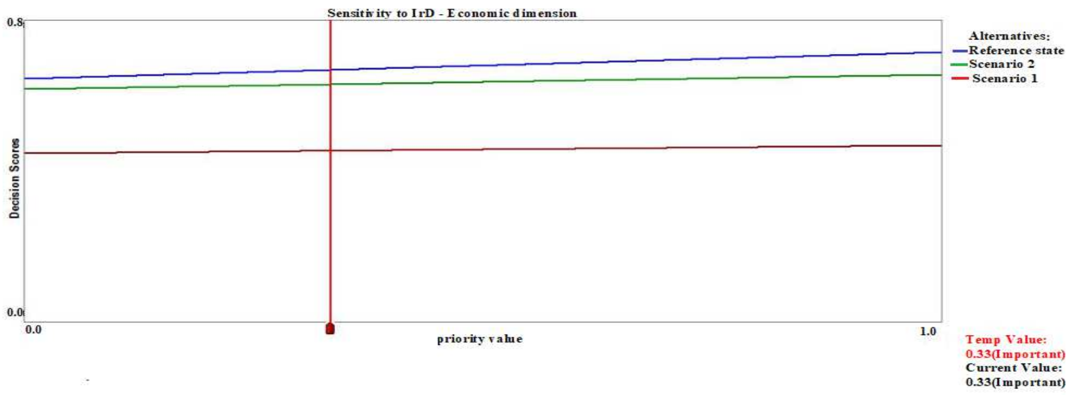

Figure 6. Sensitivity analysis on the economic dimension

3. Conclusion.

In this work, we try to describe and apply the regionalized computable general equilibrium model. The simulations allowed us to calculate the regional reference balance, the regional balance in the case of considering climate change, and the regional balance in the case of taking into account climate change and adaptation measures. Recall that the major goal of our research is to war political orientation on the subject of climate change rather than to provide a generic analysis tool on a regional scale.

The results showed that climate change would have a significant impact on economic aggregates on a regional scale. Thus, the Regional GDP by 2035 will fall by -1.95%, domestic production by -1.66%, private consumption by -1.32%, investment by - 5.57%, and regional export by -1.20%. The results of the model showed that the decline in economic aggregates at the regional level would be much smaller with the consideration of adaptation strategies. Regional GDP will drop by 0.37% instead of 1.95%, the investment will drop by 1.34% instead of 5.57%, and domestic production will drop by 0.51% instead of 1.66%.

It remains to be said that these results must be interpreted with caution for several reasons. Climate change is a dynamic phenomenon; however, our model was of the static type, which ignores the time factor. Besides, it has been assumed that the labor and capital stock is limited to the availability of the region despite the perfect mobility of capital between regions. Also, we assumed perfect substitutability between the factors of production, natural capital (water and land), physical capital, and labor (production function CES). The logic of things especially for the agricultural sector dictates the use of the production function of Leontief. This will be the future extension of our research project.

As has been shown, regarding the impact of climate change on regional sustainability, beyond the weight of 0.17for the environmental pillar, the results confirm the superiority of the reference state in terms of sustainability at the expense of the first and second scenario. For a weight, less than 0.17, the first scenario (climate change) keeps the last rank in terms of sustainability but the second scenario (adaptation scenario) outperforms the reference state. Thus, despite the reduction of the weight of the environmental pillar in the formation of the regional sustainability index, the effects of the reduction of natural capital by climate change remain high and the baseline scenario retains its superiority. This is in fact due to the presence of natural capital as a factor of production and to the indirect effects induced by the decline in productivity in the agricultural sector. The possibility of reducing the impacts in order to stay within the limits of environmental sustainability depends on regional or even local conditions, in particular the consistency between technology and the environment. Therein lies the importance of adopting new technologies that conserve natural resources, especially in the agricultural sector.

5. Acknowledgements, The authors declare no Acknowledgements

Conflict of Interest "The authors declare no conflict of interest".

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 10, Issue1, 2021

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

6. References

[1] Batten .S "Climate change and the macro-economy: a critical review", Bank of England Working Paper n° 706. 2018.

[2] Hsiang .S "Climate econometrics", Annual review of resource economics, Volume 8. 2016.

[3] IPCC, Intergovernmental Panel on Climate Change, Climate Change 2013: The Scientific Elements, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, [Stocker, TF, D. Qin, G.- K. Plattner, M. Tignor, SK Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and PM Midgley (eds.)], Cambridge University Press, Cambridge, UK and New York, NY, United States, 1535 pp. 2013.

[4] IPCC, Intergovernmental Panel on Climate Change, Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects, Contribution du Groupe de travail II au cinquième Rapport d'évaluation du Groupe d'experts intergouvernemental sur l'évolution du climat [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea et L.L.White (dir. pub.)], Cambridge University Press, Cambridge, Royaume-Uni et New York, NY, États-Unis, 1132 pp. 2014a.

[5] Dell, Melissa, Benjamin F. Jones, and Benjamin A. Olken. "Temperature and Income: Reconciling New Cross-Sectional and Panel Estimates." American Economic Review (2): 198–204. 2009.

[6] Dell, Melissa, Benjamin F. Jones, and Benjamin A. Olken. "Temperature Shocks and Economic Growth: Evidence from the Last Half Century." American Economic Journal: Macroeconomics 4 (3): 66–95. 2012.

[7] IPCC, Intergovernmental Panel on Climate Change, Climate Change 2007 - The Physical Science Basis: Working Group I Contribution to the Fourth Assessment Report of the IPCC, Cambridge University Press, September. 2007a.

[8] IPCC, In: Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, A.P.P.R., et al. (Eds.), Global Warming of 1.5 °C An IPCC Special Report On the Impacts of Global Warming of 1.5 °C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission pathways, in the Context of Strengthening the Global Response to the Threat of Climate change, Sustainable development, and Efforts to Eradicate Poverty. 2018.

[9] Bosello, F. et J. Zhang, Assessing climate change impacts: Agriculture, FEEM Working Papers, 94.2005 Fondazione Eni Enrico Mattei, Milan, Italy. 2005.

[10] Zhai, F., T. Lin, et E. Byambadorj, A general equilibrium analysis of the impact of climate change on agriculture in the People's Republic of China, Asian Development Review, 26(1), pp. 206-225.2009.

[11] Bosello, F. R. Roson, et R.S.J. Tol Economy-wide estimates of the implications of Climate change: Human health. Ecological Economics, 58(3), pp. 579-581. 2006.

[12] Nordhaus, William.D. Expert Opinion on Climatic Change,� American Scientist, January-February 1994, vol. 82, pp. 45-51. 1994.

[13] Nordhaus, William.D. A Question of Balance: Weighing the Options on Global Warming Policies, Yale University Press, New Haven, CT.USA. (2007).

[14] Nordhaus, William.D. "Economic Aspects of Global Warming in a Post-Copenhagen Environment." Proceedings of the National Academy of Sciences 107 (26): 11721–26. 2010.

[15] Tol, R.S.J. '"Emission abatement versus development as strategies to reduce vulnerability to climate change: an

application of FUND", Environment and Development Economics, Vol. 10(5), pp. 615-629. 2005.

[16] Stern, N. Stern Review: The Economics of Climate Change, Cambridge: Cambridge University Press. 2007.

[17] Agrawala, S., F. Bosello, C. Carraro, E. De Cian, E. Lanzi, K.C. De Bruin and R.B. Dellink, "Plan or React? Analysis of adaptation costs and benefits using Integrated Assessment Models", Climate Change Economics, Vol. 2(3), pp. 175-208. 2011.

[18] OECD,Organization for Economic Co-operation and Development, OECD Environmental Outlook to 2050 : The Consequences of Inaction, OECD Publishing, Paris. http://dx.doi.org/10.1787/env_outlook-2012-fr. 2012a.

[19] OECD,Organization for Economic Co-operation and Development "Meta-analysis of the value of statistical life in studies of declared preferences: other questions relating to the sensitivity of models and transfer of advantages", Working Group on National Environmental Policies, ENV / EPOC / WPNEP (2010) 10 / FINAL, OECD, Paris. 2012b.

[20] Garnaut Ross. The Garnaut Climate Change Review, Cambridge University Press, Melbourne.2008.

[21] Garnaut Ross. The Garnaut Review 2011: Australia in the Global Response to Climate Change, Cambridge University Press, Melbourne. 2011.

[22] Ciscar, J.C., Iglesias, A., Feyen, L., Szabó, L., Van Regemorter, D., Amelung, B., Nicholls, R., Watkiss, P., Christensen, O.B., Dankers, R. and Garrote, L., Physical and economic consequences of climate change in Europe. Proceedings of the National Academy of Sciences, 108(7), 2678-2683. 2011.

[23] 23. Ciscar. J.C. et al. « Climate impacts in Europe. The JRC PESETA II project », JRC Scientific and Policy Reports, n° EUR 26586EN, Office des publications de l'Union européenne, Luxembourg. 2014.

[24] Steininger, K. W. et al. Economic Evaluation of Climate Change Impacts: Development of a Cross-Sectoral Framework and Results for Austria, Springer International Publishing, Suisse. 2015.

[25] Bosello, F., Roson, R. and Tol, R.S., Economy-wide estimates of the implications of climate change: Sea level rise. Environmental and Resource Economics, 37(3), 549-571. 2007.

[26] Eboli F, Parrado R, Roson R. Climate-change feedback on economic growth: explorations with a dynamic general equilibrium model. Environment and Development Economics 15(5), 515–533. 2010.

[27] Roson, R., & der Mensbrugghe, D. V. Climate change and economic growth: Impacts and interactions. International Journal of Sustainable Economy, 4, 270–285.2012.

[28] Bosello, F., E. de Cian et L. Ferranna, « Catastrophic risk, precautionary abatement, and adaptation transfers », document de travail de la FEEM, n° 108.2014, Milan. 2014.

[29] Aguiar, A., Narayanan, B., & McDougall, R. An overview of the GTAP 9 data base. Journal of Global Economic Analysis, 1(1), 181–208. 2016.

[30] Corong, E. L., Hertel, T. W., McDougall, R., Tsigas, M. E., & van der Mensbrugghe, D. The standard GTAP model, version 7. Journal of Global Economic Analysis, 2, 1–119. 2017.

[31] Hertel, T. W. Global trade analysis: Modelling and applications. Cambridge, New York: Cambridge University Press. 1997.

[32] Dixon, P. B., & Rimmer, M. T. Dynamic general equilibrium modelling for forecasting and policy: A practical guide and documentation of MONASH, contributions to economic analysis (Vol. 256). North-Holland: Elsevier.2002.

[33] Ianchovichina, E., & Walmsley, T. L. Dynamic modeling and applications for global economic analysis. New York: Cambridge University Press. 2012.

(online) = ISSN 2285 – 3642
ISSN-L = 2285 – 3642
Journal of Economic Development, Environment and People
Volume 10, Issue1, 2021

URL: http://jedep.spiruharet.ro
e-mail: office_jedep@spiruharet.ro

[34] Ha, P. V., Kompas, T., Nguyen, H. T. M., & Long, C. H. Building a better trade model to determine local effects: A regional and intertemporal GTAP model. Economic Modelling, 67, 102–113.2017.

[35] McKibbin, W. J., & Wilcoxen, P. J. The theoretical and empirical structure of the G-Cubed model. Economic Modelling, 16(1), 123–148. 1999.

[36] Sue Wing, I. et E. Lanzi, « Integrated assessment of climate change impacts: Conceptual frameworks, modelling approaches and research needs », EOCD Environmental Working Papers, No. 66, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jz2qcjsrvzx-en. 2014.

[37] Harris, G., Integrated assessment and modelling: an essential way of doing science: Environmental Modelling & Software, v. 17, no. 3, p. 201-207. 2002.

[38] Rotmans, J., and Asselt, M., Integrated assessment: a growing child on its way to maturity: Climatic Change, v. 34, no. 3, p. 327-336. 1996.

[39] Weitzman, M. L. GHG targets as insurance against catastrophic. Journal of Public Economic Theory, 14, 221–244. 2012.

[40] Stern, N. Economics: Current climate models are grossly misleading. Nature, 530, 407–409. https://doi.org/10.1038/530407a Tol, R. S. (2002). Estimates of the damage costs of climate change—Part 1: Benchmark estimates. Environmental and Resource Economics, 21, 47–73.2016.

[41] Kompas, T., Pham, V. H., & Che, T. N. The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. Earth's Future, 6, 1153–1173.2018.https://doi.org/10.1029/2018EF000922

[42] Sghaier, M., Arbi, A. M., Tonneau, J. P., Ounalli, N., Jeder, H., and Bonin, M., Land degradation in the arid Jeffara Region, Tunisia, in McNeil, D., Nesheim, I., and Brouwer, F., eds., Land Use Policies for Sustainable Development: Exploring Integrated Assessment Approaches, Edward Elgar, p. 89. 2012.

[43] 43. Pérez-Soba, M., Petit, S., Jones, L., Bertrand, N., Briquel, V., Omodei-Zorini, L., Contini, C., Helming, K., Farrington, J. H., and Mossello, M. T., Land use functions—a multifunctionality approach to assess the impact of land use changes on land use sustainability, Sustainability impact assessment of land use changes, Springer, p. 375-404. 2008.

[44] König, H., Sghaier, M., Schuler, J., Abdeladhim, M., Helming, K., Tonneau, J.-P., Ounalli, N., Imbernon, J., Morris, J., and Wiggering, H., Participatory Impact Assessment of Soil and Water Conservation Scenarios in Oum Zessar Watershed, Tunisia: Environmental Management, v. 50, no. 1, p. 153-165. 2012.

[45] Fofana, I. Developing a Social Accounting Matrix for the Analysis of Impacts of Shocks and Macroeconomic Policies: Poverty and Economic Policy, and Interuniversity Center on Risk, Economic Policies and Employment, University of Laval. Training material. 2007.

[46] Abdeladhim, M. A., Chant, L., Abdallah, A., and Sghaier M., Ex-Ante Impact Assessment of water policy reform in Southeastern of Tunisia: Sustentabilidade em Debate, v. 2, no. 2, p. 43-54. 2011.

[47] IPCC "Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change", Geneva: Meyer (Eds.). 2014.

[48] Kukal M. & S. Irmak "Climate-Driven Crop Yield and Yield Variability and Climate Change Impacts on the U.S. Great Plains Agricultural Production", Nature, Volume 8. 2018.