Food and Agriculture Organization of the United Nations

# Assessing the impacts of climate change on the agriculture sectors in Malawi

## The MOSAICC methodology for national adaptation planning

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# Contents


# Introduction

This case study describes the implementation of the capacity development tool **Modelling system for agricultural impacts of climate change (MOSAICC)** in Malawi and its role in: **(1) strengthening technical capacity of national institutions** and **(2) producing evidence-based results**. MOSAICC is a FAO tool developed to build the national capacity of key ministries and research institutions to produce after medium- to long-term (year 2040 and 2070, respectively) impact assessments of climate change on the agriculture sector. The outputs of the process are incorporated into national planning and policymaking. The MOSAICC methodology broadly includes:

- collection and stocktaking of national data (i.e. weather station, crop yields etc.);
- computing server and open source platform provided to the country for facilitated data exchange between groups of experts and model components;
- design analysis based on the country interest (i.e. major sectors, time period, specific crops, etc.);
- training of national experts by specialists in each area of interest;
- analysis and production of technical report/policy brief by national teams;
- communication and application of results.

The following case study will highlight the contributions of the MOSAICC process in Malawi to the national adaptation plans process in the agricultural sector and the key lessons learned during the implementation process.

# Acknowledgements

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The work related to MOSAICC was led by Olivier Crespo (University of Cape Town), Hideki Kanamaru (FAO), Rodrigo Manzanas (University of Cantabria), Mariko Fujisawa (FAO), Mauro Evangelisti (FAO) and the MOSAICC Malawi team.

# Abbreviations and acronyms

| | |
|---|---|
| AFOLU | Agriculture, Forestry and Other Land Use |
| BMU | Federal Ministry for the Environment, Nature Conservation and Nuclear Safety |
| CISONECC | Civil Society Network on Climate Change |
| FAO | Food and Agriculture Organization of the United Nations |
| GHG | greenhouse gas |
| IKI | International Climate Initiative |
| IPPU | industrial processes and product use |
| MOSAICC | Modelling system for agricultural impacts of climate change |
| NAP | National Adaptation Plan |
| NAP-Ag | Integrating Agriculture in National Adaptation Plans |
| NAP-GSP | National Adaptation Plan Global Support Programme |
| NCCTC | National Climate Change Technical Committee |
| NEP | National Environmental Policy |
| PSC | Project Steering Committee |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNDP | United Nations Development Programme |

# 1. Highlights

Lessons learned from Malawi's experience implementing MOSAICC in the framework of its ongoing National Adaptation Plan (NAP) process:

- identify **data availability and data gaps** early in the NAP process to ensure that the most relevant and updated information is used;
- **engage local experts** across institutions in order to build a multidisciplinary team for data analysis and promote dialogue around prioritisation of national objectives;
- ensure that **evidence-base produced in the MOSAICC process are directly included in decision making** at the ministry level;
- **align and integrate the MOSAICC process with relevant ongoing technical work** within the country to ensure coordination and avoid duplication of efforts;
- **prioritize capacity development and country ownership** at every stage to ensure sustainability of knowledge and consistency in the message presented for planning and policy making;
- ensure **visualization and interpretation of the final results** to facilitate and encourage uptake of analysis and information by the broader audience;
- **identify areas for future work based on the evidence produced**, such as identification of climate change impact hotspots, before project completion.

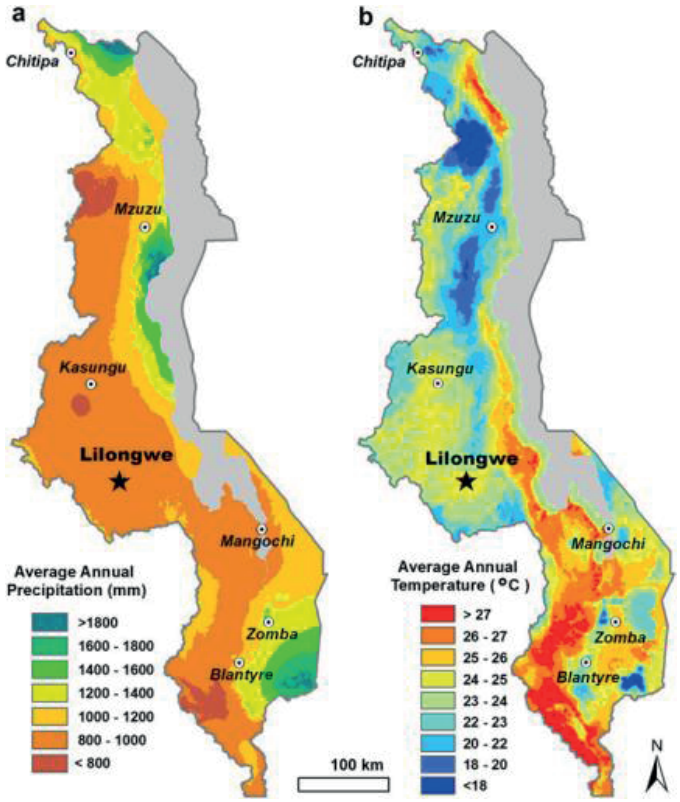
# 2. The challenge

Changes in seasonality, climate extremes and climate-driven pest and disease outbreaks are negatively impacting agricultural production and rural livelihoods in Malawi. A robust understanding of the current and expected impacts of climate change on the agriculture sector is essential to minimize damages and adverse effects for a large portion of the population. While climate studies and impact assessments are available, the scientific outputs often lack the necessary links to policymaking and planning. Evidence-informed medium to long-term adaptation planning in Malawi will support identification and implementation of appropriate and timely climate adaptation measures. For this purpose, building the climate evidence base and national capacity of local experts is an essential step in the country's NAP process.

# 3. Climate change impacts in Malawi

Malawi has a subtropical climate, which is relatively dry and strongly seasonal. Although Malawi has diverse agro-climatic zones and abundant fresh water resources, its natural ecosystems are highly exposed to natural disasters, climate variability and climate change. These environmental pressures are exacerbated by socioeconomic factors including population growth and agricultural intensification, which are increasingly degrading land and forest resources. As a landlocked least developed country with no direct access to marine ports and marine natural resources, Malawi remains among the poorest countries in the world, with over half the population living below the poverty line and a quarter living in extreme poverty. 85 percent of Malawi's population lives in rural areas, where poverty rates are highest. About half of all children in Malawi are suffering from acute or severe malnutrition.

**Figure 1. (a) Annual average rainfall (mm) and (b) Annual average temperature (celcius) in Malawi (Li, Messina, Peter and Snapp, 2017)**




*Source:* Conforms to UN Malawi map, date 2012.


Climate change is acting as an incremental threat and risk multiplier, hitting the most vulnerable people and ecosystems hardest. Over the past two decades, drought and flood events have increased in frequency and intensity with severe consequences for food and water security, as well as the wellbeing and livelihoods of rural people. As a predominantly agrarian country, where agriculture accounts for *one* third of the GDP and nearly 80 percent of employment, it is crucial that the potential impacts of climate change on the agriculture sector are well understood and adaptive measures are taken.

In 2015/16, Malawi experienced erratic rains and prolonged dry spells due to strong El Niño conditions. The drought resulted in a delayed start to the agricultural season by 2 to 4 weeks and severe crop failure particular in the Southern and Central Regions. It was estimated that this season saw a 12.4 percent decline in food production compared to the 2014/15 season, which was already down by about 30 percent (due to flooding in 2015) compared to the season of 2013/14 (Government of Malawi, 2016a; FAOSTAT). Combined, these two extreme weather events reinforced the country's motivation to assess the impacts of climate change on agriculture.

Malawi relies heavily on rainfed cultivation, not only for food security and employment, but also for increasing export earnings important for economic development. This means that the key climate stressors of heavier and less predictable rains, heat waves, extended dry periods and changes in growing/planting seasons are fundamentally undermining its economic performance (Government of Malawi, 2016b; Irish Aid, 2018). The resulting higher incidence of floods, droughts, pest and disease outbreaks are equally detrimental for human health and wellbeing.

# 4. Adaptation planning in the agricultural sectors in Malawi

## Policy landscape: At a glance

The Government of Malawi has committed to take action to face these challenges. Over the last two decades, Malawi has scaled up its efforts to identify vulnerabilities and related adaptation priorities, and to mainstream climate change into development and sectoral planning.

**Table 1. Key policy frameworks related to climate change and environment in Malawi**

| Year adopted/ launched | Policy | Period covered (if defined) | Main objectives |
|---|---|---|---|
| 2000 | Malawi Vision 2020 | 2000-2020 | Malawi's overarching long-term strategy that aspires for a technologically driven middle-income economy while providing an enabling framework for addressing climate change and other environmental challenges in a comprehensive manner. |
| 2004 | National Environmental Policy | Not defined | The 2004 National Environmental Policy (NEP)'s overall goal is the promotion of sustainable social and economic development through the sound management of the environment and natural resources. It represents an update of Malawi's first NEP of 1996. |
| 2004 | Malawi National Strategy for Sustainable Development | 10-15 year | The objective of the National Strategy for Sustainable Development is to provide the basis for Malawi's sustainable development framework to implement the World Summit on Sustainable Development recommendations. |
| 2006 | National Adaptation Programme of Action (NAPA) | Not defined | To date, the NAPA has been the main framework for addressing adaptation in Malawi. It addresses the urgent and short-term adaptation needs for the country. |
| 2013 | Malawi Climate Change Investment Plan | 2013-18 | The primary objective of the National Climate Change Investment Plan is to increase climate change investments in Malawi. Specifically, the Plan aims at developing capacity of the environment and climate change management sector; increasing the protection and conservation of the environment and natural resources and increasing the productivity of the environment and natural resources. |
| Launched in 2014 | NAP process | Process ongoing | Provides a medium to long-term option for Malawi to addressing adaptation needs in a long run. The NAP process will contribute to the government's commitment to prioritizing climate change adaptation in its long-term development strategies including the National Development Strategy. |
| 2015 | Nationally Appropriate Mitigation Actions (NAMA) | Not defined | The NAMA highlights actions to be undertaken voluntarily by the country to reduce greenhouse gas (GHG) emissions and/or enhance carbon sinks to absorb the GHG in the atmosphere. The Malawi NAMA covers five key sectors namely: agriculture, forestry, energy, transport and waste management. |


**Table 1.** *(continued)*

| Year adopted/ launched | Policy | Period covered (if defined) | Main objectives |
|---|---|---|---|
| 2015 | Nationally Determined Contribution | 2015-20 | Under adaptation, Malawi's NDC prioritized agriculture (crops, livestock, fisheries), water resources, health, infrastructure, land-use planning, transport, population and human settlements, disaster risk management, forestry; wildlife, energy and gender. The key sectors under mitigation include; energy, industrial processes and product use (IPPU), AFOLU, and waste. |
| 2016 | National Climate Change Management Policy | Not defined | Aims to create an enabling policy and legal framework for a pragmatic, coordinated and harmonized approach to climate change management. |
| 2017 | Malawi Growth and Development Strategy (MGDS) III | 2017-22 | Building on Vision 2020, MDGS I and II, to move Malawi to a productive, competitive and resilient nation through sustainable economic growth, energy, industrial and infrastructure development while addressing water, climate change and environmental management and population challenges. |
| 2018 | National Resilience Strategy | 2018-2030 | This strategy aims to break Malawi's dependence on humanitarian assistance and has the following pillars; Resilient agriculture growth; Risk Reduction, Flood Control and Early Warning and Response Systems; human Capacity, livelihoods and social protection and Catchment protection and Management. |
| Draft | Draft National Meteorological Policy | Process ongoing | According to the Civil Society Network on Climate Change (CISONECC), the delay in approving the policy is exacerbating the challenges and constraints that the meteorological sector is facing such as weak sector coordination in collection and use of data. |

In support of these policies, institutional arrangements in the form of National Steering and Technical Committees have been put in place to coordinate climate change related initiatives in the country (see Figure 1 below).

**The NAP process in Malawi**

As shown in Table 1 above, adaptation planning in Malawi has been ongoing for some time, through a range of planning instruments. Given the country's strong dependence on agricultural livelihoods, there has been a strong emphasis on the agricultural sectors throughout these efforts. As defined by Malawi's first NDC in 2015, "the biggest adaptation challenge is Malawi's heavy reliance on rainfed agriculture". At the same time, **the 2016 National Agriculture Policy of Malawi** identifies climate change as a cross-cutting issue, and aims to enhance "sustainable management of agricultural resources, increased agricultural exports and incomes, food security, and improved nutrition in the face of growing population pressure, urbanization, increasing global economic interdependence, and climate change".


Given the significant number of ongoing policy initiatives on adaptation, and specifically adaptation in agriculture, in Malawi, bringing these efforts together under the overall umbrella of a NAP process was felt to be an important way to coordinate between complementary activities and to ensure that the mid- to longer-term planning perspective was duly taken into account (see Box 1 for a description of the NAPs rationale at international level, as established under the United Nations Framework Convention on Climate Change (UNFCCC)).

Malawi therefore embarked on its NAP process in 2014, with support from the LDCF-funded UNDP-UNEP National Adaptation Plan Global Support Programme (NAP-GSP), a number of national stakeholder consultations and NAP trainings have taken place to date. In 2016, Malawi's **NAP stocktaking report** was completed, identifying key steps for the NAP formulation process ahead and highlighting both strengths to be built on and gaps to be filled in Malawi's NAP process. This process is ongoing to this, and Malawi, in partnership with UN Environment, has a NAP readiness in the Green Climate Fund pipeline to scale up NAP activities over a three-year (see Figure 2) period.

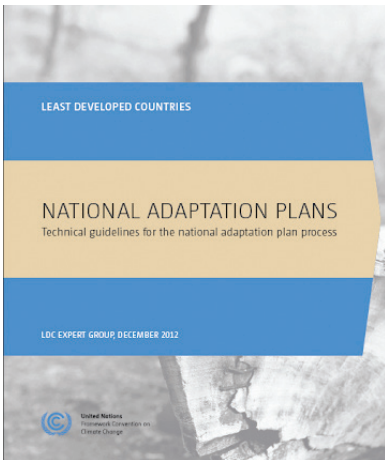
**Box 1**
**NAP background**

**National Adaptation Plans (NAPs)**

NAPs were established in 2010, as part of the Cancun Adaptation Framework to enhance urgent action on adaptation, and were adopted by Parties to the UNFCCC (Decision 1/CP.16.). NAPs enable countries to identify, prioritize and implement the most needed medium - and long-term adaptation actions. They aim to :

- reduce vulnerability to climate change by building adaptive capacity and resilience; and
- ensure that climate change adaptation is integrated into development planning in all sectors and at all levels of planning within the country.

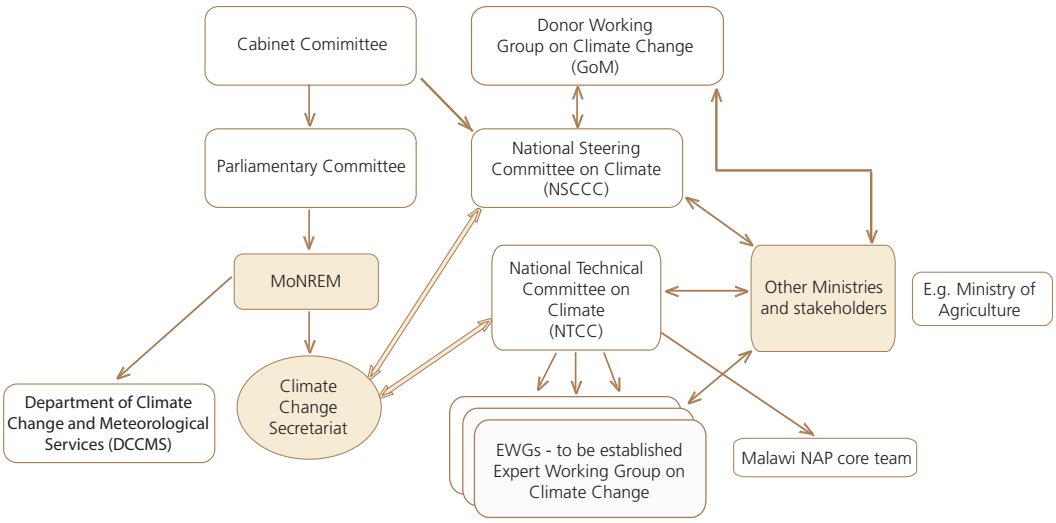
*Source:* UNFCCC, 2012.




**Institutional arrangements**

Under the National Climate Change Programme, two coordinating committees were established in Malawi: the National Climate change Technical Committee (NCCTC) and the Project Steering Committee (PSC) which provides oversight on climate change activity (See Figure 2) implementation. The NCCTC provides a platform for the implementation of national, regional, and global partnerships on climate change. The PSC provides a forum for effective policy dialogue on frameworks, priority setting, and ways and means of facilitating investment and transfer of technology on climate change initiatives in the country.


**Figure 2. Malawi institutional coordination framework for climate change**




Adapted from: National Climate Change Management Policy, Government of Malawi, 2016a.

## Support from FAO

**Box 2**
**The Integrating Agriculture into National Adaptation Plans (NAP-Ag) programme**

FAO's early NAP support in Malawi provided valuable lessons learned and an evidence base for further agriculture related NAP support, and contributed to the creation of the 11 country, USD 17 million NAP-Ag programme, which is co-led by FAO and UNDP. NAP-Ag is funded by the IKI of the BMU.

FAO began supporting the integration of the agricultural sectors into the Malawi NAP process[1] in 2015, through the FMM project "National Adaptation Plans - Climate Smart Agriculture". FAO is an active member of Malawi's NAP Core Team - the formal coordinating mechanism at national level driving this process and reporting to the National Climate Change Technical Committee (NCCTP) - and has conducted trainings of Ministry experts in the use of FAO's MOSAICC, as well as facilitated the participation of agricultural sector representatives in decision-making processes usually exclusive to environment sector actors.

According to the recommendations of the UNFCCC Least Developed Countries Expert Group, taking stock of information and data are key components for laying the groundwork and addressing data gaps (Element A), but also for ensuring that implementation of adaptation

[1] Under the "Malawi: National Adaptation Plans – Climate Smart Agriculture" project (2015-17), funded by Belgium through the FMM.

actions is enhanced by adequate coordination and capacity development for using and analyzing climate data. Following these recommendations, the MOSAICC was identified as a suitable capacity development tool for implementation in Malawi. Key areas for FAO support in Malawi included:

1. identifying capacity and data gaps ;
2. developing the capacity of national institutions to collect and analyse climate data, and ;
3. engaging relevant stakeholders for incorporation of the evidence base in planning. To initiate this process, national stakeholders were engaged to design the study and identify national data availability in Malawi.

These activities also represent first key steps towards addressing priority interventions already identified in the 2006 NAPA, such as increasing resilience of food production systems to erratic rains and improving climate monitoring to enhance Malawi's early warning capability and decision-making. Similarly, Malawi's NAP Stocktaking Report identifies information capabilities (especially at sectoral level) as key gaps and barriers for successful adaptation planning.

# 5. Implementation: How was MOSAICC rolled out in Malawi?

**Step 1:** Engagement of stakeholders and assessment of national interest.

Through bilateral meetings and an inception workshop with key stakeholders (see **Box 3**), the interests of national experts and status of the national capacity were evaluated. The participants included representatives from the Ministries as well as national and local research institutes, covering those involved in policy-making, extension and research. In this context, the study design was discussed and decided, and the technical working group for the assessments was established. At this stage, a preliminary work plan was developed and plans introduced to consult a larger audience for the validation of the results.

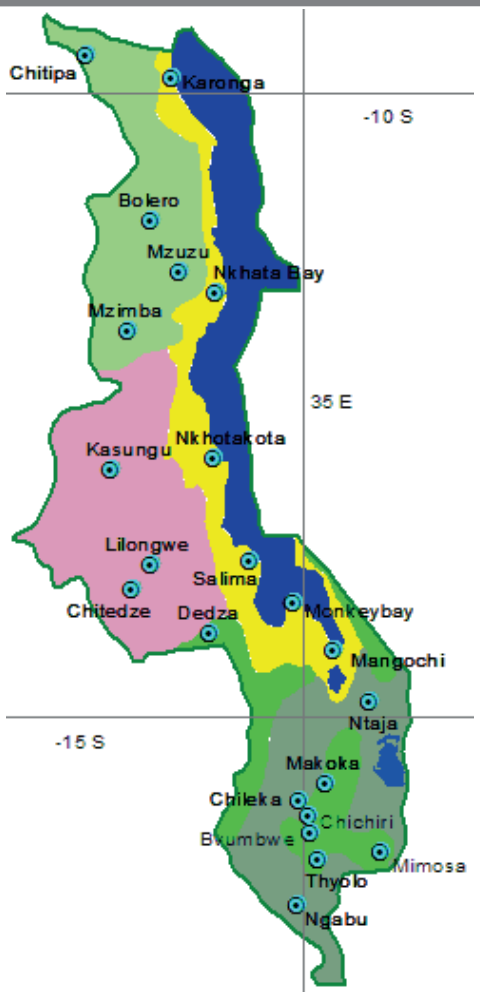
**Box 3**
**National stakeholders engagement in MOSAICC implementation**

Key national stakeholders, generally technical experts in climate and each impact area, were engaged at every stage in the MOSAICC process to ensure that the outputs exemplify national priorities and utilize local knowledge and expertise. By bringing together national experts from across institutions during the project development stage, participants in the process can prioritize activities taking diverse perspectives and objectives into consideration. In addition, national stakeholder engagement ensures long-term sustainability and capacity development. Upon completion of the initial MOSAICC process, local experts are left with the capacity to repeat the exercises if new information (i.e. emission scenarios or updated data) becomes available. In Malawi, the key national experts involved in the MOSAICC process were from the Lilongwe University of Agriculture and Natural Resources; the Department of Climate Change and Meteorological Services; and the Departments of Agriculture Research Services, Agriculture Planning and Irrigation of the Ministry of Agriculture.

**Step 2:** Identifying data availability and gaps in country data.

With the working groups in place, the process began with the collection of country data (meteorological, crop yield data, etc.), a process that also acts as a **stocktaking exercise to identify potential data gaps within the country.** Based on the data available in the country, the MOSAICC methodology can be slightly adapted. In Malawi, climate data (maximum temperature, minimum temperature, and precipitation) was collected from all available weather stations in the country for the years 1961-2015 (varying slightly depending on station).


**Figure 3. Meteorological station network in Malawi consisting of 22 full meteorological stations, 21 subsidiary agrometeorological stations and over 400 rainfall station (Malawi Meteorological Service, 2018)**




*Source:* Conforms to UN Malawi map, date 2012.

This exercise identified 1. chronological gaps in data records of climate (**Table 2** yellow cells) and 2. geographical gaps in station data for temperature (**Table 2** red cells).


**Table 2. Shows that name and ID of meteorological stations in Malawi and geospatial location (longitude and latitude). The columns shows the number of years that data is available for precipitation, minimum temperature and maximum temperature at each station. Cells highlighted in red, show stations that lack temperature data. Cells highlighted in yellow show stations that have a limited period of data. The termination of the record is likely due to lack of maintenance or lack of monitoring of the station from the end data recorded**

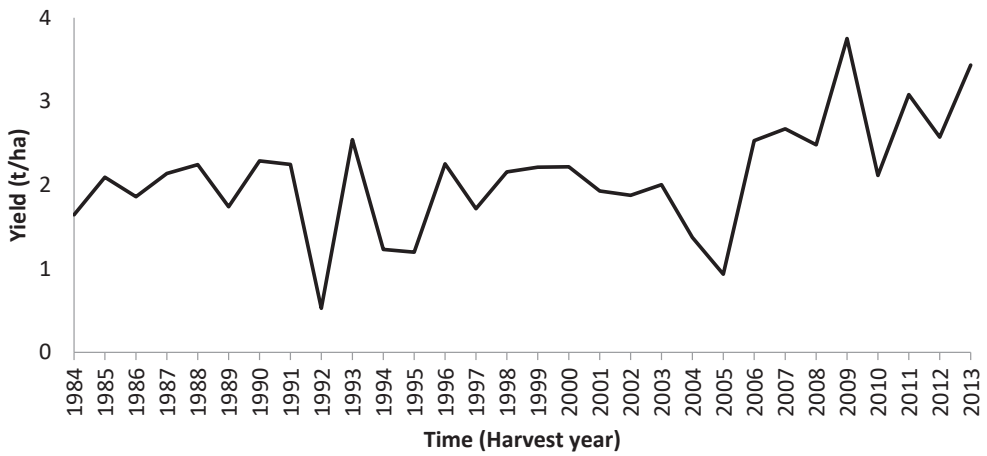
| ID | Station | Latitude | Longitude | Precipitation | Min Temperature | Max Temperature |
|---|---|---|---|---|---|---|
| 1 | Chitipa | -9.7 | 33.27 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 2 | Karonga | -9.88 | 33.95 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 3 | Bolero | -11.02 | 33.78 | 1962 - 2015 | 1982 - 2015 | 1982 - 2015 |
| 4 | Zombwe | -11.33 | 33.82 | 1961 - 1990 | | |
| 5 | Mzuzu | -11.43 | 34.02 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 6 | Nkhata Bay | -11.6 | 34.3 | 1961 - 2015 | 1961 - 2004 | 1961 - 2004 |
| 7 | Mzimba | -11.9 | 33.6 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 8 | Dwangwa | -12.48 | 34.08 | 1972 - 2010 | | |
| 9 | Nkhota Kota | -12.92 | 34.28 | 1961 - 2015 | 1961 - 2015 | 1961 - 2006 |
| 10 | Kasungu | -13.02 | 33.47 | 1961 - 2015 | 1983 - 2005 | 1983 - 2004 |
| 11 | Mponela | -13.533 | 33.75 | 1961 - 2008 | | |
| 12 | Chitala | -13.68 | 34.25 | 1961 - 2012 | | |
| 13 | Salima | -13.75 | 34.58 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 14 | KIA | -13.78 | 33.78 | 1982 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 15 | Mchinji | -13.82 | 32.87 | 1961 - 2015 | | |
| 16 | Tembwe | -13.92 | 33.07 | 1966 - 2015 | | |
| 17 | Chitedze | -13.97 | 33.63 | 1961 - 2015 | 1961 - 2005 | 1961 - 2005 |
| 18 | Monkey Bay | -14.08 | 34.92 | 1979 - 2015 | 1979 - 2005 | 1979 - 2005 |
| 19 | Bunda College | -14.15 | 33.78 | 1967 - 2013 | | |
| 20 | Dedza | -14.32 | 34.25 | 1961 - 2015 | | 1961 - 2015 |
| 21 | Mangochi | -14.47 | 35.25 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 22 | Ntcheu-Nkhande | -14.78 | 34.58 | 1961 - 2010 | | |
| 23 | Balaka | -14.98 | 34.97 | 1976 - 2015 | | |
| 24 | Phalula | -15.27 | 34.95 | 1970 - 2015 | | |
| 25 | Chingale | -15.37 | 35.25 | 1961 - 2014 | | |
| 26 | Chancellor College | -15.38 | 35.35 | 1975 - 2013 | | |
| 27 | Neno | -15.4 | 34.65 | 1961 - 2015 | | |
| 28 | Makoka | -15.53 | 35.18 | 1964 - 2015 | 1968 - 2005 | 1968 - 2005 |
| 29 | Mwanza | -15.62 | 34.52 | 1965 - 2015 | | |
| 30 | Chileka | -15.67 | 34.97 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |

**Table 2.** *(continued)*

| ID | Station | Latitude | Longitude | Precipitation | Min Temperature | Max Temperature |
|---|---|---|---|---|---|---|
| 31 | Chichiri | -15.78 | 35.05 | 1965 - 2015 | | 1971 - 2015 |
| 32 | Bvumbwe | -15.92 | 35.07 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 33 | Chikwawa | -16.03 | 34.78 | 1961 - 2015 | | |
| 34 | Lujeri | -16.033 | 35.65 | 1961 - 1989 | | |
| 35 | Satemwa | -16.05 | 35.1 | 1969 - 2007 | | |
| 36 | Mimosa | -16.07 | 35.62 | 1961 - 2015 | 1961 - 2015 | 1961 - 2015 |
| 37 | Thyolo | -16.13 | 35.13 | 1961 - 2015 | 1962 - 2004 | 1962 - 2004 |
| 38 | Nchalo | -16.23 | 34.93 | 1971 - 2015 | | |
| 39 | Ngabu | -16.5 | 34.95 | 1961 - 2015 | 1971 - 2015 | 1971 - 2015 |
| 40 | Makhanga | -16.52 | 35.15 | 1961 - 2014 | | |
| 41 | Nsanje | -16.95 | 35.27 | 1973 - 2015 | | |

For the crop component of MOSAICC, data was collected in a similar way, targeting the official historical crop yield statistics nationally and by province. Using local knowledge, the key crops for each province were selected by national experts. In the case of Malawi, yield and phenology data were collected for **maize, rice, sorghum, soya, common beans and groundnuts.**

**Figure 4. Historical maize yield data from 1984 to 2016 (Malawi Ministry of Agriculture, 2018)**




Some of the issues encountered at this stage, identified by national experts, include differences **in data format** of country-level data which requires capacity and time to harmonise for use in any data processing activity. In Malawi, the team identified a **lack of systematic recording of planting dates** as a limitation for the crop modelling. It was also noted that different departments within the same Ministry of Agriculture use **different descriptions of adequate rainfall** when advising farmers when to plant. Overall, this exercise identified the most useful datasets in the country as well as key limitations to be addressed in future exercises.


**Step 3:** Training: Strengthening national technical capacity.

Capacity building is a core component of MOSAICC and ensures that lessons learnt in establishing a system for climate impact assessment are sustainable. Through training and peer-to-peer learnings, national experts in IT, climate and crop modelling (detailed below) are able to **continue analysis in the future as new information becomes available or the country interests and objectives change**. The FAO MOSAICC team supports the installation of a physical server to the country on which to run the models. MOSAICC trainings on each module of MOSAICC are carried out by FAO experts. In Malawi, the trainings carried out were IT, climate downscaling and crop, as described in detail below. The trainings targeted direct involvement of focal point persons identified in the inception workshop.

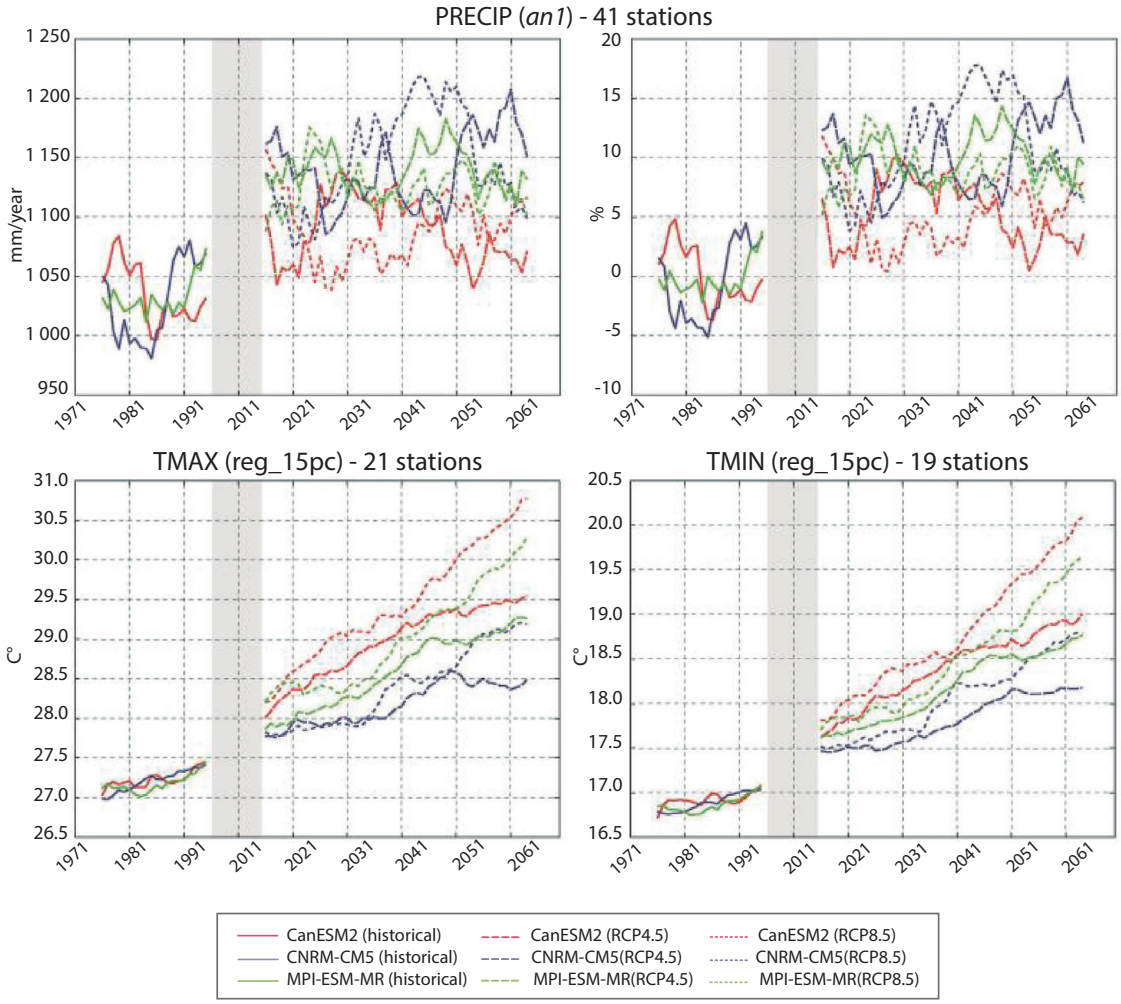
**Training 1:** IT training.

In order to support the MOSAICC interface and data management, IT experts in Malawi were trained on the configuration and codes used to run the models. The MOSAICC IT training included the installation of a physical server and training on the IT requirements for development and implementation of the other MOSAICC components. The objective is for the national IT experts to understand the architecture of the MOSAICC system and the overall objectives of the process. Participants were trained on maintenance of the server to continue the work in the country and troubleshoot throughout the process.

**Training 2:** Climate component: downscaling.

The climate component of MOSAICC trained climate experts from universities and the (DCCMS) Department of Climate Change and Meteorological Services. The first step of the training provided an overview of the handling and analysis of historical climate data and trends collected for meteorological stations (as highlighted above). With this data, participants were trained to carry out statistical downscaling of climate data. This process entails using the outputs of General Circulation Models (GCMs) and downscaling these outputs to weather station level. The final outputs of this component are future climate projections at local or province level. Figure 5 shows the preliminary results of projected climate for Ngabu station to 2100. The final stages of the training focus on quality check and analysis of the results. After training and testing of each stage of the climate downscaling process, participants prepared a work plan to complete the analysis with additional datasets and climate models.

**Figure 5. Future projection of precipitation, maximum temperatures and minimum temperatures for 41 stations across Malawi (DCCMS, 2017 preliminary results)**



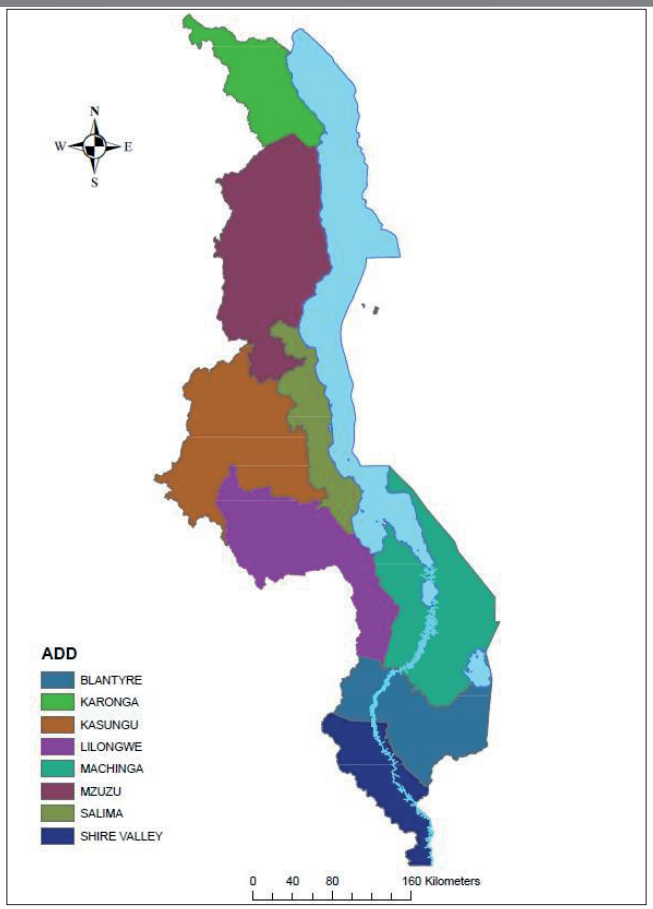

## **Training 3:** Crop component: yield projection.

The crop component of MOSAICC aims to assess the impacts of projected climate change (outputs from the climate component) on crop yield projections for the priority crops chosen by the country experts. In the case of Malawi, priority crops chosen were **maize, rice, soya, common beans and groundnuts.** The crop trainings introduced participants to one method of modeling future crop yields based on water balance parameters. The first stage of the training explained the analysis of historical crop yields from country data (discussed in previous section). Subsequently, participants were trained to input crop specific coefficients, growing season, and climate information into the crop-modelling component. During the training period, participants went through the entire crop modelling process with one example crop together with trainers. The final stage involved drafting a work plan to complete the analysis for all remaining crops.

**Step 4:** Validation of results and completion of technical reports and policy briefs.

The final outputs of MOSAICC in Malawi were medium to long-term climate projections downscaled to local (weather station) level and projected crop yields, up to year 2070, for 6 major crops across 8 Agricultural Development Divisions (ADD) (Figure 6). **The responsibility, management and ownership of the data, tools and results remain in the country.** The final results were presented to a wide range of stakeholders in a follow-up workshop held in Lilongwe. The working groups submitted technical reports and are currently drafting policy briefs summarizing the final results of the MOSAICC process.

**Figure 6. Agricultural Development Divisions (ADDs) in Malawi. An ADD is a physical area with diversified crop production and sustainable crop production and productivity. Malawi has been divided into 8 ADDs identified by the Malawi Ministry of Agriculture, Irrigation and Water Development**




*Source:* Conforms to UN Malawi map, date 2012.

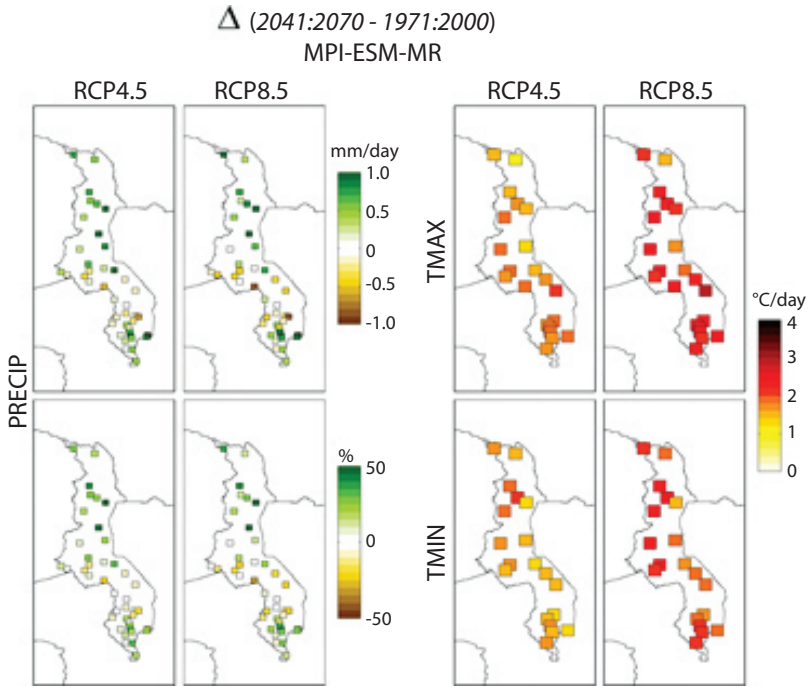

## Box 4
## Main outputs for MOSAICC in Malawi

The main outputs of the MOSAICC process in Malawi include:

- medium (2010-2040) to long-term (2041-2070) projections of **temperature and precipitation** downscaled to station level and interpolated to 8 ADDs;
- analysis of agro-climatic indices using climate outputs and agricultural parameters;
- medium (2010-2040) to long-term (2041-2070) **crop yield projections** based on climate projections across the 8 ADDs;
- final technical reports and policy briefs visualizing and summarizing final outputs (in progress).

Note: Crops modelled: **Maize, rice, soya, common beans, sorghum and groundnuts.**

**Figure 7. Changes projected for the period 2041-2070 compared to 1971-2000, as obtained from one illustrative ESM (MPI-ESM-MR) under the two RCPs (DCCMS, 2017 preliminary results)**



# 6. Integration of MOSAICC into the planning process

Two national working groups were created under the framework of the NAP process in Malawi. The first is the core technical working group consisting of experts from the relevant ministries and researchers from the universities outlined above, tasked with the implementation of MOSAICC. The second working group is the larger group identified to apply the results, including those involved in policy making from wider ministries. Throughout the process, the second group served as the consulting and validating body for the outputs of work. In the validation workshop, the MOSAICC results to date were presented to the larger working group and feedback was provided. By involving the technical experts as well as senior policy makers, the mainstreaming as well as the sustainability of the MOSAICC are reinforced throughout the entire process. The aim of the working groups is to maintain the communication and promote the technical outputs of the process in future planning and policy making at all levels.

## Key lessons learned

### 1. Identifying inconsistencies and gaps in country data

- Differences **in data format** of country-level data require capacity and time to harmonise for use in any data processing activity.
- **Lack of systematic recording of planting dates and the information for the irrigation usage** in Malawi as a limitation for the crop modelling.
- Different departments within the same Ministry of Agriculture use **different descriptions of adequate rainfall** when advising farmers when to plant.
- Physical server based in country allows for use of MOSAICC without strong internet connection as well as security of sensitive data, however in the case of Malawi, **problems with maintenance of the physical server** resulted in delays and difficulty to use the system.

### 2. Motivation of participants

- Participants referred to the **lack of human resources** within the ministries as a limiting factor in maintaining momentum to complete the MOSAICC process.
- Motivation and engagement of **the focal point to push the process forward** is necessary to coordinate the various components and link the key participants.
- National experts performing the analysis should ideally have a **professional interest** in the MOSAICC methods and outputs, i.e. publications, research, relevant to current work streams. The MOSAICC process should also highlight other methodologies used in these areas for possible future development.
- **MOSAICC should be well integrated into planning process** and roadmap to ensure that the outputs are directly utilized. Technical working groups should include experts in climate, agronomy as well as relevant policy makers.

## 3. Sustainability – is the capacity built?

- Examples of countries displaying MOSAICC results online and **utilizing the results for future research or climate-related objectives:**
  - Morocco created an online portal that is used by researchers and governments: www.changementclimatique.ma/?q=en/node/19.
  - In Peru, the National Drought Observatory used the outputs of MOSAICC in an online portal: http://ons.snirh.gob.pe/Peru/maproom/Forecasts/index.html#tabs-2.
- **Maintenance of the MOSIACC server is required** to allow experts access it and run the analysis again after the process is complete.
- **Follow-up** of the country capacity and continuation of modelling exercises should be monitored in Malawi.

# 7. Conclusion and recommendations

The main objective of the MOSAICC process is to build the national capacity of ministries and research institutions to handle climate data, produce medium to long-term climate projections and assess local impacts on key crops for adaptation planning. The outputs of the process in Malawi, highlighted in this case study, were presented to relevant stakeholders and policy makers with the objective to incorporate a strong evidence base in policymaking. As identified by the NAP stocktaking report, capacity constraints and/or lack of suitable climate information at ministry level may lead to decisions with only limited backing of data, making it more difficult to monitor the impact of the policies concerned. The activities described in this case study were undertaken to help address this issue. It is recommended that the outputs from this exercise, as well as other climate impact assessment initiatives and future work by national experts, should be integrated into the national planning process on an iterative basis. This emphasis on an enhanced agriculture sector climate information system will supports Malawi's achievement of its adaptation priorities, as identified in its NDC as well as related Sustainable Development Goals (especially SDGs 1, 2 and 13).

After the final workshop, the technical teams received comments and suggestions from the working group, which has now finalized a workplan and is currently completing the analyses for the final report. The final results will identify key crops in each ADD that will be negatively impacted by the projected changes in climate variables. The results outlined throughout this case study and outputs of the MOSAICC process should feed the evidence-base for selecting adaptation options throughout the NAP process. The technical working groups formed during the MOSAICC process should be continuously consulted throughout the NAP process and results can be modified according to new information or requests.

With this in mind, Malawi's experiences point to the following recommendations that support improved prioritization of adaptation actions and strengthened planning and budgeting for adaptation:

- National adaptation planning in the agriculture sector must be a **country-driven process,** to ensure local ownership and synergy with complementary policy initiatives within the country.
- **Identification of an effective focal point** to coordinate the expert teams is an essential part of ensuring momentum to complete the MOSAICC process.
- MOSAICC should be **well integrated into Malawi's planning process and NAP roadmap** to ensure that the outputs are directly utilized and to **create the link between technical experts and policy makers.**
- The results and capacities enhanced by the activities undertaking should be monitored in the months and years following the intervention, to **ensure sustainability** of the work.
- **Targeted documentation** should be produced in order to facilitate the continuation of the activities at different times with different national staff (procedures, databases, etc.).

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