The Coalition of Finance Ministers for Climate Action

Assessment of the impacts of climate change on the national economy via the agricultural sector

Morocco—Ministry of Economy and Finance

A contribution to the 'Compendium of Practice from a Global Community of Ministries of Finance and Leading Organizations: Economic analysis and modeling tools to assist Ministries of Finance in driving green and resilient transitions'

Topic: Modeling tools relevant to Ministries of Finance

June 2025

Access the full Compendium at www.greenandresilienteconomics.org

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This contribution was prepared at the request of, and with guidance from, the Ministry of Finance of Denmark as Lead of the Coalition's Helsinki Principle 4 initiative 'Economic Analysis for Green and Resilient Transitions' and its Steering Group, with input from its Technical Advisory Group. The views, findings, interpretations, and conclusions expressed are those of the authors. While many Coalition members and partners may support the general thrust of the arguments, findings, and recommendations made in this contribution, it does not necessarily reflect the views of the Coalition, its members, or the affiliations of the authors, nor does it represent an endorsement of any of the views expressed herein by any individual member of the Coalition.

Context

Climate change raises important issues in terms of the adaptation and resilience of Morocco's development trajectory and requires anticipating risks, including at the economic and social levels. Aware of this, from the start the Kingdom of Morocco has been resolutely committed to the global effort to implement the Paris Agreement and implement the 17 goals of the 2030 Agenda for Sustainable Development.

Thus, Morocco submitted its first Nationally Determined Contribution (NDC) in 2021, with an ambition to reduce greenhouse gas emissions, revised upwards and set at 45.5% by 2030. At the same time, Morocco initiated reforms aimed at providing appropriate responses to current challenges and preparing Morocco to better cope with the upheavals induced by future climate developments. Particular attention was paid to sectors highly exposed and highly sensitive to climate change, and on which the country's economy depends, namely the water and agriculture sectors.

In this perspective, medium- and long-term structuring actions are being undertaken in the water sector, which are part of the deployment of the National Water Plan 2050 and the Priority National Drinking Water Supply Program and irrigation 2020–2027. Furthermore, as part of the Green Morocco Plan 2008–2020 strategy and the new Generation Green 2020–2030 strategy, Morocco has undertaken structuring actions aimed at strengthening the sustainability and resilience of the sector in the face of climate change.

In this context, the Directorate of Studies and Financial Forecasts (DEPF) under the Ministry of Economy and Finance of the Kingdom of Morocco and the French Development Agency (AFD), in collaboration with the General Directorate of Meteorology (DGM), the Water Research and Planning Directorate (DRPE) of the Ministry of Equipment and Water, and the AAA Initiative Foundation, as well as the Mediterranean Institute of Biodiversity and Marine and Continental Ecology (IMBE), undertook a project to model the impacts of climate change on the Moroccan macroeconomy, via the agricultural sector.

The objective of this project was to develop a prospective vision, making it possible to anticipate the consequences of climate change on water resources and the agricultural sector and thus to assess the impacts on the Moroccan economy at the territorial and national level. In doing so, it highlights the economic gains linked to water and agricultural policies, while allowing Morocco to best manage its long-term strategies.

The choice of modeling

This project is based on two modeling tools.

The Lund-Potsdam-Jena managed Land (LPJmL) model. This is a spatial digital model developed by the Potsdam Institute for Climate Impact Research. 'It is based on physical processes and capable of the coupled simulation of natural vegetation and its dynamics, the terrestrial carbon cycle, and the hydrology surface area as well as the productivity of different crops. It also makes it possible to study the impact on agriculture of possible water restrictions for irrigation. Its input variables are Climate (temperature, precipitation, cloudiness); the type of soil; the distribution of different cultures; agricultural practices, including irrigation; and the atmospheric CO2 content, which influences photosynthesis and plant respiration.

Digital land cover maps with a spatial resolution of 100 m from spatial remote sensing between 2009 and 2020, are available on the WaPOR portal.[1] These maps distinguish between bour [rainfed] and irrigated areas. To constitute the digital land use files necessary as input to the LPJmL model, this data was aggregated at the spatial resolution of the model (~9 km), then, for each region, the different crops were distributed homogeneously over the pixels classified as agricultural, maintaining the proportions observed at the regional scale.

1 https://wapor.apps.fao.org/home/WAPOR_2/1

The high spatial resolution climate simulations used as the input to the LPJmL are those of the ALADIN regional climate model, for the RCP4.5 and RCP 8.5 scenarios. These simulations are available as part of the EURO-Cordex program and cover Europe and the Mediterranean region, including the northern half of Morocco, where most agricultural activities are located. The climatic conditions at the limits of the ALADIN simulation domain come from the CNRM-CM global climate model.

This model was used to make quantitative projections of changes in surface water resources and the production potential of the main Moroccan crops and their water needs over the decades up to 2050. The results remain provisional because they depend on the degree of refinement of the calibration of agricultural yields, scenarios for the evolution of practices and land use, and surface hydrology on a regional scale.

The General Monetary and Multisectoral Macrodynamics for the Ecological Shift (GEMMES) macroeconomic model. The GEMMES model is a dynamic, multi-sector, macrofinancial model developed by the AFD. It is based on a theoretical framework at the crossroads of three schools of thought of economic theory: post-Keynesian, ecological, and institutional economics.

The model integrates the existence of a monetary and financial sphere to model the interactions between the climate, the macroeconomy, and finance, particularly through the financial risks associated with climate change and the energy transition. This model was adapted, using the annual data, to study the mechanisms of transmission of agricultural production shocks to the Moroccan economy and to explore scenarios and appropriate responses for adaptation and resilience capable of coping with the harmful effects of climate change on the national economy. The balance sheets of the sectors of the economy are modeled and the main financial assets/liabilities are tracked explicitly. These systemic interrelationships between sectors, the incorporation of feedback mechanisms between stock accumulation arising from flow dynamics and the responses of flows to stock accumulation processes, are fundamental to the macrodynamics of the economy.

The simulations

The simulations carried out retained two scenarios corresponding to the degree of adaptation to the irrigation constraint: The first concerns the situation where the State's investment effort in surface water resources would only be maintained up to 50% of irrigation needs by 2050. The second projects the more favorable case of an investment effort making it possible to maintain the current situation in terms of water supply, i.e., up to 75% of irrigation needs.

The hydrological and agricultural simulations are carried out with the LPJmL model in order to quantitatively estimate changes in surface water resources, the production potential of the main Moroccan crops, and their water needs over the coming decades. The impacts of climate change scenarios on agricultural yields are then transformed with GEMMES into macroeconomic impacts, mainly through the following channels: agricultural income, household consumption, exports and imports of agricultural products.

The results of these two models remain preliminary. They were the subject of a presentation at COP26 in Glasgow in 2021. They highlight the negative effects of climate change on Moroccan agriculture by 2050 in the event of significant water restrictions for irrigation. According to the various simulations, the State's investment effort in water infrastructure will proves be decisive in mitigating these negative effects on agricultural production and therefore on household consumption, exports, and GDP.

It should be noted that the DEPF is currently participating with the AFD in the adaptation and refinement of the GEMMES model to carry out an evaluation, as part of a project led by the Department of Sustainable Development, on the impact of Morocco's long-term national low-carbon strategy for 2050 (LEDS). To do this, this new version of the GEMMES model will be coupled with the technical-economic sector model Low Emissions Analysis Platform (LEAP) developed by the Stockholm Environment Institute (SEI) design office. The LEAP tool allows the energy system of a country to be modeled and analyzed, with a focus on reducing greenhouse gas emissions. It allows us scenarios of energy systems to be created and analyzed, including energy supply and demand, energy efficiency, and renewable energy. It is a bottom-up modeling tool that starts with the modeling of individual energy technologies and energy uses and then combines them to form the overall energy system.

It should also be emphasized that the DEPF considers the mobilization of international skills and access to this tool as of great importance strengthening its capacities and expertise in the field.