



# ASSESSMENT AND MAPPING OF VULNERABILITY AND ADAPTATION OF SMALL FARMERS TO CLIMATE CHANGE IN MOROCCO

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**ACTIVITY AREA:** Adaptation

**FOCUS AREA:** Preparing

**COUNTRY:** Morocco

## SECTORS

**INVOLVED:** Agriculture

**TIMEFRAME:** 2016 - 2018

**CASE SUMMARY:** The 'Assessment and mapping of vulnerability and adaptation of small farmers to climate change' in Morocco is a study launched by the Moroccan Agency for Agricultural Development (ADA for its acronym in French) and financed by the International Fund for Agricultural Development (FIDA for its acronym in French). It proposes actions to enhance the resilience to climate change of the regions targeted by the projects and programmes of Pillar II of the Green Morocco Plan (PMV in its French acronym), a national plan to improve the productivity and resilience of the agricultural sector.

The study encompasses the development of the climate change adaptation planning tool 'Vulnerability and Adaptation Map of Small Farmers to Climate Change' for decision-makers, that combines data on the socio-economic vulnerability of small farmers with climate-related risk factors within the national territory. The tool provides essential access to adaptation-relevant information. For instance, it is used as a 'digital map' and provides accurate well-detailed data on the vulnerability of small farmers in FIDA-funded areas. The results from the study are being used to inform the development of the country's national adaptation strategy, which will seek to enable the Moroccan agriculture to face the challenges of climate change.

This study demonstrates good practice both in its highly scientific approach and critical added value to national policy discussions. Besides, it anchors the tool in national flagship programmes such as the PMV, thus mainstreaming the project results into important national planning documents. The study has been realised in an utmost transparent manner, enabling its replication across different regional contexts.





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**BACKGROUND:** Over the last few decades, Morocco has experienced very significant economic and demographic development alongside significant impacts from climate change across all sectors of the economy. The country's Nationally Determined Contribution (NDC), submitted in September 2016, highlights an increased pressure on natural resources, particularly with regards to the availability of water resources which was three times higher in 1960 (about 2600 m<sup>3</sup>/year/inhabitant) compared to today (about 700 m<sup>3</sup>/year/inhabitant). This water scarcity has in turn directly affected the resilience of forest ecosystems and the agricultural sector. Morocco is located between two climatic zones (temperate and tropical) and has a 3500km long coastline. 80% of its industrial and energy infrastructure is located along this coastline, making the country particularly vulnerable to sea-level rise and the increasing scarcity of groundwater.

Morocco's agricultural sector accounts for 19% of the Gross National Product (GNP), with 15% from primary agriculture and 4% from agro-industry, employs more than 4 million rural inhabitants, and has created approximately 100,000 jobs in the agro-industry sector. In total 80% of the 14 million people living in rural areas in Morocco depend on revenues from the agricultural sector. The sector is directly responsible for the food security of nearly 30 million people per year (Royaume du Maroc, 2009).

Rainfed crops represent 87% of total crop production and are particularly vulnerable to climate change effects such as increased rainfall variability, water scarcity, and decreased productivity. Socioeconomic characteristics in the regions also exacerbate the vulnerability of rainfed crop production, including insufficient investment and access to capital, disorganised and uncoordinated action, parcelling of farms, and an overreliance on cereal crops. Overall, climate change is expected to cause a 10% decline in cereal yields and even a 50-75% decline in drought years, a 7-12% increase in water demand for irrigation coupled with general water shortage by 2020 due primarily to declining resources in reservoirs and overstressing groundwater systems (Royaume du Maroc, 2016).

To address the challenges posed by climate change, the Government of Morocco formulated the Green Morocco Plan (PMV) covering the years from 2006 to 2016. It is a national plan to improve the productivity and resilience of the agricultural sector and integrate sustainable development through the promotion of climate-resilient agriculture. The PMV strategy aims to create 1.5 million additional jobs, fight poverty and double or triple agricultural income for 3 million rural people. In addition, it seeks to increase the value of exports from 8 to 44 billion Moroccan dirhams (MAD) (around USD 827 million to 4.5 billion, based on conversion rate: 1 MAD = 0.103401 USD) in those sectors in which Morocco is competitive. This plan has made it possible to enhance the value of uncultivated land and increase the area of forests. The plan's priority measures are water control and rationalisation.

To support the plan, the 'assessment and mapping of vulnerability and adaptation of small farmers to climate change' study was commissioned by ADA to assess and map the vulnerability of small-scale farmers to climate change at the provincial level (i.e. the areas covered by the network of all nine Regional Offices of Agricultural Development (ORMVA) as well as the provinces of Taza, Boulmane, Sefrou, Azilal, Beni Mellal, Ifrane, Midelt, Khenifra, Taounate, Al Haouz, El Hajeb, Figuig, Oujda, Taourirt, Marrakech (Ezzine et al., 2018)). The ORMVAs are responsible for the application of the entire agricultural policy in all its components (irrigation water management, hydro-agricultural development, planning, agricultural development, etc.) and have financial autonomy. The study also aims at developing an adaptation strategy that would enable small-scale farmers to effectively respond to the threats of climate change.

The specific objectives of the study include:

- Assessing and mapping the current and future climate change exposure factors in each of the action areas in the regions covered by the FIDA-funded PMV support programmes
- Identifying and evaluating climate change sensitivity factors, including biophysical and socio-economic factors
- Evaluating the potential impact of climate change on drought and water erosion
- Building a systemic vision to identify the constraints imposed by climate change on small-scale agriculture
- Highlighting future risks related to climate change
- Proposing guidance for coherent strategies of adaptation

**ACTIVITIES:** ————— The methodological approach to develop national adaptation monitoring and evaluation systems adopted in the study is based on the methodology recommended by the Intergovernmental Panel on Climate Change (IPCC) and the German development agency (GIZ in its German acronym) (GIZ, 2015). After a first phase that focused on the development and implementation of the methodological approach in accordance with the identified action areas, the second phase of the study extended the methodological approach to collect and synthesise all of the results from the first phase on a provincial level (including those provinces scoped for the study that were listed in the background section).

The main activities of the study to assess the vulnerability of small farmers to climate change are as follows (Ezzine et al., 2018):

- **MAPPING OF LAND COVER AND LAND USE DYNAMICS:** Land cover and land use dynamics mapping was carried out using Landsat 5-TM, Landsat 7-ETM and Sentinel 2 satellite images acquired at a 10-year interval, specifically in 1996, 2006 and 2016. Land use maps and their dynamics have been used at several levels to assess land use change with the expansion of the urban environment and to assess sensitivity to drought and water erosion. For example, land use maps for 1996, 2006 and 2016 show a general trend towards an increase in land under cultivation and a general trend towards an increase in urban areas in the targeted provinces.
- **ASSESSMENT AND MAPPING OF EXPOSURE FACTORS:** This action area entails the assessment of the magnitude of climatic variations that the territory is likely to face and the probability of these climatic variations occurring. In this sense, several variables were used: precipitation, temperature, Standardised Precipitation Index (SPI), Vegetation Condition Index (VCI), Water Requirement Satisfaction Index (WRSI) and rain erosion. These indicators have helped to assess exposure to drought and water erosion and to produce maps of current and projected exposure to variable precipitation, drought and water erosion.
- **ASSESSMENT AND MAPPING OF SENSITIVITY FACTORS:** The mapping assesses the degree to which an exposed system is impacted by climate change. Biophysical and socio-economic sensitivity were assessed through a combination of several factors. These were first standardised and then aggregated based on a hierarchical analysis process. Thus, a map of the sensitivity of small farmers to climate change was produced, showing that the entire study area is characterised by a high sensitivity to drought.



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- **ASSESSMENT AND MAPPING OF POTENTIAL IMPACTS OF CLIMATE CHANGE DUE TO DROUGHT AND WATER EROSION:** These impacts were assessed on the basis of a Geographic Information System (GIS) using a linear combination of exposure factor maps and sensitivity factor maps. This allowed for the generation of a drought impact map that shows that the study area is significantly impacted and that by 2050, the high drought impact would intensify further in space.
- **ASSESSMENT AND MAPPING OF ADAPTIVE CAPACITIES AND EFFECTIVE MEASURES TO REDUCE THE SENSITIVITY OF THE COMPLEX AND INTERCONNECTED SOCIAL, ECONOMIC, HYDROLOGIC, AND CLIMATE SYSTEMS:** The assessment was based on several indicators related to knowledge and awareness of climate risks (i.e. rainfall variability and drought), access to natural resources and adaptation technologies. Thus, a synthetic map of adaptive capacities in the face of climate change was produced and revealed a moderate to low adaptive capacity profile for small-scale agriculture.

### INSTITUTIONS

#### INVOLVED:

- **GOVERNMENT AGENCIES:** Ministry of Agriculture; Ministry of Maritime Fisheries; Ministry of Rural Development and Water and Forestry; Provincial Directorate of Agriculture; Regional Directorate of Agriculture; Regional Office of Agricultural Development (ORMVA in its French acronym); Strategy and Statistics Directorate; Directorate of Rural Development and Mountain Affairs; National Agency for the Development of Oasis and Arganeraei Zones; National Office of the Agricultural Advisory
- **IMPLEMENTATION PARTNERS:** Agency for Agricultural Development (ADA)
- **INTERNATIONAL PARTNERS:** International Fund for Agriculture (FIDA); German development agency (GIZ in its German acronym);
- **OTHER INSTITUTIONS:** National Institute of Agronomic Research (INRA); National School of Agriculture; Geographic Information System for Decision Support (GIS 4DS); High Commissioner for Planning

#### COOPERATION WITH:

Provincial/Regional Directorates of Agriculture; American Research and Development Programme in Arido-culture; government ministries and technical services; research institutes; design office; civil society organisations (including producers' organisations, NGOs, etc.), media, opinion leaders, research institutions and think tanks, local elected officials and representatives of local authorities, municipalities, subregional organisations and regional and international partners.

#### FINANCE:

Funding amounting to USD 450,000 has been provided by FIDA for the development of the study.

#### IMPACT OF ACTIVITIES:

The study created a flexible and comprehensive planning tool for decision-makers with specific maps, data baselines, and characterisations of vulnerability at the regional and sub-regional level. Specific outputs completed by the project include:

- Analysis and comparative maps for baseline land use change in the study regions for 1996, 2006, and 2016, including an analysis of the increase in cropland at the expense of rangeland and forest, an analysis of urban sprawl, and an analysis of the increase in fruit arboriculture
- Current and projected exposure maps in the study regions including an analysis of rainfall availability, temperature increases, drought impact, and water erosion vulnerability

- Sensitivity maps combining socioeconomic and biophysical features to highlight the sensitivity of different regions to drought and erosion impacts
- Maps of current and projected impacts of drought and water erosion on regional livelihoods
- Regional maps and analyses of adaptive capacity of the study regions including factors like farm size, education, access to roads, risk reduction measures, telecommunications, etc.

The outputs of the aforementioned activities were combined into a GIS environment assessing the overall vulnerability of each region to the impacts of climate change. This assessment is ultimately being used to inform the development of the overall country adaptation strategy (to be expected in 2020) by providing more granular understanding of risks in this critical sector and the regions examined. Specific propositions for adaptation include:

- Improving adaptive capacity through training farmers, managers, and technicians to better advise farmers on climate issues
- Promoting transfer of adaptive technologies including dryland farming, conservation agriculture, and targeted observation and monitoring of climate data
- Improving programmes for soil erosion control and slopes management
- Developing and implementing ecosystem-based adaptation opportunities for farming communities
- Strengthening seeding systems to defend against drought
- Improving the resilience of agricultural infrastructure including improving efficiency of water use and supporting effective mechanisation for small scale farmers
- Encouraging the integration and utilisation of agricultural research results into actual strategic planning
- Establishing early warning systems and other strategies for disaster risk management
- Integrating the agricultural sector specifically into the National Adaptation Plan

#### WHY IS IT GOOD

##### PRACTICE:

- **SCIENCE-BASED:** There is a scientifically robust climate and adaptive baseline. The data utilised in developing the maps and analysis was aggregated from a variety of primary and secondary sources in the target regions. By utilising actual observational data in conjunction with other factors, the estimates of vulnerability in the maps are more representative of the key context in the individual regions.
- **ALIGNMENT WITH NATIONAL FRAMEWORKS:** From inception, the project was anchored to the overall Green Morocco Plan, and as such the outputs were tailored to identifying key vulnerabilities and strategies to address those vulnerabilities that could be directly integrated into the national sectoral planning.



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• **TRANSPARENCY AND REPLICABILITY:** The methods utilised in the study to develop the comparative maps and analyse them to identify specific vulnerabilities are adapted from the IPCC-recommended methodology with clearly documented steps and assumptions, and with integrated processes for monitoring and evaluating objectives. Combined with the relative flexibility of the mapping tools and capacity built, the transparent methods used lay the groundwork for replication of the vulnerability analysis to other regions in Morocco and beyond.

### SUCCESS FACTORS:

• **ACTIONABLE INPUTS FOR DECISION-MAKERS:** In developing the maps and underlying analysis into digestible, actionable and visually appealing outputs, the project has provided a planning tool that facilitates awareness building and actual decision making. This is key for ensuring that the project can be integrated effectively into national planning.

• **STRONG TECHNICAL SKILLS AND CAPACITIES IN GEOSPATIAL ANALYSIS:** The project leveraged significant technical capacity both internally at ADA and at FIDA to develop the maps and geospatial analysis. The expertise leveraged was effective in creating operational graphics and tools for decision-makers.

• **AVAILABILITY OF QUALITY INPUT DATA:** The critical element in developing the vulnerability maps was the availability of regional observational data and socioeconomic factors. This has been a priority for Morocco in its National Climate Policy from 2014, which coordinates and aligns various sectoral policies (including agriculture) addressing climate change (Kingdom of Morocco, 2014). The project was able to capitalise on and operationalise the available data.

### OVERCOMING BARRIERS / CHALLENGES:

#### WHAT WERE THE MAIN BARRIERS / CHALLENGES TO DELIVERY?

**INFORMATIONAL:**  
Information gaps existed in some local data streams.

**INSTITUTIONAL:**  
There was a lack of agricultural technicians at the local level and an absence of a functional coordination structure both at the communal and provincial level.

#### HOW WERE THESE BARRIERS / CHALLENGES OVERCOME?

Local researchers and other actors at the local level were engaged to help bridge gaps and identify additional data.

The capacities of local technicians, actors and operators have been strengthened through training, awareness-raising, demonstrations and thematic activities. They have also been involved and empowered in local participatory development and the preservation of natural resources. Similarly, the opportunities offered by the Green Morocco Plan have been exploited to develop good coordination and synergy between the projects and programmes present in the intervention area and to recommend the necessary accompanying measures for small-scale farmers.

**LESSONS LEARNED:** ——— Certain key lessons learned can be leveraged by future mapping and vulnerabilities initiatives both in Morocco and beyond:

- **PLAN AHEAD FOR HOW OUTPUTS WILL BE UTILISED:** When developing maps and other geospatial analysis, outputs need to be clearly approachable for decision-makers. Especially in the rural agriculture sector, it is important to proactively consider how local farmers can make use of the data, otherwise risking shortfalls in the uptake of suggested measures.

- **ENGAGE THE RIGHT EXPERTS:** When it comes to bridging the gap between decision-makers and technical research, engaging experts with experience in communication is critical. Messages need to be tailored and deliverables refined in order to affect and support the right decisions from policy-makers, but this can be hampered by overly technical communication devoid of connectivity to practical decision points.

## HOW TO REPLICATE

**THIS PRACTICE:** ————— In order to be successful in replicating this project in other countries, the following elements need to be addressed:

- **COLLECT AND INVENTORY KEY SOCIOECONOMIC AND BIOPHYSICAL DATA AT GRANULAR LEVELS** to improve precision of vulnerability assessments and help connect the findings to concrete local policies and planning.

- **ADAPT EXISTING METHODOLOGIES FOR EFFECTIVE VULNERABILITY MAPPING TO LOCAL CONTEXTS.**

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## FURTHER KEY

**RESOURCES:** ————— · Ezzine, H. et al. (2018). Assessment and mapping of vulnerability and adaptation of small farmers to climate change, ADA & FIDA.

· Observatoire du Sahara et du Sahel (2014). Perspectives de développement de l'approche Filière pour la structuration des activités des Communautés Locales au niveau des OASIS (Prospects for the development of the Filière approach for the structuring of local communities' activities at the OASIS level). Available at: <http://www.cariassociation.org/Publications/Perspectives-de-developpement-de-l-approche-filiere-pour-la-structuration-des-activites-des-communautes-locales-au-niveau-des-oasis-de-la-region-MENA>

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**WEBSITES:** ————— · Website of the Agency for Agricultural Development: <http://www.ada.gov.ma/>

· The Ministry of Agriculture, Fisheries, Rural Development, Water and Forests on the Green Morocco Plan: <http://www.agriculture.gov.ma/en/pages/strategy>

· Website of the Centre de Compétences Changement Climatique du Maroc: <https://www.4C.ma/fr>



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