COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.

December 2023

Malawi DCCMS Peer Review Report

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UNDP

SOFF Systematic Observations Financing Facility — Weather and climate data for resilience

WORLD METEOROLOGICAL ORGANIZATION

Alliance for Hydromet Development

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Authorisation for release of this report has been received from the Peer Reviewing Agency and the Country NMHS as of December 2023.

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Acknowledgements

The peer advisor team extends heartfelt appreciation to Dr. Lucy Mtilatila and her staff at the Department of Climate Change and Meteorological Services (DCCMS) in Malawi for their outstanding hospitality and cooperation during the entire Country Hydromet Diagnostics process. A special acknowledgment is reserved for Mr. Amos Mtonya, whose comprehensive insights into DCCMS and its projects, coupled with his positive attitude, greatly contributed to the success of the collaboration.

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List of acronyms and abbreviations

ARPEGE	Action de Recherche Petite Echelle Grande Echelle
AWS	Automatic weather stations
ACMAD	African Centre for Meteorological Applications for Development
AFTN	Aeronautical Fixed Telecommunication Network
AMO	Aerodrome Meteorological Offices
AMS	African Meteorological Society
CAP	Common Alerting Protocol
CBA	Cost-benefit analysis
CHD	Country Hydromet Diagnostics
CISONECC	Civil Society Network on Climate Change
COSMO	Consortium for Small Scale Modelling
CWIS	Climate and weather Information System for Farmers and Fishers
DCA	Department of Civil Aviation
DCCMS	Department of Climate Change and Meteorological Services
DoDMA	Department of Disaster Management Affairs
DoF	Department of Fisheries
DPRA	Disaster Preparedness and Relief Act
DRM	Disaster Risk Management
DWR	Department of Water Resources
EAD	Environmental Affairs Department
ECMWF	European Centre for Medium-Range Weather Forecasts
EGENCO	Electricity Generation Company Limited
ENACTS	Enhancing National Climate Services
EW4All	Early Warning for All
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organisation
FFGS	Flash-flood Guidance System
FRT	Farm Radio Trust
GBON	Global Basic Observing Network
GCF	Green Climate Fund
GFS	Global Forecast System
GHG	Greenhouse Gases
GTS	Global Telecommunication System
HRC	Hydrologic Research Center
IBF	Impact Based Forecasts
ICAO	International Civil Aviation Organization
ICON	Icosahedral Non-hydrostatic Weather and Climate Model
ICPAC	IGAD Climate Prediction and Applications Centre
ICT	Information and Communication Technology
IMO	Icelandic Meteorological Office
IRI	International Research Institute for Climate and Society
IT	Information Technology
LUANAR	Lilongwe University of Agriculture and Natural Resources
M-CLIMES	Modernized Climate Information and Early Warning Systems
MadiPhs	Malawi Digital Plant Health Service
MDP	Meteorology Data Policy
MET Norway	Norwegian Meteorological Institute
MGDS	Malawi Growth and Development Strategy
MGDS II	Malawi Growth and Development Strategy II
MHEWS	Multihazard Early Warning System
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoH	Ministry of Health
MoJ	Ministry of Justice
MoU	Memorandum of Understanding
MoNRCC	Ministry of Natural Resources and Climate Change
MoTPW	Ministry of Transport and Public Works
MRDRMP	Malawi Resilience and Disaster Risk Management Project
MUST	Malawi University of Science and Technology
N-WIP	National WIGOS Implementation Plan
NCCMP	National Climate Change Management Policy
NDRM-C	National Disaster Risk Management Committee
NDRMP	National Disaster Risk Management Policy
NDRM-TC	National Disaster Risk Management Technical Committee

NDRM-TSC	National Disaster Risk Management Technical Sub-Committees
NETP	National Emergency Telecommunications Plan
NFCS	National Framework for Climate Services
NGO	Non-Governmental Organization
NHS	National Hydrological Services
NMHS	National Meteorological and Hydrological Service
NMP	National Meteorological Policy
NMS	National Meteorological Services
NOAA	National Oceanic and Atmospheric Administration
NORAD	Norwegian Agency for Development cooperation
NORCAP	Norwegian Capacity, operated by Norwegian Refugee Council
NWP	Numerical Weather Prediction
NWRA	National Water Resources Authority
ODSS	Operation Decision Support System
OSCAR	Observing Systems Capability Analysis and Review tool
ORT	Other Recurrent Transactions
PISCA	Participatory Integrated Climate Services for Agriculture
PUMA	Preparation for the Use of Meteosat Second Generation in Africa
PWS	Public Weather Service
QMS	Quality Management System
RCOF	Regional Climate Outlook Forum
RSMC	Regional Specialized Meteorological Centre
RWC	Regional WIGOS Centre
SAREPTA	Institutional Support and Capacity Building for Weather and Climate Services
SADC	Southern Africa Development Community
SADIS	Secure Aviation Data Information Service
SARCOF	Southern Africa Regional Climate Outlook Forum
SARFFGS	Southern Africa Flash Flood Guidance System
SFFGS	Southern Africa Flash-Flood Guidance System
SOFF	Systematic Observations Financing Facility
SOP	Standard Operating Practices
SWFP	Severe Weather Forecasting Programme Southern Africa
SWIOCOF	South-West Indian Ocean Climate Outlook Forum
TAHMO	Trans-African Hydro-Meteorological Observatory
TNM	Airtel Malawi and Telecom Network Malawi
TSC	Technical Sub Committee
UKMO	UK Met Office
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
USD	United States Dollar
WB	World Bank
WDQMS	WIGOS Data Quality Monitoring System
WFP	United World Food Programme
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting model

Executive Summary

In this Country Hydromet Diagnostics report the peer-reviewers have evaluated the ten elements suggested by the CHD methodology and provided a maturity level score for each of them.

The assessment was performed via extensive literature study and many meetings, both in-person and on-line, with staff members of the Department of Climate Change and Meteorological Services in Malawi and main stakeholders and users of their services, as well as with extensive email and on-line correspondence. This process has allowed the peer-reviewers to get a good overview of the institutional capacity of DCCMS and its governance setting, as well as the main challenges the department faces in providing the numerous services in its mandate. Moreover, it has also provided enough insight to see opportunities provided information to make specific recommendations.

DCCMS is a pivotal player in meteorological services, climate management, and disaster risk mitigation in Malawi. Its data, warnings, and forecasts are crucial for various sectors, supporting both short and long-term planning, and decision making. The institute holds significant importance in implementing EW4All in Malawi. The maturity scores, mostly at 3 with two exceptions at 2, indicate a progressively developing institution committed to contributing to the establishment of a climate and disaster risk-resilient society.

Element	Maturity level score
1. Governance and institutional setting	2
2. Effective partnerships to improve service delivery	3
3. Observational infrastructure	3
4. Data and product sharing and policies	2
5. Numerical weather prediction model and forecasting tool application	3
6. Warning and advisory services	3
7. Contribution to climate services	3
8. Contribution to hydrology	3
9. Product dissemination and outreach	3
10. Use and national value of products and services	3

The maturity level of several elements can be elevated with relatively little effort. Progress has been made in simplifying and coordinating governance structures in meteorology, climate, and disaster risk management in recent years. Despite these achievements, unresolved issues persist in the governance structure, hindering a clear and comprehensive mandate for key players in the system.

Financial challenges are impeding DCCMS from effectively fulfilling its diverse roles at the national, regional, and international levels. Insufficient funds hinder human capacity building, infrastructure installation and maintenance, and the implementation of crucial sustainable projects and services. Urgent resolution of these financial constraints is imperative.

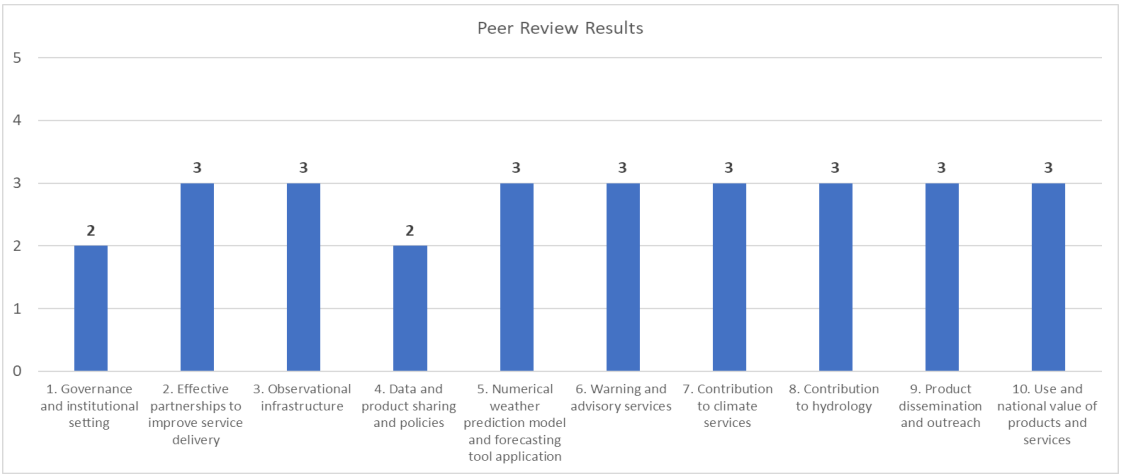
The observational network and data handling and sharing components currently lack essential elements for successful and sustainable operation. The absence of service agreements and comprehensive documentation for standard operating procedures in network maintenance and quality control is noted. The incorporation of modern and stable ICT solutions is recommended as it would greatly benefit DCCMS across the entire hydromet value chain, from monitoring to the dissemination of forecasts and warnings.

DCCMS has established various early warning services in recent years, mainly with donor financing. To ensure their continuity and improvement, it is essential to build upon them by aligning with new international programs and contemporary procedures such as CAP and Impact Based Forecasts.

Improving stakeholder and user management at DCCMS is crucial for enhancing operations and yielding multiple benefits. A more systematic approach to engagement could result in co-designed and co-financed user-tailored products, along with sector-specific services. This expanded range of provisions would not only cater to a broader population but also include marginalised communities.

Efforts should be maximised to ensure the dissemination of information, warnings, and forecasts to the entire society, spanning from governmental stakeholders to end users in rural and urban areas. This inclusive communication is vital for informed decision-making, whether it pertains to daily activities like fishing, agricultural planning for the next season, or emergency evacuations.

In summary, eight out of the ten critical elements assessed in this peer-review currently stand at an intermediate level of maturity. Successful implementation of ongoing projects and these recommendations are anticipated to elevate the remaining elements to an intermediate level and propel the DCCMS to reach maturity level 4 for most elements in the near future. Crucially, this progress is anticipated to enhance DCCMS's capacity to deliver accurate, timely, and beneficial meteorological and climate services to diverse sectors, fostering improved resilience and preparedness for climate-related challenges in Malawi.



Chapter 1: General information

Introduction to SOFF

This Country Hydromet Diagnostics (CHD) report is a part of the formal Systematic Observations Financing Facility (SOFF) project in Malawi in which the Department of Climate Change and Meteorological Services (DCCMS) is the beneficiary, Norwegian Meteorological Institute (MET Norway) and the Icelandic Meteorological Office (IMO) represent the peer-advisors, and United Nations Development Program (UNDP) is the implementing entity. The report supplements the Global Basic Observing Network (GBON) National Gap Analysis report and the GBON National Contribution Plan for Malawi, also part of the SOFF project.

In this report, the peer-advisors evaluated 10 elements (A to J on Figure 1) critical to the hydromet value chain in Malawi using various means, including three in-person consultation sessions, questionnaire, WMO guidance material and survey data as well as various published documents and website material. Moreover, biweekly online meetings were held during the peer-review process (Annex 1).

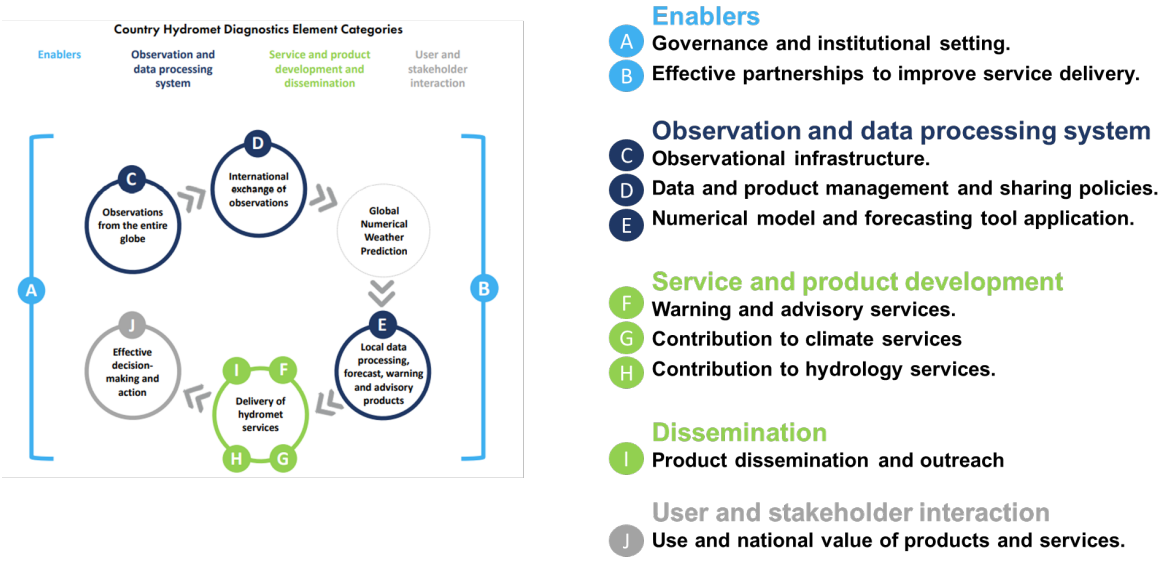


Figure 1. Main elements of the hydromet value chain (A-J) that are evaluated in this Country Hydromet Diagnostics (CHD) report.

Geographical and climate setting of Malawi

Malawi is a landlocked country in south-eastern Africa with a total area of 118,484 km^2 and with an estimated population of 21 million (Worldometers, 2023). More than 29% of the country is covered with water, of which Lake Malawi, the third largest lake in Africa, is by far the largest (29,600 km^2)(Fig. 2). The lake lies in the Great Rift Valley which traverses Malawi from north to south. The topography of Malawi is highly shaped by the Rift Valley, with high plateaus and mountains west and north of the valley. South of Lake Malawi, the country is dominated by the Shire Highlands and mountain ranges, where the highest peak Sapitwa reaches an elevation of 3002 m a.s.l. In contrast, the southernmost part of Malawi lies at much lower elevation, or below 50 m a.s.l. from where the Shire River flows into Mozambique where it merges the Zambezi river (based on Wikipedia contributors, 2023, September 13).

The climate in Malawi is generally sub-tropical, which is relatively dry and strongly seasonal. The annual precipitation varies between 725 and 2,500 mm with about 95% of the precipitation falling during the warm-wet season from November to April. May to August are cooler and dryer with mean temperatures varying from 17 to 27°C and low temperatures from 4 to 10°C, including occasional frost in isolated areas in June and July. A hot and dry season is usually evident in September and October when average temperature ranges between 25 and 37°C (DCCMS, 2023). The substantial elevation difference within the country creates spatial differences in climate where higher regions experience on average cooler climate than lower regions. Precipitation is highest in the northern highlands of the country and in the Mulanje Massif in the south (RCRC, 2021) (Figure 3).

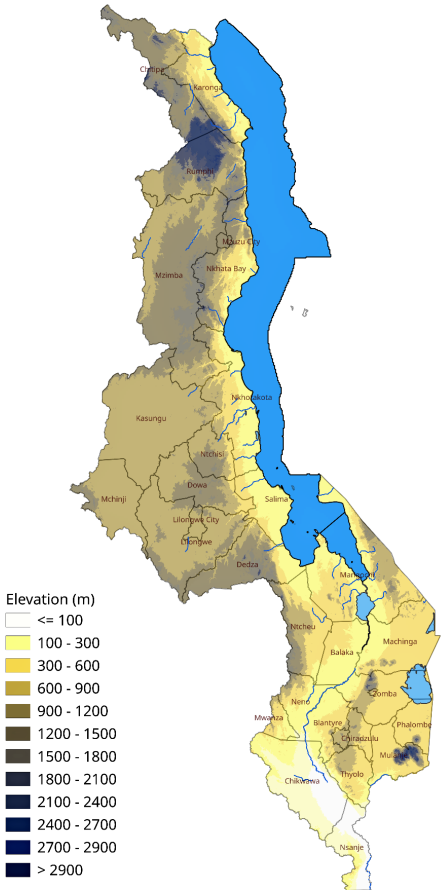


Figure 2. Main topographical features of Malawi with location of main roads and towns (Source DCCMS, modified from [RCMRD open data site](), 2023).

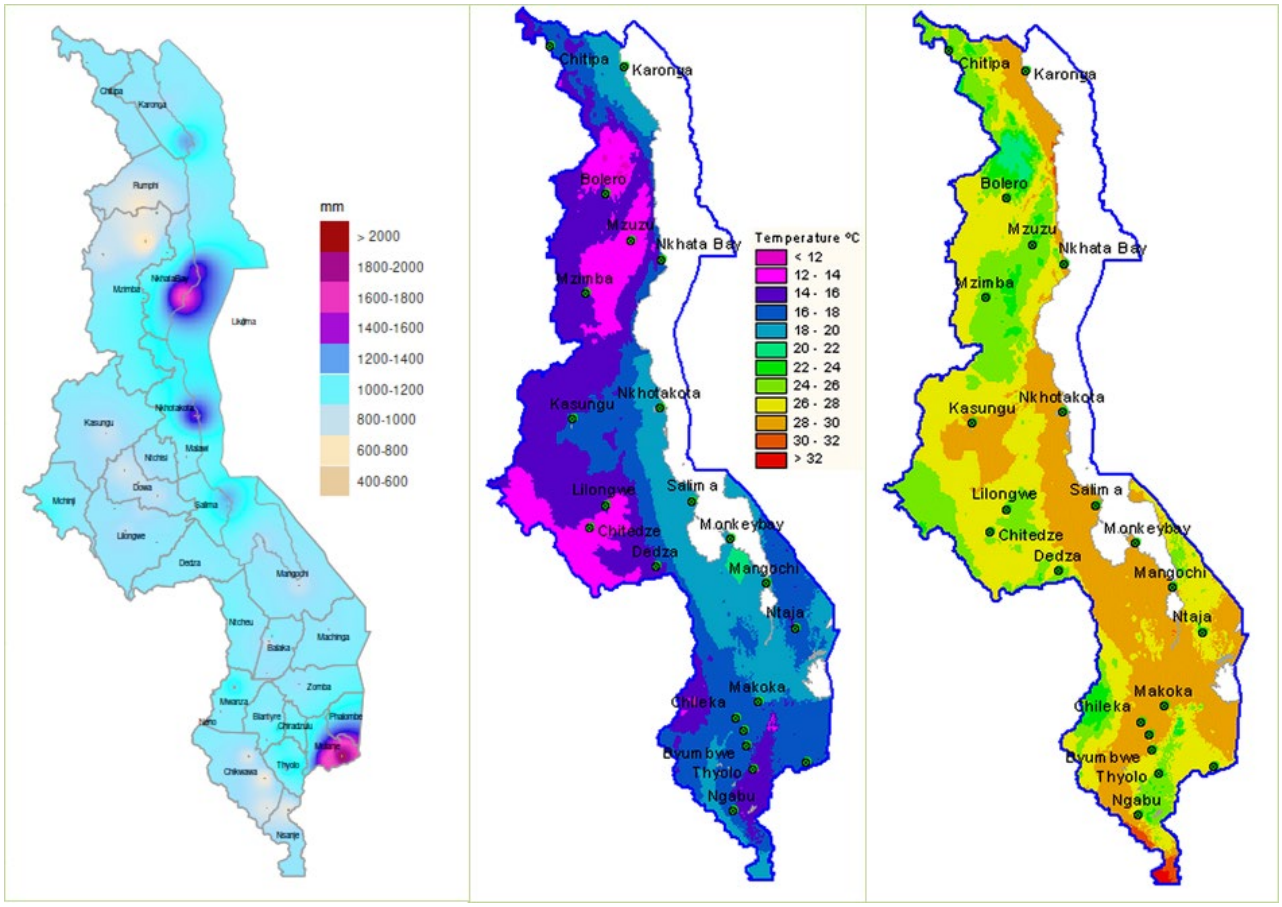


Figure 3. Average annual precipitation for the period 1991-2020 (left), Average minimum (centre) and maximum temperatures (right) in Malawi for the period 1981-2010. Data from DCCMS.

Malawi has been exposed to major weather-related disasters in recent decades, including floods and landslides, droughts and dry spells as well as cyclones and their related hazards. These events have caused significant loss of lives, crop failure and food insecurity, damage to habitat and various infrastructure, health problems (e.g. cholera outbreaks), and displacement of people to name some of the consequences (RCRC, 2021). Climate projections show the mean national temperature increase by 2.7° by 2075 with warmer winters and hotter summers. Similarly, annual rainfall is suspected to be similar or decrease throughout the country, but heavy precipitation events are projected to increase (MREE, 2011; McSweeney et al., 2012; RCRC, 2021), although models do show high uncertainty in the precipitation projection (Warnatzsch & Reay, 2019). Frequency of catastrophic events is expected to increase as they have been doing in the last decades.

The Country Climate and Development Report - Malawi published by the World Bank (WB) in 2022 highlights the challenges Malawi will face during the next decades in relation to changing climate and emphasises some of the measures to be taken to strengthen climate resilience. Some of these measures are strongly related to enhancing the present meteorological and climate services in Malawi.

Chapter 2: Country Hydromet Diagnostics

Element 1: Governance and institutional setting

Department of Climate Change and Meteorological Services (DCCMS) is a governmental department under the Ministry of Natural Resources and Climate Change (MoNRCC). DCCMS is the sole provider of meteorological services in Malawi and is the NMHS which is under exploration in this Country Hydromet Diagnostics.

1.1 Existence of Act or Policy describing the NMHS legal mandate and its scope

At present, there is no legislative Act which describes the legal mandate and scope of DCCMS. However, a draft version of a new Meteorological Act by DCCMS was forwarded to the Ministry of Justice (MoJ) for review in October 2022. Some of the issues raised in the current draft include the independence of DCCMS and the definition of DCCMS scope, e.g., regarding climate change and aviation services. DCCMS is currently the main service provider of climate change and observation services in Malawi, whereas coordination is to a large extent carried out in other departments. Multiple government departments share the responsibility for climate related issues, this may result in disagreements or misunderstandings over when to address various issues. Similarly, a better designation of the responsibility in aviation meteorological services cost recovery is needed.

The process of endorsing the new Meteorological Act can be long and the original draft can change substantially during the process. Whatever the outcome, improved definition of the current Departments functions would be valuable.

Presently, DCCMS uses the National Meteorological Policy (NMP) (2019-2023) from 2019 and the National Climate Change Management Policy (NCCMP) from 2016 as their main policy guidelines for service delivery. Both NMP and NCCMP are now in need of review.

According to the NMP, DCCMS provides Public Weather Service (PWS) and other related services only to the state or the public (commercial activities are not allowed). The main mandates (see web site for details) are:

- To monitor, analyse and predict weather and climate. The thrust of this objective is to ensure that the weather forecast is produced for early warning purposes. This information is vital for advisory in natural disaster early warnings.
- To provide weather and climate data and information for various socio-economic sectors such as Aviation, Agriculture, Water, Marine, Construction industry, Insurance, Tourism, Health, Sports, and Recreation.
- To carry out research and development that would improve quality of weather and climate data and information for the general public. The main focus is to carry out research for all aspects of meteorology inter alia the general public through mass media.
- To establish and maintain a well-equipped network of Met stations. This Objective intends to ensure that meteorological data and information is reliable, timely and up to date.

DCCMS also shares responsibilities with other ministries and departments in a number of areas, including:

- *Climate change services and research* with the Environmental Affairs Department (EAD) in the Ministry of Natural Resources and Climate Change (MoNRCC).

- *Flood forecasting* where DCCMS supplies data and expertise for riverine flood forecasting to the Department of Water Resources (DWR), and is responsible for the Flash-flood monitoring and warnings.
- *Agro-meteorology*: DCCMS has a strong agro-meteorology unit and is in close collaboration with the Ministry of Agriculture (MoA). The MoA hosts several weather stations and the DCCMS is heavily involved in crop forecasting and crop weather insurance. MoA maintains a close partnership with farmers (extension agents) and this helps disseminate seasonal forecasts and warnings from his DCCMS and raise awareness on specific projects.

Additionally, DCCMS is interested in expanding their responsibilities in *Air quality* and *Landslide monitoring and warnings* fields.

Aviation services: Although DCCMS is not the Meteorological Authority in Malawi as per ICAO Annex 3, it provides *aviation weather services* to both the public and military by providing both observers, forecasters, and technicians at the international airports in Blantyre and Lilongwe, as well as the Mzuzu and Karonga national airports. The changes proposed in the draft Meteorological Act provides that DCCMS is the Meteorological Authority (aka ICAO Annex 3). Furthermore, the proposed changes within the governance of aviation services suggests a better definition of the role of service provider (DCCMS) and the regulation of the aviation meteorological services (Civil Aviation Authority (a parastatal)).

Multihazard Early Warning System (MHEWS): The Disaster Preparedness and Relief Act (the DPRA Chapter 33.05) of 1991 (with most recent updates from 2023) provides the legislative framework for Disaster Risk Management (DRM) in Malawi. The DPRA is complemented by the National Disaster Risk Management Policy (NDRMP) of 2015 that provides strategic objectives for Disaster Risk Management (DRM). DCCMS is a fundamental participant in the DRM system of Malawi, with special emphasis on Early Warnings.

The main bodies of the DRM system are:

- The Department of Disaster Management Affairs (DoDMA) which is primarily responsible for managing and coordinating the implementation process of the DRM Policy.
- The National Disaster Risk Management Committee (NDRM-C) – provides policy guidance and direction to DoDMA for DRM programmes' implementation;
- The National Disaster Risk Management Technical Committee (NDRM-TC) – serves as a national DRM platform, providing technical support and ensures coordination for mainstreaming DRM;
- The National Disaster Risk Management Technical Sub-Committees (TSCs) oversee the coordination of several sectors across the different thematic areas of DRM, including one technical sub-committee on Early Warnings.
- NDRM-TSC on Early Warnings includes members from 14 governmental entities: main Civil Society Organizations and the UN, as well as the private and academic sectors. DCCMS is the chair of the sub-committee, DWR is the co-chair, and DoDMA acts as the Secretariat for the sub-committee (ToR available upon request).
    - The sub-committee should meet quarterly, but mainly meets ad-hoc due to imminent hazards. This platform has proved very effective for collaboration between the entities to prepare and respond to climate related disasters. See more: IDRL Emergency Fact Sheet,Malawi

Summary and comments for Element 1.1

The current state of meteorological and climate change governance in Malawi is characterised by the absence of a specific legislative act outlining the legal mandate and scope of the DCCMS. DCCMS currently provides climate change services, but coordination efforts are dispersed across various departments, leading to potential conflicts and misunderstandings in responding to different subjects.

DCCMS relies on the National Meteorological Policy (2019-2023) and the National Climate Change Management Policy from 2016 for guidance. However, both policies require updates, which might impact the governance of climate change issues. DCCMS has diverse responsibilities related to weather and climate. Additionally, DCCMS is a key participant in Malawi's Disaster Risk Management system.

The governance structure of climate change and meteorological services in Malawi is subject to potential reforms pending the approval of the new Meteorological Act. More clear roles on the governance of resources within the provision of aviation meteorological services is also expected once the draft of the Meteorological Act will be accepted.

1.2 Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

There is a Strategic Plan for DCCMS available for the years 2017-2022 which was aligned to the Malawi Growth Development Strategy III (2017-2022). The 2017-2022 plan has six main outputs:

1. Improved weather and climate monitoring and prediction.
2. Strengthened environment for climate change and meteorological services delivery.
3. Improved infrastructure and human capacity in climate change and meteorological services.
4. Improved communication and dissemination of climate change and meteorological information to sector specific stakeholders and the general public.
5. Improved provision of aviation weather services.
6. Effective and efficient climate, climate change and research services provided.

There have been challenges in implementing the tasks/activities in the last Strategic Plan, mainly due to lack of funding and human resources which have hindered development of crucial services, see more in Indicator 1.3. The strategic plan has an operational matrix, which is tracked and updated by DCCMS to monitor and evaluate the progress of the implementation of the strategic plan. An annual report is prepared and an attempt is made to issue quarterly progress reports. A draft strategic plan for the next five years has been produced, but further input is required, including better alignment with updated policies/laws and other relevant national and international initiatives and projects. These include the Malawi Investment Plan (2021-2030) and the Early Warning for All (EW4All) agenda (by 2027). Additionally, a World Bank (WB) project (4-month-long) to assess Malawi's gaps towards fulfilling EW4All before 2027 is in its inception phase and the results

of the project, along with results from this CHD, will be incorporated into the next Strategic Plan.

The proposed release date of the new strategic plan is the end of 2023, but it is likely to be postponed to early 2024 and then be effective for the next five years (2024-2028). Sector strategic plans are not necessarily approved by parent agencies in the Malawian government system.

Summary and comments for Element 1.2

The Strategic Plan of DCMMS covers the years 2017-2022. It outlines six main goals, improving weather and climate monitoring, strengthening climate change and meteorological services, enhancing infrastructure and human capacity, improving communication of climate information, providing better aviation weather services, and ensuring effective research services.

The plan faced challenges due to a lack of funding and human resources, hindering service development.

A draft of the next 5-year Strategic Plan requires more input and alignment with updated policies and initiatives. The publication date for the new Strategic Plan may be early 2024.

1.3 Government budget allocation consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions

Today, the governmental budget allocation does not cover DCCMS's needs in terms of its national, regional, and global responsibilities. Government consistently provides salaries on time, but other funding for operations costs and projects is usually reduced and is disbursed late. Funding has at times been cut by up to 50%.

There has been controlled hiring in the Malawi civil service, including at DCCMS for years so recruitment of new staff has been very challenging. DCCMS has not been able to adequately replace personnel who retired, quit, or died. Hence, total staff decreased from over 170 in 2012 to just below 120 in 2021 with associated decrease in annual budget. Additional funding has now been provided for recruitment of new staff and already in 2023 there have been 46 new observers and 6 meteorologists hired. In addition, one ICT specialist has been recruited through MET Norway in the SAREPTA project (seconded by NORCAP an financed by NORAD)

The annual governmental budget is MK 962,866,764 (USD 834,764) including salaries and related payments and Other Recurrent Transactions (ORT) funding for DCCMS Headquarter and the Kamuzu international office (see table). In addition, DCCMS receives funding through projects, such as the M-CLIMES project funded by The Green Climate Fund (GCF) and implemented by the United Nations Development Program (UNDP), but the annual amounts vary greatly from one year to another and are project-specific. We have here used 150,000 USD as a mean annual donor funding.

Cost recovery funds for the provision of aviation meteorological services in Malawi do not go directly to DCCMS. The services (including different aviation forecasts and warnings as well as provisions and calibration of meteorological instruments and equipment) are provided as a package and the cost compensated as a percentage of air navigation service charge collected by the Department of Civil Aviation (DCA).

Hence, the cost recovery model is not well defined and there might be opportunities for DCCMS to claim more actual cost for e.g. Quality Management System (QMS) implementation and Information and Communication Technology (ICT). A new Meteorological Act establishing more independent DCCMS with clearer mandate for aviation services might help portraying these opportunities.

DCCMS does not have the legal framework to work on commercial activities so other sources of funding are minor, such as for cost recovery for data distribution and provision technical services (Meteorological Data Policy, 2017).

Compared to previous years the annual budget of 2022/2023 of DCCMS has increased with higher salaries due to recruitment of new staff members; however, the operational budget has decreased.

Table 1. Annual budget for DCCMS for the fiscal period from March 2022 to April 2023.

Type of funding	**MK**	**USD**
Salaries, Leave grants, Duty/Personal Allowance	716,858,440	621,464
Other Recurrent Transactions (ORT) funding (for DCCMS Headquarter's stations)	206,008,324	178,594
Other Recurrent Transactions (ORT) funding (for Kamuzu Int' Office)	40,000,000	34,677
Total governmental DCCMS budget	962,866,764	834,764
Additional donor funding and other projects	≈173,000,000	≈150,000

There has not been a real cost-benefit analysis (CBA) of the services DCCMS provides. Such CBA would show the extended economic and social benefit of the services DCCMS provides and would be greatly beneficial when lobbying for more funding for the department. Today, the governmental budget allocation does not cover DCCMS's needs in terms of its national, regional, and global responsibilities.

Summary and comments for Element 1.3

Between 2012 and 2020 there has been a reduction of staff of 50 persons. This has greatly impacted the annual budget. DCCMS has struggled to secure funding for operational costs and projects. In 2023, additional funding was provided to recruit new staff, resulting in the hiring of 46 new observers and 6 meteorologists.

The annual governmental budget is MK 962,866,764 (USD 834,764), with additional funding from donor-supported projects. DCCMS lacks a legal framework for

commercial activities, leading to limited alternative funding sources.

There is a strong need for a cost-benefit analysis to demonstrate the economic and social benefits of DCCMS services, which could aid in securing more funding to fulfil its national, regional, and global responsibilities.

At present there is no cost-recovery mechanism in place directly to DCCMS for the services they provide, including the aviation services.

1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS.

Table 3 shows the number of staff in different fields of DCCMS, including education, age, and gender. It is difficult to classify some staff members into the categories in the table as many staff members work in more than one category. No staff member works solely in research although meteorologists participate in research projects and could be partly classified as researchers.

Of 310 available posts 164 are currently filled; of which 116 are male and 48 are females, or about 29% of the DCCMS staff (Table 3). The gender equality differs among the jobs with 60% women working in corporate support but only 11% in IT. The overall proportion of staff with BSc or higher education at DCCMS is about 23%, albeit 74% and 71% for meteorologists and IT personnel, respectively. The age distribution differs similarly among the staff categories where higher age is observed in supporting staff groups.

The on-going recruitment of observers and meteorologists in 2023 has increased the human resources and competence significantly. Continued recruitment of staff should focus on improving the gender balance based on a gender equality plan which should be made and implemented to comply with WMO gender action plan. In addition, DCCMS should conduct a gender assessment analysis that will facilitate establishment of a gender policy with affirmative actions to bridge the gap between female and male staff. There is e.g. a noticeable disparity in the gender ratio in the IT group, although it is also the group with the highest percentage of people over 40 years old (78%). The retirement age in Malawi is 60 years although staff members can retire voluntarily with benefits after 20 years in governmental services. Hence, the high percentage of IT personnel should be considered of special concern.

A detailed organigram of DCCMS is also provided with this CHD (Figure 4).

Table 3. Composition of DCCMS staff with information on education, age, and gender.

	Head-quarters	Regional Center	Education (number of staff with BSc or higher)	Age (number of staff older than 40 years)	Gender
Corporate support	8	2	1 (10%)	8 (80%)	Women: 6 (60%) Men:4
Meteorologist	14	20	25 (74%)	15 (44%)	Women: 8 (24%) Men:26
Meteorological technicians	1	61	> 5 ** (10%)	19 (31%)	Women: 18 (29%) Men:44
Hydrologists	NA	NA	NA	NA	NA
Hydrological technicians	NA	NA	NA	NA	NA
Climatologists	NA	NA	NA	NA	NA
Researchers	*				
IT	7	2	5 (71%)	7 (78%)	Women: 1 (11%) Men: 8
Other	12	37	0	29 (59%)	Women: 15 (31%) Men:34
Total	42	122	37 (23%)	78 (48%)	48/116 (29/71%)

*Meteorologists work informally in research; **Used 6 to calculate percentage of educated staff

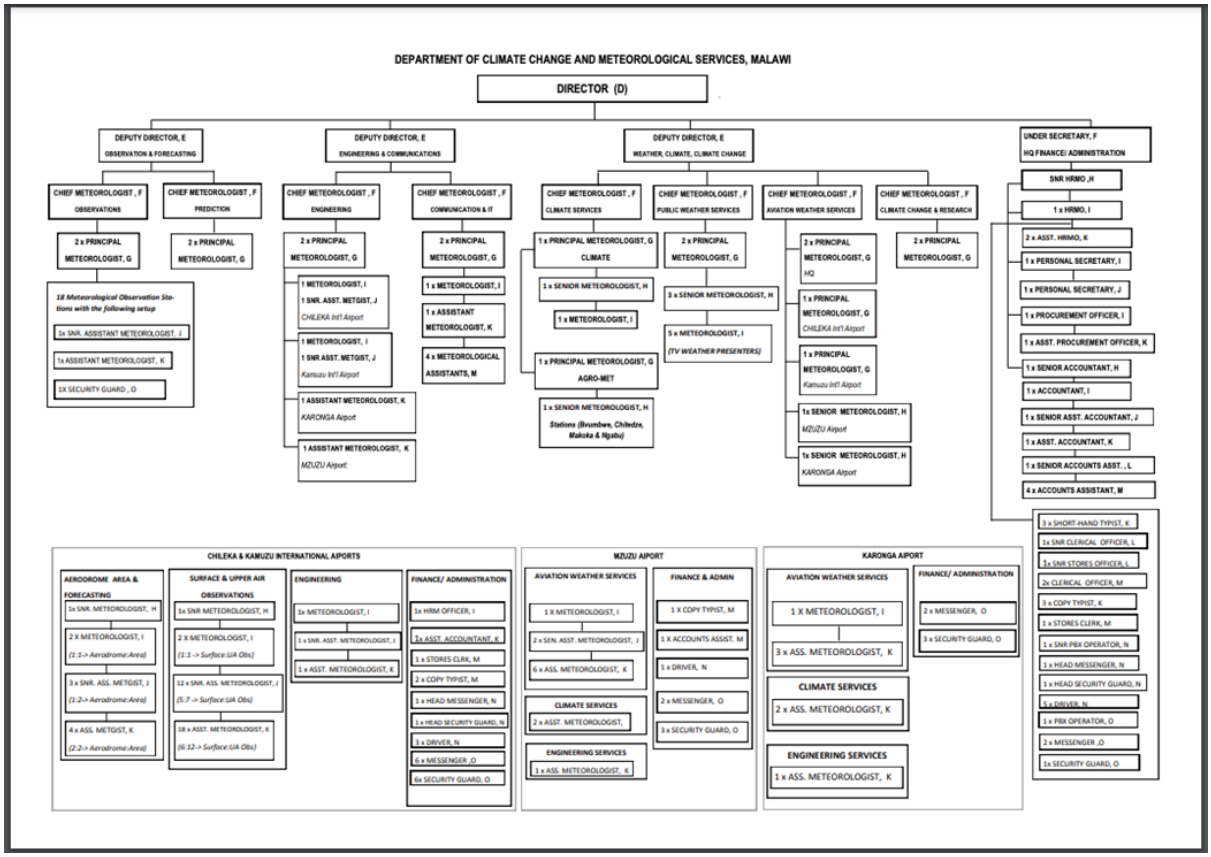


Figure 4. Organogram of the DCCMS (based on data from September 2023).

Competency assessment of DCCMS staff has only been developed for aviation meteorological officers (both observers and forecasters) as a part of QMS implementation. Otherwise, DCCMS uses the Performance Appraisal System for Malawi Government Civil Service.

Capacity building of human resources is not formal, i.e. there is no special Training Policy for staff members at DCCMS although staff is trained through different means. Job training standards for meteorologists and observers exist but are not documented. Annual training plan is made by the DCCMS training committee which is governed by the governmental policy on training. It would be ideal to include capacity building as a part of QMS procedure which would then supersede the government policies. However, QMS implementation has been delayed until adequate funding is available. Insufficient finances hence affect training of officers although new recruitments receive initial training.

There are several institutional arrangements for capacity building, both with national and regional institutions. There is a Memorandum of Understanding (MoU) between DCCMS and Malawi University of Science and Technology (MUST) to train potential recruits. Additionally, DCCMS assists with development of curriculums for the MUST. Similar arrangement is in place with Lilongwe University of Agriculture and Natural Resources (LUANAR) although it is not as focused on education which might benefit future recruits at DCCMS.

Regional Climate Centres affiliated with WMO include African Center of Meteorological Applications for Development (ACMAD), Regional Specialized Meteorological Centre (RSMC) Pretoria, and IGAD Climate Prediction and Applications Centre (ICPAC) do offer training, internships and secondments which benefit DCCMS. In addition, several capacity building programs/courses/workshops are available through WMO directly, including the WIS2.0 training session held in April 2023 and meetings/training affiliated with the

Southern Africa part of the Severe Weather Forecasting Programme (SWFP-Southern Africa).

DCCMS participates in regional cooperation including Southern Africa Regional Climate Outlook Forum (SARCOF) and South-West Indian Ocean Climate Outlook Forum (SWIOCOF) before main rainfall seasons. The cooperation does not include formal arrangement for human capacity building although this cooperation does train participating officers informally. Regionally NHMS in the SADC are linked through the SADC Climate Services Centre (located in Botswana). Its coordination capability is not very strong and has so far dealt with weather/seasonal forecasting issues and network expansion and management, but less with capacity building.

Summary and comments of Element 1.4

In 2023, the recruitment of observers and meteorologists has increased human resources and competence. 164 of 310 positions are filled. A human resource plan taking into account gender, education and age distribution should be made and implemented through staff recruitment. A gender equality plan is needed.

DCCMS uses a competency assessment for aviation meteorological officers and for other staff members they use a Performance Appraisal System for the Malawi Government Civil Service, otherwise there is only informal training and lack of documentation.

DCCMS has established MoU's MUST and LUANAR. These arrangements involve curriculum development and training for potential recruits. Regional climate centres affiliated with WMO offer training, internships, and secondments. WMO directly provides capacity building programs which DCCMS take part in.

DCCMS would benefit from better documented training procedures which could e.g. be implemented through future QMS implementation. Regional capacity building could be strengthened and be beneficial for many countries in southern and eastern Africa. WMO training should be used when possible where new advances in hybrid meetings are a great opportunity to reduce cost.

1.5 Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general.

DCCMS has participated in several research and development projects during the last 5 years as well as the decade before that. Main partners include Green Climate Fund (GCF), UNDP, World Bank, NORAD, Norwegian Government, WMO, European Commission, Adaptation Fund, and USAID.

Tables 3 and 4 list the main internationally funded hydromet projects, both donor-funded projects and cooperation projects/research projects with academia. More detailed description of each project can be seen in a separate file.

Table 3. Information on donor-funded hydro-met projects DCCMS has participated in during the last 5 years.

Years	**Short name/ acronym**	**Name**	**Funding/implementing agency**
2023-2027	**SAREPTA**	Institutional Support and Capacity Building for Weather and Climate Services	NORAD/MET Norway
https://bistand.met.no/en/SAREPTA			
2020-2024	**FOCUS-Africa**	Fully Optimized User Centric Climate Services Value Chain for Southern Africa	European Commission
https://focus-africaproject.eu/			
2020-2024		Adapting to Climate Change Through Integrated Risk Management Strategies and Enhanced Market Opportunities for Resilient Food Security and Livelihoods	Adaptation Fund
https://fifspubprd.azureedge.net/afdocuments/project/8901/8901_WFP%20AF%20project%20proposal%20Malawi%20resubmission%202%20September%202019%20clean.pdf https://www.adaptation-fund.org/project/adapting-to-climate-change-through-integrated-risk-management-strategies-and-enhanced-market-opportunities-for-resilient-food-security-and-livelihoods/			
2017-2023	**M-CLIMES**	Saving Lives and Protecting Agriculture-based Livelihoods in Malawi: Scaling Up the Use of Modernized Climate Information and Early Warning Systems	Green Climate Fund
https://www.greenclimate.fund/project/fp002			
2022-2023	**CBFM**	Community-based Flash Flood Management in Malawi	USAID/WMO
The Flash Flood Guidance System – early warnings for the most vulnerable | World Meteorological Organization (wmo.int)			

2012-2019	**SWFP**	Severe Weather Forecasting Programme Southern Africa	many participants
https://community.wmo.int/en/swfp-southern-africa			
2019-2023	**SARFFGS**	Southern Africa Flash Flood Guidance System	WMO, USAID, NOAA and HRC
https://doi.org/10.3390/w8060258			
2017-2020		Malawi Strategic Program for Climate Resilience	World bank
https://documents1.worldbank.org/curated/en/976421565941535792/pdf/Disclosable-Restructuring-and-or-Additional-Financing-Paper-Malawi-Strategic-Program-for-Climate-Resilience-P163245.pdf			
2017-2019		GFCS Adaptation Programme in Africa Building Resilience in Disaster Risk Management, Food Security and Health II	NORAD
https://public.wmo.int/en/projects/adaptation-programme-africa-gfcs-apa-phase-ii-building-resilience-disaster-risk-management			
2013-2017		Strengthening climate information and early warning systems in Eastern and Southern Africa for climate resilient development and adaptation to climate change – Malawi	UNDP
https://www.adaptation-undp.org/sites/default/files/downloads/undp_malawi_ews_brief_c4es_10_october_2013.pdf https://drive.google.com/file/d/17bjlOGRLpSgNYNM26hm1TYP5LnlvQoby/view?usp=drive_link			

Table 4. Information on hydro-met academic and/or research projects DCCMS has participated in during the last 5 years.

Acronym	Name	Main international participant	Website
PISCA	The development and implementation of Participatory Integrated Climate Services for Agriculture	University of Reading, UK but is also a part of the M-CLIMES project, see above	https://research.reading.ac.uk/picsa/
ENACTS initiative	Establishment and operations of Enhancing National Climate Services	University of Columbia, IRI, USA	https://iri.columbia.edu/resources/enacts/
MadiPhs	Malawi Digital Plant Health Service - MadiPhs	Norwegian Institute of Bioeconomy Research (NIBIO)	https://www.nibio.no/en/projects/malawi-digital-plant-health-service-madiphs
Water-in-Sight	Upgrade of dissemination of manual observations	Water in Sight	https://www.waterinsight.se/
FFGS	Operations of flash-flood guidance System (also in donor part of table)	Hydrological Research Centre, USA	https://www.hrcwater.org/

The long list of internationally funded projects above shows that DCCMS is a desired partner in hydromet projects. The track-record of the projects can be measured by the services that have been set up and which are still operating. This is true for most of the established services within these projects and can be confirmed e.g. in an impact evaluation report of the PISCA project (part of M-CLIMES) and an assessment of the Shire River Basin Management Program. However, the sustainability of such short-lived projects is often hampered by lack of resources for maintenance of hardware, software and other consumables, and continued capacity training. This is especially evident in infrastructure projects where funding is available for installation of equipment, but funding for future maintenance lacks. The installation of automatic Weather Stations (AWS) during the M-CLIMES project is such an example where some of the stations are already out of order. The SOFF strategy for sustainable operations of selected stations should eliminate this problem.

Summary and comments of Element 1.5

DCCMS has been successfully involved in various research and development projects during the last five years, which encompass both donor-funded initiatives and collaborations with academic and research institutions. The partners include the Green Climate Fund, UNDP, World Bank, MET Norway, WMO, European Commission, Adaptation Fund, and USAID, as well University of Reading, University of Columbia, Hydrological Research Centre, NORDBIO and Water-in-Sight.

The projects aim to enhance climate services, resilience, and early warning systems in Malawi. However, sustaining these services is a challenge because of lack of resources. Efforts are being made to address observation sustainability issues through the SOFF strategy for sustainable operations of selected stations.

Summary score, recommendations, and comments for Element 1: 2

DCCMS plays a crucial part in the meteorological and climate services and disaster risk management in Malawi. Its data, information, warnings and forecasts are of uttermost importance to the different sectors of society, both for short- and long-term planning and decision making and is one of the fundamental institutes in implementing EW4All in Malawi.

Recommendations:

Finalisation, update and coordination of governance acts/policies/strategies is needed to better define the responsibility among the different governmental departments:

- New Meteorological Act
- Update of the Meteorological Policy
- Update of the Meteorological Strategy Plan
- Update of the National Climate Change Management Policy
- Update of the National Disaster Risk Management Policy
- Finalise and launch the National Framework for Climate Services (NFCS)

More stable and increased funding is needed for all DCCMS operations.

- Socio-Economic Benefit analysis of Meteorological and Climate Data and Services to make the case for increased funding to ministries of finance, other departments, donor agencies and stakeholders in the private sector.
- Continue active discussion with the abovementioned partners on financing and projects.
- Re-evaluate cost-recovery funding arrangements with ICAO, including co-funding of human capacity, QMS implementation and ICT systems. This funding should be allocated to DCCMS and should be adjusted accordingly to match the full cost of the aviation services provided by DCCMS.

Human resources:

- Continued and regular recruitment of highly qualified staff.

- Develop a gender policy with affirmative actions to bridge the gap between female and male staff at DCCMS, especially for educated staff.
- Document better training procedures and prepare and implement training plans for all personnel.
- Make use of regional and global human capacity training with hybrid meetings.
- Develop specific expertise within DCCMS for sustainability.

Implementation of internationally funded hydromet projects:

- Aim for a project to directly address DCCMS' human and infrastructural capacity needs.
- Aim for sustainable projects with long-term benefit.

Element 2: Effective partnerships to improve service delivery

2.1. Effective partnerships for service delivery in place with other government institutions.

DCCMS provides various services to different governmental sectors although they are mostly informal without a formal contract/MoU. The services vary from tailored warnings and forecasts to observation service delivery. A list of the different services can be observed at DCCMS| Climate Services to Different Sectors, many of which are offered to governmental institutes through informal partnerships.

Examples of partnerships, although mostly informal, between DCCMS and other governmental institutes include:

Ministry of Agriculture (MOA)

- Services include seasonal forecasting used for crop decisions
- Publication of Weather and Agrometeorological Bulletin every 10-days during October to April (https://www.metmalawi.gov.mw/agromet/MWApril22023.pdf)
- Partnership regarding CWIS - the Climate and weather Information System for Farmers and Fishers in Malawi (https://wimes-malawi.brl.fr/)
- Station installation/maintenance/education/cooperation

Department of Fisheries (DoF)

- Co-hosting bouys in Lake Malawi
- Partnership regarding CWIS - the Climate and weather Information System for Farmers and Fishers in Malawi (https://wimes-malawi.brl.fr/) including warnings of weather, wave heights

Department of Disaster Management Affairs (DoDMA)

- Main recipient of information of extreme weather events
- DCCMS coordinates with DoDMA various efforts during disasters – dissemination - communication - education

Department of Water Resources (DWR)

- Supports Flood Management systems (the ODSS and IBF platforms) for riverine and flash flood monitoring in cooperation with DWR
- DCCMS operates a Flash-Flood Guidance System (FFGS) for flash-floods information which DWR uses

National Water Resources Authority (NWRA)

- Informal cooperation on water related issues

Ministry of Education (MoE)

- MoE hosts several weather stations through informal partnerships
- DCCMS has affiliation with both MUST and LUANAR for training/teaching and syllabus development

Ministry of Transport and Public Works (MoTPW)/ Department of Civil Aviation (DCA)

- Aviation meteorological services

Summary and comments of Element 2.1
DCCMS provides a range of services to different governmental sectors through informal partnerships. These services include tailored warnings, forecasts, and observation service delivery. Examples are the Ministry of Agriculture for seasonal forecasting and agrometeorological bulletins, the Department of Fisheries for co-hosting buoys in Lake Malawi and weather and wave warnings, the Department of Disaster Management Affairs for disseminating information during extreme weather events, the Department of Water Resources for flood management systems and flash-flood information, and the Ministry of Transport and Public Works/Department of Civil Aviation for aviation meteorological services. Formal service agreements and increased coordination between DCCMS and stakeholders is recommended.

2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects.

There are no legislation provisions concerning private sector participation in the delivery of information. Participation of non-NMS entities in provisions of met information and services is prohibited so the DCCMS is the sole provider of met services. There is no real trend of provisions of services by the private sector.

There are several effective partnerships between DCCMS and the different sectors outside the governmental administration although in most instances they are not promoted with formal agreements. Below are examples of different cooperation with the private sector, research and academia for different parts of DCCMS.

SERVICE DELIVERY: DCCMS has a MoU with the Farm Radio Trust (FRT) on agromet services, including dissemination and communication. Another formal agreement is currently under discussion with TNM, a mobile service provider. There are other services to other public/private sectors without formal agreements, e.g. the energy sector. Meetings with the Electricity Generation Company Limited (EGENCO) have been arranged but no formal MoU has been drafted.

OPERATIONS AND MAINTENANCE OF NETWORKS: No formal agreements. Most partnerships are project-based, e.g. through UNDP and the M-CLIMES project. There are several informal agreements regarding hosting weather stations, e.g., with Kasungu National Park, Liwonde National Park, Lilongwe Water board.

OBSERVATION DATA: There is a formal agreement with Trans-African Hydro-Meteorological Observatory (TAHMO) on cooperation on observation data. TAHMO (team from Delft, Oregon State University, staff in various Africa countries) operates about 25 hydromet stations in Malawi with partly free and open data exchange. (TAHMO Data Access Policy)

MULTI-SECTOR CONSULTATIVE PLATFORM: DCCMS participates in multi-sectoral consultative platforms which foster cooperative dialogue; however, their participants are predominantly from governmental administration, not the public/private sector. These include the National Early Warning technical committees and Disaster Risk and Climate

Change Committee. These committees should meet quarterly but they also meet ad-hoc when a disaster is forecasted. ToR is available for both committees. DCCMS co-chairs National Early Warning technical committees with Department of Water Resources (DWR) and the Disaster Risk and Climate Change Committee is co-chaired with the Department of Disaster Management Affairs (DoDMA). Potential collaboration with the aviation sector (coordination committee) could prove beneficial.

There is a working cooperation with the Civil Society Network on Climate Change (CISONECC) Malawi and there is a small team working on establishment of Malawi Meteorological Society which could then merge into the African Meteorological Society (AMS).

The stakeholder meeting like the one DCCMS hosted in September 2023 for the SOFF Readiness Phase (see Annex 5) was a good start to extend the discussion of available/needed/desired services to the public and private sectors.

ACADEMIA and RESEARCH: The Office of the Director in liaison with the Climate Change Research section and relevant divisions sets the main research priorities at DCCMS. However, the main funding for research at DCCMS is through donor-funded projects, international consultants and research institutions which can affect the prioritisation of the research activities.

DCCMS collaborates with several national and international academic/research institutes on a range of projects/provisions. Some have already been mentioned in Table 4, e.g., PISCA, ENACTS, FFGS, MadiPhs, and Water-in-Sight. Other partnerships include provision of meteorological courses and advice on syllabus for the Lilongwe University of Agriculture and Natural Resources Malawi (LUANAR) and Malawi University of Science and Technology (MUST). A MoU between DCCMS and the Norwegian Meteorological Institute has been signed on Capacity Building on Weather and Climate Services in connection with the SAREPTA project (see table 3).

Summary and comments of Element 2.1
DCCMS is the exclusive provider of meteorological services due to legislation prohibiting private sector participation. Despite the absence of formal agreements, DCCMS has established effective partnerships with various sectors, including agriculture, energy, and telecommunications. Formal agreements include an MoU with the Farm Radio Trust (FRT) for agromet services, and discussions with TNM, a mobile service provider, are underway. Project-based partnerships exist with UNDP and the M-CLIMES project for network maintenance and weather station hosting with entities like Kasungu National Park and Lilongwe Water board. DCCMS collaborates on observation data with the Trans-African Hydro-Meteorological Observatory (TAHMO) and participates in multi-sectoral consultative platforms related to early warning and disaster risk management. A formal MoU has been signed with the Norwegian Meteorological Institute for Capacity Building on Weather and Climate Services as part of the SAREPTA project.

2.3. Effective partnerships in place with international climate and development finance partners.

There are many effective partnerships including UNDP, WB, WFP, FAO, NORCAP, MET Norway, WMO, Green Climate Fund, UNICEF. List of development and research projects is

shown in 1.5 which many are related to climate. The funding is usually through governmental payments, not directly to DCCMS.

Summary and comments of Element 2.3
List of partnerships, mainly climate related, found in Table 3.

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

Several services have been implemented through partnerships with governmental, various academic and research institutions, and international climate and development finance partners. Examples of products/services that have been generated through partnerships:

- Generation of climate change scenarios for Malawi.
- Lightning warnings via SMS. They have been tested but not implemented yet. Based on lightning sensors installed within the M-CLIMES project.
- Implementation of Participatory Integrated Climate Services for Agriculture (PICSA) in 14 districts of Malawi including production and dissemination of regional seasonal forecast, see https://doi.org/10.1016/j.cliser.2022.100298
- Tailored advisories for agriculture and fisheries sectors - Lake Malawi forecasts, see https://wimes-malawi.brl.fr

Summary and comments of Element 2.4
New services like generation of climate change scenarios of Malawi, lightning warnings, Climate Services for agriculture and weather and wave advisories for the fisheries sector are implemented.

Summary score, recommendations, and comments for Element 2: 3

- Map the possibilities for co-financing, co-production, and co-managing of different resources.
- Enhance and formalize coordination between DCCMS and stakeholders with service agreements and formation of platforms for engagement and research.
- Formal service agreements and collaboration strategies that enhance DCCMS's position in financial decision-making and resource allocations.
- Establish sustainable and meaningful partnerships with the private sector including the civil society organization especially for operation and maintenance of observation networks.

Element 3: Observational infrastructure

3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.

There are 21 manual synoptic surface weather stations but no upper-air station. Additionally, there are 123 automatic weather stations (AWS) with varying status of operations (80-90%). Many of these stations were installed in 2022 through M-CLIMES (33+), SADC (5) and TAHMO (30). However, the sustainability of these stations is not guaranteed because funding for future maintenance of stations and telecommunications systems is not provided for.

Of all the AWS, only about 9% are consistently compliant with GBON regulations. The number compliant including station names vary almost daily due to various problems with hardware/software/data transfer issues. These stations are those installed as a part of the M-CLIMES project and were used in the WMO WIS2BOX pilot project in Malawi. An overview is available from the GBON National Gap Analysis for Malawi (2023). From this report we learn that 11 AWS meets the GBON requirements (April 2023).

Summary and comments of Element 3.1
Of the 123 AWS in Malawi about 9% meet the GBON requirements, but both the number and stations vary significantly from one month to another.

3.2. Additional observations used for nowcasting and specialized purposes.

A lightning detector system with 8 sensors for lighting warnings operates in Malawi and covers about 95% of the country. Two lake-buoys have been installed on Lake Malawi for real-time weather monitoring, wave height estimation and water quality measurements. Precipitation gauges are used as a part of the early warning system.

Summary and comments of Element 3.2
Additional observations are, lightning detectors, lake buoys and precipitation gauges.

3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational network.

There are SOPs in place, but only for maintenance purposes. Calibration and quality assurance components are addressed but not with specific SOPs. DCCMS has a designated WMO Integrated Global Observing System (WIGOS) focal person for data quality management systems as well as an OSCAR focal person. These officers work hand in hand

with Regional WIGOS Centre (RWC). One officer has been trained in OSCAR/Surface and is the same OSCAR National Focal Point.

Currently, there is no established nationwide procedure for addressing quality problem information obtained from the WIGOS. Nevertheless, efforts are underway to develop such a process. Presently, concerns are dealt with via the WMO/regional WIGOS framework, through the WIGOS Data Quality Monitoring System (WDQMS) and OSCAR focal points.

Summary and comments of Element 3.3
DCCMS has SOPs for maintenance but not for calibration and quality assurance. To address these aspects, DCCMS has designated personnel responsible for WIGOS data quality management systems and OSCAR coordination. DCCMS is in the process of designing a national process for addressing quality issues based on information received from the WIGOS.

3.4 Implementation of sustainable newer approaches to observations.

DCCMS has not yet finished a National WIGOS Implementation Plan (N-WIP). To meet the N-WIP, DCCMS has through SOFF project conducted GBON National Gap Analysis and identified the estimated number of surface and upper-air observing stations needed to close the observational data gaps based on GBON standard requirement. The GBON National Contribution Plan, identified infrastructure and the human and institutional capacity needed to achieve a progressive target toward GBON compliance, including the sustained operation and maintenance of the national observing network.

Through the SOFF project, DCCMS in collaboration with MET Norway and IMO held a SOFF stakeholders meeting in Lilongwe, Malawi (see Annex 5). The aim of the stakeholder workshop was to bring together relevant stakeholders in both the public and private agencies as well as academia, across the meteorological value chain in Malawi to facilitate dialogue and consultations that will promote future collaboration with DCCMS especially on sustainability of observation networks. Emphasis was made to encourage funding agencies to not only factor in investments/capital cost when supporting DCCMS with observation stations, but also to have a futuristic approach to station networks that are both fit for purpose and fit for budget.

Summary and comments for Element 3.4
DCCMS has not yet finished a National WIGOS Implementation Plan (N-WIP). Upon implementation of the SOFF National Contribution Plan, DCCMS will fulfil the GBON standard requirements.

3.5. Percentage of the surface observations that depend on automatic techniques.

AWS uses GPRS for communication. The network is provided by Malawi mobile service providers (Airtel Malawi and Telecom Network Malawi (TNM)). This is either on a contract (post-paid) or pay as you go (prepaid). Since data generated and communicated by AWS is not large, no data bundles are required. AWSs sends data to a server in the Server room at DCCMS HQ in Blantyre. Preferred temporal steps are hourly or half hourly. From here weather data is available for integration into a climate database management system, input into data visualisation and processing systems (e.g., Synergieweb). Data on the station's status is also sent, and using relevant software it is visualised as part of monitoring performance.

In the server room all servers are powered by a solar-Mains hybrid power backup system which minimises operations disruptions in case of blackouts. The servers are all on a local network, and data transfer for archiving or processing is done locally. A selected number of stations were also piloted on WIS2Box implementation. These transfer data to WIS2Box in the cloud using ftp. Global data transfer to Global Telecommunication System (GTS) and NWP centres are done from WIS2Box. In the case of GTS, DCCMS is using a Netsys message handling system. The current challenge with this is that it is working well for manual stations only where meteorological coded alpha-numeric SYNOPs are generated and manually entered for exchange through GTS.

Given that the full surface station list (including synop stations) totals 141 stations, 85% of the stations network in Malawi is fully dependent on automatic techniques. However, the percentage of data sharing through automatic techniques to WMO is much lower.

Summary and comments of Element 3.5

DCCMS utilises Automatic Weather Stations (AWS) equipped with GPRS communication technology. Data generated by AWS, is sent to a server located in the DCCMS headquarters in Blantyre. where they are integrated into a climate database management system. Some stations use the WIS2Box system for cloud-based data transfer, enabling global data exchange with meteorological centres.

Out of 141 total stations, 85% are fully dependent on automatic techniques for data transmission although the percentage of data sharing from these stations is much lower.

Summary score, recommendations, and comments for Element 3: 3

- Implement the GBON national contribution plan with fully GBON compliant surface and upper air stations.
- Prioritise maintenance of stations which are possible to make GBON compliant.
- Seek co-financing of observation networks where possible.
- Conduct an observation network performance analysis in terms of maintenance cost, data quality, use, and value to optimize and sustain the network.
- Prepare SOPs for calibration and quality assurance based on best practices.
- Fully implement the National WIGOS Implementation Plan (N-WIP) through SOFF

- Sustainable operation of installed stations though development projects should be of primary concern.
- Develop proper maintenance and management plan of existing station network through e.g. scheduled preventive maintenance and calibration plans to lengthen the life cycle of sensors.
- Build and improve capacity of DCCMS staff with regards to AWS and upper-air station operations and maintenance.

Element 4: Data and product sharing and policies

4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centres.

Out of the 123 existing AWS, DCCMS has designated 37 surface stations for data exchange internationally. These stations were used in the WMO WIS2BOX pilot project in Malawi where participants were trained on operation of the WIS2Box software. Observation data is therefore exchanged internationally through WIS2box in the cloud using ftp. Since the training, DCCMS have been transferring their data using the WIS 2.0 protocol albeit with some challenges. As such, only 30% of the designated GBON stations have been compliant to GBON requirements. The number of stations compliant based on data availability to the WDQMS monitoring system varies from day to day (cf. Malawi GBON Gap analysis report 2023). GTS is also used in DCCMS for exchange of manually observed data.

Upper air sounding stations have been in-existence in Malawi for a long time. There are therefore no observations or exchange of upper observation. DCCMS also has no greenhouse gases (GHG) stations and so does not monitor GHG parameters.

There is currently no WIGOS implementation plan in Malawi, however, DCCMS has a designated WIGOS data quality management systems focal person. Current issues related to WIGOS are addressed through the WMO/regional WIGOS setup, WDQMS and OSCAR focal points.

Summary and comments for Element 4.1
Thirty-seven AWS out of 123 stations have been designated for international data exchange via WIS2Box. About 30% of the designated stations are GBON compliant but the number varies on a daily basis. A WIGOS implementation plan is not yet adopted but there is a focal person for WIGOS QMS.

4.2. A formal policy and practice for the free and open sharing of observational data.

DCCMS published the revised document "Meteorological Data Policy in Malawi" (MDP) in 2017 which includes 11 guiding principles regarding data classification and data sharing. It also contains policy statements regarding issues such as data access, use, exchange, as well as data quality, and states specific objectives and strategies to fulfil them. Moreover, a charging manual for various services provided by DCCMS is presented in an annex to the data policy. Some of these issues were further detailed in the National Meteorological Policy from 2019.

The data policy states that meteorological data collected at public expense should be regarded as public property, accessible to all Malawians but at the costs of making them available. Moreover, meteorological data and products should be free of charge to the National Meteorological Services of other countries. All weather and climate data shall be

classified in terms whether they are free, cost-recoverable, or commercial, and fully accessible to users in line with these classifications.

Furthermore, Basic Weather Service should comprise public forecast, severe weather warnings and information, while the Basic Climate Service will comprise long range seasonal climate forecasts, and climate monitoring information and will be provided free of charge to the public through media. The dissemination of these service products shall be on a cost sharing basis. According to the data policy, additional services should be rendered by the user-pays principle which application is described in more detail in the policy.

The NDP gives guidelines on the procedure of data sharing and costs, as well as instructions for key role players to reinforce the policy. However, present-day practices of data access and delivery may be slightly different than suggested in the policy. In general, data is generally not freely available or easily accessed via website/web services. Initially there was a specific gateway to a Customer Service Unit which dealt with data requests through the DCCMS website, but the link and procedure is not operational at present. Currently, the requests are mainly received by the means of email and phone calls.

Data for academic research and government projects and risk assessment is provided for free upon request. In contrast, data used for commercial use such as in the insurance and construction sectors are charged for based on the Annex 1 in the Data Policy with slight modifications.

Summary and comments for Element 4.2

A Meteorological Data Policy was published in 2017 including guiding principles of data classification and data sharing. Present-day practices vary slightly from the policy. Data for academic research, governmental projects and risk assessment is provided for free upon request. Data for commercial use is charged for. Data requests are handled by a special unit at DCCMS but data is generally not easily accessed through web services or API.

4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data.

DCCMS has mostly reliable access to several model and satellite data as well as other data products. These include:

- European Meteorological Satellite data from Meteosat operational system every 15 minutes through a PUMA platform (data originates from EUMETSAT not WMO).
- Numerical Weather Prediction (NWP) data is obtained four times daily; from GFS, ECMWF products (not the model output data), ICON, UM (Unified Model), ARPEGE, UKMO
- Global synoptic observations - GTS via the NetSys MSS
- Tropical Cyclone advisories from Tropical Cyclone Advisory Centre (La Reunion)
- Aviation meteorological data from Secure Aviation Data Information Service (SADIS)

- Flash-Flood Guidance Data - Southern Africa Flash-Flood Guidance System (SFFGS). There is no direct access between SFFGS and ODSS. SFFGS provides graphical output at 6, 12, 24 hours.

There has been improvement in the last couple of years in DCCMS's access to products provided by global and regional centers, especially with improved NWP and Satellite access. Still the access to products faces challenges regarding low bandwidth. There is an ongoing discussion with the network provider to improve the bandwidth. Some services like the CWIS platform for warnings are hosted outside Malawi due to this problem.

DCCMS is interested in accessing additional products such as:

- The model outputs data from ECMWF (not just charts).
- Greater access to the SFFGS data to be able to manipulate the data, e.g., changing the underlying NWP as needed to make the system more effective for individual countries.
- Radar data from neighbouring countries (Mozambique, Zambia, Zimbabwe, Tanzania).

Summary and comments for Element 4.3

DCCMS has access to satellite data from the Meteosat operational system, Numerical Weather Prediction (NWP) data from multiple global centres, global synoptic observations via the NetSys MSS, Tropical Cyclone advisories, aviation meteorological data, and Flash-Flood Guidance Data from the Southern Africa Flash-Flood Guidance System (SFFGS).

DCCMS needs access to less processed data and additional data from neighbouring countries.

Challenges relate to low bandwidth and DCCMS is in discussions with network providers to enhance bandwidth. Increasing bandwidth opens opportunities to receive larger data sets and make acquisition of existing data and dissemination of warnings and forecasts more secure and timely.

Summary score, recommendations, and comments for Element 4: 2

- Implement GBON national contribution plan with fully GBON compliant surface and upper air stations, including ICT and other necessary infrastructure for data sharing.
- Capabilities of the WIS2Box data sharing solution should be well maintained and upgraded (if necessary) and used as much as possible.
- Challenges using WIS2Box should be mapped and worked on with the help of WMO.
- Increased bandwidth and a more stable network is urgently needed.
- Implement API to share significant data sets.

- Work on agreements and data sharing facilities to access less processed output data from SFFGS.
- Work on agreements and data sharing facilities to access radar data from neighbouring countries.
- Review the data sharing policy and implement strategies therein in order to respond to current best data sharing practices.
- Build and improve capacity of DCCMS staff to enhance capabilities of its existing database system for long-time archiving and sustainable international exchange of observational data.

Element 5: Numerical model and forecasting tool application

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

DCCMS utilises various data processing and forecasting systems. These systems include Synergieweb and BARON workstations, which are capable of tailoring alerts. DCCMS also operates a PUMA satellite receiving station to acquire METEOSAT satellite imagery data.

DCCMS relies on SigWx charts from the Southern Africa RMSC to identify potential weather hazards in short-range forecasts. These charts are generated from Numerical Weather Prediction (NWP) analysis. Additionally, DCCMS accesses and utilises NWP outputs from sources like ECMWF charts (not gridded) and GFS in their forecasting processes.

The ICON gridded data is used to run the COSMO model as a Limited-Area Model (LAM) specifically designed for Malawi. Local NWP model data serves as input for other modelling and forecasting platforms, particularly for flood monitoring and the creation of customised agricultural and fisheries advisories.

Low network bandwidth at DCCMS impedes hosting warning platforms such as the CWIS used for the advisories for farmers and fisheries sector.

Summary and comments for Element 5.1
DCCMS utilises various data production and forecasting systems that are capable of tailoring alerts. They operate satellite receiving stations and utilise NWP outputs in their forecasting process. DCCMS and their stakeholders, including the public, would benefit greatly with more stable and better network connection.

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

DCCMS employs Numerical Weather Prediction (NWP) by running local weather models, namely COSMO and WRF, and utilising global weather model outputs such as GFS, ECMWF, and ICON. Currently, both COSMO and WRF provide deterministic NWP for specific limited areas, with COSMO offering a 5-day forecast and WRF extending to a 7-day forecast.

COSMO is in the process of being upgraded to ICON-LAM and can be run at resolutions of 7 km and 2.8 km. However, it lacks a data assimilation feature and has limited capacity. The model has been constructed with a focus on verification.

WRF is also undergoing an upgrade and will be capable of running at a 3 km resolution. Importantly, WRF is set to incorporate data assimilation using AWS (Automatic Weather Stations) data and will additionally generate seasonal forecasts with a built-in verification system.

Summary and comments for Element 5.2

DCCMS runs internally NWP based on COSMO and WRF, and utilises global weather model outputs from GFS, ECMWF, and ICON. COSMO and WRF both provide deterministic NWP for specific limited areas and are both being upgraded for higher resolution, and better options for data assimilation (WRF) and verification (WRF and COSMO).

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

DCCMS has the capability to post-process Numerical Weather Prediction (NWP) data using preset tools or platforms, particularly through a workstation equipped with Synergieweb. However, there is a limitation in terms of human resources for initiating post-processing.

Currently, DCCMS lacks the capacity for Ensemble Prediction Systems (EPS) in the Limited-Area Models (LAN) it utilises. The upcoming upgrade of the WRF model will include a probabilistic forecast option, and its inclusion is recommended to enhance forecasting capabilities.

Summary and comments for Element 5.3

DCCMS does not yet produce probabilistic forecasts and does not rely on ensemble predictions. New upgrade of WRF will include a probabilistic forecast option.

Summary score, recommendations, and comments for Element 5: 3

- Assess which model has the highest skill for Malawi for use in production of weather forecasts.
- Train staff in data assimilation, verification, and post-processing methods of NWP models.
- Implement probabilistic forecasting option of NWP model and train staff appropriately.
- Build capacity to automate office and public access to model outputs.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

The Department of Climate Change and Meteorological Services (DCCMS) operates aviation meteorological services, which are expected to be available 24/7 or as required. These services are provided at four airports in Malawi: Kamuzu International airport in Lilongwe, Chileka International airport in Blantyre, Mzuzu airport, and Karonga airport.

At Chileka and Kamuzu airports, the staffing includes 10 forecasters, 33 observers, 3 engineers, and 22 individuals working in finance, administration, and assistance. Mzuzu airport has 12 meteorologists who work in aviation weather, climate, and engineering services, along with 8 staff members handling finance and administration.

Karonga airport is served by 7 meteorologists who cover aviation meteorological services, climate services, and engineering services. Additionally, 5 individuals are involved in related administrative tasks.

Other services that DCCMS provides are not 24/7 and more on a daytime or ad-hoc basis.

Summary and comments for Element 6.1
Aviation meteorological services at airports are the only services provided 24/7. Other warning and alert services are carried out when needed.

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

There is a Multi-hazard Early Warning System (MHEWS) in Malawi and DCCMS provides info to the different sectors such as for health, animal, crops, weather, flash-floods etc. The main hydrometeorological hazards DCCMS provides warning services for are the following:

- Tropical cyclone warnings, in three stages: The Information stage, when the cyclone is in the Indian Ocean, but the likelihood of affecting Malawi is small; the Alert stage, when the cyclone is in the Mozambique Channel, and the chances of affecting Malawi are high; and the Warning stage, when the cyclone is getting closer to Malawi.
- Mwera (strong winds) and wave height warnings on Lake Malawi.
- Heavy rainfall associated with flood warnings (Flash-floods).
- Strong wind warnings.
- Lightning warnings/Thunderstorm alerts.
- Drought/ dry spells warnings
- Heat waves.
- Fog warnings.

Most of the relevant warnings are provided through DCCMS' website, social media and specific warning services, see below:

DCCMS operates **Aerodrome Meteorological Offices (AMO)** at Kamuzu International Airport Lilongwe and at Chileka International Airport in Blantyre. Services include provisions of TAF, METAR, SIGMET (at Kamuzu), flight weather reports, forecasts for low-level flights, aerodrome warnings, wind shear warnings and alerts. AMOs also provide meteorological services for search and rescue operations and support global data exchange via the AFTN (Aeronautical Fixed Telecommunication Network) and GTS (Kamuzu International Airport).

Flood monitoring and warning in Malawi is a shared and coordinated responsibility of DCCMS and DWR. DWR is mandated to monitor and warn on riverine flooding while DCCMS has the mandate over flash-flood monitoring and warning. Available tools for flood modelling and forecasting include the 1) Operation Decision Support System (ODSS) for riverine floods, 2) the Impact Based Forecasts (IBF), and 3) the Southern Africa flash flood guidance system (SAFFGS) for flash floods.

1) The **Operational Decision Support System (ODSS)** was initially developed in cooperation with DWR for the Shire River basin as part of the Shire River Basin Management Programme (SRBMP) funded by the WB to support forecasts and decisions in the Shire river basin and to enhance productivity and reduce climate risks through timely generation of flood warnings and access to such information. The ODSS uses hydro-meteorological data collected from ground and satellite-based observations to produce hydro-meteorological forecasts at both short-term and seasonal timescales. The ODSS hydrological forecasts are based on MIKE software products (models and operational framework), and these are now being upgraded to be based on HEC-RAS which is open source. It is currently operated by designated staff at both DCCMS and DWR. The ODSS has been operational since the start of the 2018/2019 rainfall season and successfully issued flood warnings during the season, the most extreme of which have been the March 2019 floods in the Shire due to the tropical depression which was the precursor to tropical cyclone Idai. It has now been extended to river basin catchments in the central and northern region of Malawi as part of activities under the M-CLIMES Project.
2) Impact Based Forecasts (IBF) are made through a GIS-based platform for the modelling, visualisation and issuance of warnings and impact-based information for both riverine and flash floods for North and South Rukuru rivers in northern Malawi.
3) DCCMS operates a **Flash-Flood Guidance System (FFGS)** which has been implemented as a part of the Southern Africa FFGS (SAFFGS). To address the issues associated with flash floods, especially the lack of capacity to develop effective flash flood warnings, the FFGS was designed and developed for interactive use by meteorological and hydrological forecasters throughout the world. DCCMS has been supported by the Hydrologic Research Center (HRC) and the WMO to build the capacity to operate the FFGS.

The Climate & Weather Information System (CWIS) platform is an electronic customised early warning service developed as part of an UNDP tender. It provides decision support for farming and fishing communities with daily weather alerts and warnings. The main parameters for daily weather forecasts include information on thunderstorms, waves, wind speed and wind direction.

The National Emergency Telecommunications Plan (NETP) has pointed out the challenges to effectively disseminate the vital warnings to the whole public in a timely manner as the telecom/ICT mechanisms are not currently effective enough. DCCMS staff member participates in meetings with NETP as an advisor. M-CLIMES, SAREPTA are projects to increase the audience of such warnings.

DoDMA takes stock of what type and location of disasters and carries out an assessment of the performance of the Multi-hazard Early Warning System (MHEWS) platform in the wake of disasters with participation of main stakeholders including DCCMS. Already there have been two sessions with stakeholders after tropical cyclone Freddy with another meeting planned to investigate the effectiveness of warnings. The full value chain is evaluated, from measurements to warnings, including telecommunication systems and dissemination processes. These meetings might be more quantitative, but already they have proved useful for improvements of the MHEWS. A basic performance assessment was executed on where and how fast warnings were disseminated. The assessment showed that MHEWS would improve substantially with better support from mobile services. Today, DCCMS is working on new agreements with a mobile company to enhance these services.

It would be valuable to increase formal discussion on what services and data are available from DCCMS and DoDMA's needs.

Summary and comments for Element 6.2

The main hydrometeorological hazards covered by DCCMS include tropical cyclones, strong winds and high waves on Lake Malawi, heavy rainfall and flash-flood warnings, strong wind and thunderstorm/lightning warnings, drought and dry spells alerts, heat waves, and fog warnings.

Examples of warning services offered by DCCMS include operation and support for flood management systems (ODSS, IBF, FFGS), tailored services for farmers and fishermen around Lake Malawi (CWIS platform). DCCMS also provides aerodrome meteorological services at key airports, offering various aviation-related forecasts and warnings.

There are challenges in effectively disseminating vital warnings to the entire public due to limitations in the current telecommunication and information and communication technology (ICT) mechanisms. Efforts are underway to enhance these services through projects like M-CLIMES and SAREPTA. DCCMS collaborates with the National Emergency Telecommunications Plan (NETP) to address these challenges.

DCCMS actively participates in assessments and discussions with stakeholders to evaluate the performance of the MHEWS platform, focusing on the entire warning value chain. The assessments have led to improvements, including the need for better support from mobile services. DCCMS is currently working on new agreements with mobile companies to enhance these services.

Overall, DCCMS plays a vital role in providing early warning services to various sectors and is continuously working to improve and expand its offerings to meet the needs of its stakeholders.

6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities.

DCCMS has begun issuing warnings in the Common Alerting Protocol (CAP) format. These CAP warnings are e.g. integrated into the Climate & Weather Information System (CWIS)

for Farmers and Fishers in Malawi, enabling the issuance of CAP warnings for specific designated areas when necessary. Example of CAP warning:

https://wimes-malawi.brl.fr/api/cap/alert/urn:uuid:f017003b-020c-4b59-987f-d1375a54aac7.xml District/local CAP warning

While not all warnings issued by DCCMS include CAP messages, the department aims to improve this ratio, and a new app under development will include CAP warnings.

DCCMS utilises Multi-Hazard Early Warning System (MHEWS) Protocols during hazardous events.

Impact-based forecasts and warnings are provided to some extent but are not yet regular. The CWIS platform includes elements of impact-based forecasts and warnings, but more specific forecasts are required, particularly those addressing who will be affected and to what extent. The IBF (Impact-Based Forecasting) platform used for flash-flood warnings might serve as a starting point to overlay demographic data and provide more detailed impact forecasts.

Summary and comments for Element 6.3

DCCMS has started using CAP format for warnings within specific projects such as the CWIS platform for farmers and fishers. The ratio of CAP formats in other warnings and advisories is much less but will be improved in near future.

Impact-based forecasts and warnings are provided to some extent but are not yet regular.

Summary score, recommendations, and comments for Element 6: **3**

- Increased bandwidth and a more stable network is urgently needed.
- Cost-recovery model of Aviation Meteorological Service provision should be evaluated.
- Warning and advisory services offered through the DCCMS website should be promoted in various sectors.
- Cooperation with main stakeholders should be continued to implement tailored warning and advisory services as needed.
- The process of dissemination of warnings and services should be simplified if possible.
- Close cooperation with other departments is essential to reach as many as possible for disaster risk reduction.
- Follow up on the improvements suggested in the assessment of MHEWS platform in the wake of recent disasters.
- Increase the use of CAP warnings.
- Start planning and implementing impact-based forecasts and warnings.
- Extend successful warning and forecasting projects and products to other communities and districts (e.g. the PISCA project).

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate service

DCCMS is taking steps to enhance climate service delivery and contribute to national adaptation planning. The key mechanisms for coordinating climate services are mainly outlined in the National Meteorological Policy (NMP) and National Climate Change Management Policy (NCCMP). Today there are grey areas in the governance structure regarding the responsibility of different governmental establishments which will become better constrained when a new Meteorological Act will be implemented and aligned to a revised version of the NCCMP. Both will feed into a new National Framework for Climate Services (NFCS) to be finalised for launch by mid-2024. The draft NMP is aimed at regulating all climate service delivery efforts, whereas the NCCMP provides the guidance. The NFCS will align climate services deliveries to WMO requirements.

Several components are needed to be able to provide basic climate services:

Observing networks are available but are limited due to limited maintenance resources;

Data and data management systems are in place although there are data gaps that will require sufficient capacity to objectively fill missing gaps. Lack of resources and infrastructure hampers fully digitisation of data in a timely manner;

Performance of **monitoring** is relatively good;

Forecasting systems that allow the production of climate information are available although extra work is needed on forecast verification and presentation of uncertainty;

Delivery is, however, basic with limited channels and limiting spatial and temporal dissemination of information (forecasts) resulting in generalised forecasts. Access to TV and internet is limited in rural areas so SMS, radios, and stakeholder meetings are used for dissemination. There is an opportunity to increase dissemination through different means, including the DCCMS website.

Specific Climate Services have been implemented in recent years, e.g. within different development projects such as M-CLIMES, to make different sectors better prepared to take climate related decisions. These decisions support products and services include:

- **Annual rainfall season forecasts** are issued for all districts on which drought forecasts, seasonal outlooks for crop planting, and crop weather insurance are based on. The 2023/2024 forecast was published in a meeting with main stakeholders on September, 25, 2023, and will be updated again in December. For news on this event see:
    - https://www.facebook.com/photo?fbid=625179533125784&set=a.232422952401446
    - https://www.facebook.com/photo/?fbid=327525543192896&set=pcb.327521486526635 https://www.facebook.com/NaturalResourcesMalawi/
- **10-day weather and agrometeorological outlooks** are published during the rainy season from November to April which could forecast riverine floods, flash floods and droughts.
- **Participatory Integrated Climate Services for Agriculture (PICSA)** is a participatory approach for climate services and agricultural extension, developed by researchers at the University of Reading. PICSA aims to support smallholder farmers to make informed decisions under variable and changing climatic

conditions. It does this through combining: i) accurate, locally-specific climate and weather information, ii) locally relevant crop, livestock and livelihood options, and iii) participatory decision-making tools. In 2021, a total of 640,000 small-holder farmers in 14 districts now receive seasonal weather forecasts through mobile text messaging services (SMS) ahead of the cropping season which help them to increase farm incomes, improve food security and make positive changes to their crop enterprises.

- **CWIS platform - Decision support for fishing communities.** In addition to giving daily weather alerts for farmers and fishermen, the CWIS platform also provides weekly weather forecasts aimed at fish processors and traders at a district and sub-district scale. The main parameters for daily weather forecasts include information on thunderstorms, waves, wind speed and direction while the weekly forecasts for the fish processors must also contain information on rainfall, temperature, cloud cover etc.
- **Operational Decision Support System** (ODSS) (electronic) does, in addition to short-term forecasting functions (see element 6.2), operate on a seasonal timescale. It supports e.g., seasonal forecasts of flows and water levels in the river basin including Lake Malawi to support water infrastructure operation (Kamuzu barrage), drought monitoring, and crop calendar providing seasonal rainfall predictions and information relating to planting times and other agricultural activities.

In addition, DCCMS has a mechanism for co-design and co-production of tailored products and services. On their website, DCCMS lists various services they provide for different sectors https://www.metmalawi.gov.mw/dccms_services.php. Below are examples of tailored services or information delivery (from DCCMS website):

Aviation Services
Water Resources
- Dam design
- Flood disaster
- Information on drought monitoring, prediction, warning and management

Energy
- Information for utilization of:
- Hydropower
- Wind Energy
- Solar energy

Building and Construction Industry
- Road Construction
- Building Construction
- Installation of plant

Retail
- Weather information for marketing strategies

Insurance
- Information for utilisation of Insurance claim settlement

Environment
- Climate change Information

Legal
- Evidence in courts for weather related cases

Road and Railway Transport
- Weather information for road or railway line usage.
- Sport and recreation

- Forecasts for yachting marathon
- Forecasts for soccer matches

Health

- Weather information for prediction of disease outbreaks and planning
- Meteorological information for research

Banking

- Weather/climate forecasts for agricultural loans

There are many mechanisms used to reach the different communities and sectors and to get feed-back and provide channels for discussion between climate service users and providers. Sector-specific WhatsApp groups are used for communication with agriculture, fisheries, DRM, environment, media, and health sectors. Platforms for feedback and co-production and tailoring of services are, however, missing for the transport and infrastructure sectors as well as for private sector participation.

Community radios are still one of the best options to reach rural areas and due to the challenges that come with multilingual society information for decision making is now translated into local languages (currently 3).

The capacity development needs for climate service provision and use have not been mapped specifically. Technical advisory services and training for the DCCMS staff members has not been on a regular basis, but instead more ad-hoc, e.g. within projects and initiatives with WMO and development partners. Capacity building in the M-CLIMES project has been important for the DCCMS staff, but crucial for the participants of the different training sessions during implementation of the climate services.

The socio-economic benefits of these different products and services have not been holistically evaluated although evaluation of the PISCA project has shown the greatly positive impact on individuals and the society, both on short and long timescales. Moreover, the countless statements from individuals receiving the various information manifest their gratitude and indicate a better living environment due to the decisions made based on the services.

A cost-benefit analysis (including socio-economic benefits) of the services DCCMS provide, would be very valuable and would provide a strong argument in the request for increased and more stable funding of the services.

Summary and comments for Element 7.1

To provide basic climate services, several components are in place:

- Observing networks are available but require maintenance and resources.
- Data and data management systems exist but have data gaps and limited digitization.
- Monitoring performance is relatively good.
- Forecasting systems enable climate information production but require improvement in forecast verification and uncertainty presentation.
- Delivery methods are basic, with limited channels for spatial and temporal information dissemination. Expanding dissemination through various means is an opportunity.

The department actively engages in co-designing and co-producing tailored products and services for various sectors, promoting disaster preparedness, information for energy, construction, retail, insurance, environment, transportation, sport and recreation, health, banking, and more.

DCCMS has introduced specific climate services including:

- Climate services for agriculture, including seasonal outlooks, short-term agro-weather forecasts, and crop weather insurance.
- Participatory Integrated Climate Services for Agriculture (PICSA), supporting smallholder farmers with accurate climate information and decision-making tools.
- Decision support for fishing communities (CWIS platform).
- Operational Decision Support System (ODSS) in cooperation with the Department of Water Resources.
- Impact-based forecasts.

Various mechanisms are used to engage with communities and sectors, including sector-specific WhatsApp groups and community radios to reach rural areas.

The capacity development needs for climate service provision and use have not been systematically mapped. Similarly, the socio-economic benefits of these services have not been holistically evaluated, but anecdotal evidence suggests a major positive impact on individuals and society. A cost-benefit analysis, including socio-economic benefits, could help secure increased and more stable funding for these services.

Summary score, recommendations, and comments for Element 7: 3

- Underlying components of climate services such as observation networks, data and data management systems, forecasting systems and dissemination services all need to be enhanced, see elements above.
- Cooperation with stakeholders to produce co-financed tailored climate services is a priority.
- Sustainability of present climate services through additional and/or prolonged funding needs to be secured.
- Systematically map out the capacity development needs for climate service provision.
- Analyse the socio-economic benefits of climate services.

Element 8: Contribution to hydrology

8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community.

The Department of Water Resources (DWR) is responsible for operational hydrological services in Malawi including collection of hydrological data, water resource assessment and for hydrological forecasting. DCCMS provides precipitation data to the DWR as well as other necessary data. The two departments cooperate closely together on hydrological forecasting, see 8.4.

Summary and comments for Element 8.1
DWR is responsible for operational hydrological services in Malawi. DCCMS collaborates closely with the Department, providing precipitation data and other necessary information for hydrological forecasting in which field they cooperate closely.

8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

Multi-hazard Early Warning Protocols serve as Standard Operating Procedures (SOPs) to formalize the working relationship between the Meteorology and Hydrology sections. The National Early Warning sub-technical committee and the DRM Act (2023) provide formal mechanisms for regulating activities between the National Meteorological Service (NMS) and National Hydrological Service (NHS) on a regular basis.

The National Early Warning sub-technical committee helps coordinate disaster risk reduction activities and operational hydrology through the "Operational Decision Support System (ODSS)" platform. Additionally, the National Water Regulatory Authority (NWRA) coordinates water activities, primarily focusing on water resources.

Summary and comments for Element 8.2
Multi-hazard Early Warning Protocols serve as Standard Operating Procedures (SOPs) to formalise the working relationship between the Meteorology and Hydrology departments. Other formal mechanisms for regulating activities between them are also introduced within disaster risk reduction platforms.

8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development.

On a national level, data/information is shared among DWR, DCCMS and DoDMA; Internationally cooperation has been initiated with Tanzania on Songwe River Basin. Plans for data/information sharing with Mozambique are being considered through DoDMA. No real agreements are in place.

Summary and comments for Element 8.3
Although various hydrological data is shared between agencies both nationally and internationally no real agreements are available.

8.4 Joint projects/initiatives with the hydrological community designed to build hydrometeorological cooperation.

There are several projects/initiatives designed with the hydrological community to build hydrometeorological cooperation, such as: (i) the Songwe River Management Project between Malawi and Tanzania; (ii) Shire River Basin Management Programme (among local institutions); (iii) North and South Rukuru rivers flood forecasting system development – joint operation of UNICEF, DCCMS, DODMA and DWR to develop and operationalize the IBF; (iv) Flood management program under Malawi Resilience and Disaster Risk Management Project (MRDRMP).

Flash flood monitoring using the FFGS started as a Southern African initiative and worked jointly with the Hydrologic Research Centre (USA) and the WMO. HRC has provided physical and online training to DCCMS and DWR officers both in Malawi and at their premises. See more in Element 6.

Summary and comments for Element 8.4
Several projects/initiatives are designed with the hydrological community to build hydrometeorological cooperation, nationally and internationally.

Summary score, recommendations, and comments for Element 8: **3**

- Work on agreements and data sharing facilities to access less processed output data from SFFGS to be used for flash flood warnings and forecasts.

Element 9: Product dissemination and outreach

9.1. Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?).

DCCMS is working on a Climate Change and Meteorological Communication Strategy which will take into account the different means of dissemination of information. DCCMS uses various channels to reach its users with weather and climate information. These channels include daily updates through radio, TV, the website, social media platforms like Facebook, WhatsApp, email, and Twitter. Additionally, there is a specific CWIS platform tailored for farmers and fishers, which provides alerts. SMS is used for disseminating specific warnings, such as lightning and agro-related alerts. DCCMS is also working on developing a weather app, which is expected to launch a prototype early 2024. Phone conversations are another means of communication with users and stakeholders. Meetings of different sizes and at various locations are used to disseminate information. For instance, the recent National Climate Forum where seasonal forecasts for 2023/2024 were published is an example of such dissemination.

The Disaster Risk Cluster meets when a disaster occurs, but there is a need to enhance its effectiveness at other times. Additionally, improving the connection with TV broadcasting companies is important, as there are challenges with VPN reception. DCCMS is working on educating these companies about the importance and benefits of early warnings to enhance their commitment to broadcasting forecasts and warnings. One way could be through invitations to the regional meetings.

Summary and comments for Element 9.1

A Climate Change and Meteorological Communication Strategy is in the making. DCCMS uses various channels to reach its users with weather and climate information, including social media platforms, radio and TV. Tailored warnings through specific platforms are also available and a new weather app with warnings is in the implementation phase. Phone conversations and meetings are also used for dissemination.

There is a need to educate the broadcasting companies of the societal benefit of early warnings.

9.2. Education and awareness initiatives in place.

DCCMS conducts various awareness initiatives to promote weather, climate, and meteorological hazard awareness. While specific programs at schools are limited, DCCMS participates in meetings and visits to raise awareness about weather and climate-related issues. The week of the International Weather Day is used for specific promotion of weather and climate awareness.

As a part of the M-CLIMES and other projects such as the Adaptation Fund supported by the WFP, DCCMS has implemented education and awareness programs for farmers and fishers, focusing on weather hazards and safety at Lake Malawi. In 2021, these initiatives

reached around 10,000 individuals through community awareness programs, including fishermen, fish processors, and people involved in fish trading, to improve their understanding of weather hazards and enhance safety at the lake.

DCCMS also contributes to updating the syllabuses of institutions like Malawi University of Science and Technology (MUST) and Lilongwe University of Agriculture and Natural Resources (LUANAR). Additionally, the Department of Fisheries (DoF) has integrated climate change and early warning modules into the curriculum at Malawi College of Fisheries.

The Trans-African Hydro-Meteorological Observatory (TAHMO) initiative has installed weather stations at schools and educates students about weather and climate.

While there are various ongoing initiatives, there are opportunities to enhance education and awareness at different levels of society. This includes raising awareness of the benefits of disaster preparedness at a higher governmental level. DCCMS has engaged with the Ministry of Education (MoE) and Ministry of Health (MoH) during hazardous tropical storms to promote disaster risk mitigation strategies, such as home-stays for students and the proactive movement of relief supplies to areas likely to be affected by storms.

Efforts to target young people through electronic media are also considered as a valuable platform for awareness initiatives.

Summary and comments for Element 9.2

DCCMS has through specific projects (e.g. M-CLIMES) implemented education and awareness programs for designated sectors. Other awareness initiatives are more ad-hoc without formal platforms or plans. There is a growing need to raise awareness of weather, climate and disaster risk reduction at all levels of the society, also at the higher governmental levels. Electronic media will play a significant role in targeting young people.

9.3. Special measures in place to reach marginalized communities and indigenous people.

Gender-specific awareness initiatives have been implemented as part of the M-CLIMES project, and these efforts have been monitored to assess their impact. The project has aimed to raise awareness about weather and climate-related issues among different gender groups. The TAHMO program raises awareness of weather-related hazards and climate change for youth.

DCCMS has made efforts to raise awareness among the elderly in communities, particularly in rural areas, especially considering their vulnerability to climate-related hazards. However, these initiatives have not been systematically monitored to assess their progress and impact. One potential opportunity to enhance awareness and improve the dissemination of weather and climate warnings is to engage young people who have access to smartphones and up-to-date warnings.

Young people, often more tech-savvy and connected, can play a crucial role in conveying weather and climate information to their elderly relatives living in rural areas. By

leveraging the capabilities of smartphones and mobile communication, they can help bridge the gap and ensure that important warnings and information reach vulnerable elderly populations. This approach has the potential to improve the resilience of communities and enhance disaster preparedness.

Summary and comments for Element 9.3

Specific actions have been taken to reach elderly people in rural communities and gender-specific awareness has been implemented as a part of M-CLIMES. There are many opportunities to engage youth in conveying information to their relatives in rural areas.

Summary score, recommendations, and comments for Element 9: 3

- Finalise Weather and Warning app and implement its use at DCCMS.
- Campaign for the use of the app.
- Recruitment of public relation specialists to map the most effective way to target different sectors, gender, and age is recommended.
- Finalise DCCMS Climate Change and Meteorology Communication Strategy.
- Enhance the cooperation with the local assemblies for revived and effective operations of District Climate Change and Climate Information Centers or similar bodies to disseminate information on warnings and climate.
- Enhance civil education of governmental stakeholders to understand the importance of weather and climate information, warnings, and forecasts.
- Continue civil education for selected sectors such as farmers and fishermen.
- Meaningful partnerships with the broadcasting companies and media including enhancing their capacity on the societal benefit of early warnings.
- Make better use of the cooperation with universities (e.g. MUST and LUANAR) to produce and distribute information on weather and climate.
- Activate youth to convey information from electronic media to relatives in rural areas.
- Explore fast and effective means of disseminating flash-flood now-casts and warnings.

Element 10: Use and national value of products and services

10.1. Formalized platform to engage with users in order to co-design improved services.

The development of the National Framework for Climate Services (NFCS) is a significant step to enhance user engagement and co-production of climate services in Malawi. The draft NFCS has been finalised, but its official launch and operationalization are still pending.

In addition to the NFCS, other platforms and strategies are in place to facilitate user engagement and communication. These include the National Disaster Risk Management (DRM) Communication Strategy, which helps coordinate efforts related to early warning and risk reduction. The National Early Warning Sub-technical Committee plays a key role in this context.

Furthermore, DCCMS fosters links with civil society organisations and non-governmental organisations (NGOs) through the Civil Society Network on Climate Change (CISONECC). This collaboration allows for a broader outreach and engagement with various stakeholders involved in climate services, climate change and disaster risk management.

A SOFF stakeholder meeting in September 2023 (Annex 5) served as a platform for productive dialogue on the services and products provided by DCCMS. The feedback and discussions from this meeting provide valuable insights for further improvements in climate services and communication with users, and it is important to continue this engagement. The report from the meeting is available here.

Summary and comments for Element 10.1
There are several formalised and informal platforms and strategies within the disaster risk management sector to facilitate user engagement and communication. Moreover, the soon to be implemented National Framework for Climate Services (NFCS) will provide a similar platform for the climate sector. Informal meetings with targeted sectors and stakeholders provide important insight into societal needs. It is recommended to continue such meetings on a regular basis to further improve climate and disaster risk management services.

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

It is crucial for organisations like DCCMS to regularly assess the accuracy and timeliness of their services to ensure that they meet the needs of users effectively. While baseline surveys were conducted in 2018, it's essential to conduct independent user surveys periodically to gather feedback, identify areas for improvement, and measure the performance of services. Implementing regular review mechanisms is a standard practice in the field of climate and meteorological services. However, it's noted that such reviews have not been conducted, and there are currently no formal means for these assessments.

It is strongly recommended that DCCMS establish a system for regular review, measurement, and evaluation of their services to enhance their accuracy and timeliness continually. This will contribute to better meeting the needs of users and improving the overall quality of climate and meteorological services provided.

Summary and comments for Element 10.2

Today there are no formal means for regular review on the accuracy and timeliness of DCCMS services although such evaluation is recommended as a standard practice.

It is strongly recommended that DCCMS establish a system for regular review, measurement, and evaluation of their services to enhance their accuracy and timeliness continually.

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

The implementation of Quality Management Systems (QMS) in DCCMS, particularly for international air navigation, has been partially initiated, aligning with ISO 9001:2008 standards. However, the QMS implementation has not been fully certified by organisations like BSI (British Standards Institution) or similar service providers. Furthermore, it has not been updated to the ISO 9001:2015 standard, which is the latest version.

Lack of funding has been a significant challenge for the full implementation of QMS, and specific funding requests for this purpose have not been met. In addition, the initial steps taken for QMS implementation in other parts of DCCMS, including training of QMS managers and raising awareness of data management, have been interrupted due to changes in human resources, necessitating a restart of the process. This has resulted in the current implementation being at a standstill.

While informal Standard Operating Procedures (SOPs) are available for some services, especially those implemented within the M-CLIMES project and related to early warning (EW) protocols, these SOPs are not well-documented. There is a pending proposal for the procurement of QMS for climate services, indicating the intention to further enhance quality management within DCCMS. The full implementation of QMS, certification, and documentation of SOPs are crucial for ensuring the quality and effectiveness of climate and meteorological services.

Summary and comments for Element 10.3

DCCMS has made only partial progress in implementing a Quality Management System (QMS) within its international air navigation services. This implementation remains at ISO 9001:2008 standards and has not achieved certification.

Funding constraints have hindered the full implementation of QMS across various parts of the organisation. Addressing the financial aspect is crucial for realising a

comprehensive and certified QMS, which is essential for ensuring the quality and effectiveness of services provided by DCCMS.

Summary score, recommendations, and comments for Element 10: 3

- Initiate a formal platform for enhanced user engagement and co-production of climate services.
- Promote regular informal meetings with targeted sectors and stakeholders for insights of societal needs.
- Establish a system for regular review, measurement, and evaluation of their services to enhance their accuracy and timeliness continually, including sector-based assessment surveys.
- Use results of assessment surveys to improve the services where needed.
- Prepare an instalment plan for implementing a Quality Management System, fully compliant to ISO 9001:2015 for the whole Department.
- Implement QMS on a Department scale basis.

Annexes

Annex 1 Consultations (including experts and stakeholder consultations)

Consultation with DCCMS and stakeholders to collect information for the Country Hydromet Diagnostics report was fourfold; 1) Questionnaire; 2) In-person consultation sessions; 3) Bi-weekly meetings; and 4) Email correspondence.

1) A **questionnaire** was made based on the elements in the Country Hydromet Diagnostics and sent to DCCMS.
2) Four **in-person consultation sessions** were held during the peer-review process.
    a) The first SOFF session was held in Blantyre, Malawi, April 17-21, 2023 simultaneously with a SAREPTA workshop. The SOFF session was mostly directed towards the SOFF Gap Analysis and the National Contribution Plan; however, a wealth of information was acquired during both the SAREPTA workshop and SOFF session and used for the Country Hydromet Diagnostics report.

    Main DCCMS experts: Amos Mtonya, Clement Boyce, Edwin Frank Tadeyo, Hussein Milanzi

    Peer-advisors: Kristine Gjesdal, Elinah Kuya, Jórunn Harðardóttir

    b) A second SOFF session was held at Met Norway in Oslo, Norway on June 9th where the peer-advisors planned next steps for the CHD.

    SOFF Peer-advisors: Kristine Gjesdal, Elinah Khasandi Kuya, Jórunn Harðardóttir

    c) A third SOFF session was held at Met Norway in Oslo, Norway on August 22-24, 2023 also concurrent with a SAREPTA workshop. This session focussed on the CHD questionnaire which had been sent out to DCCMS earlier.

    Main DCCMS experts: Lucy Mtilatila and Amos Mtonya

    SOFF Peer-advisors: Kristine Gjesdal, Elinah Khasandi Kuya, Jórunn Harðardóttir, and Tor Ivar Mathisen

    d) DCCMS organised a SOFF stakeholder meeting in Lilongwe on September 18, 2023 which was attended by over 40 specialists from different governmental agencies, industrial partnerships, telecommunication and ICT companies, NGOs, main universities, and donor funding organisations (e.g. UNDP, FAO, UNICEF, World Bank). The main objectives and the structure of the SOFF project were introduced and followed with a good group discussion on 1) Engagement of stakeholders in service delivery and product development, 2) Challenges and opportunities in dissemination of forecasts and warnings, and 3) Opportunities for Public-Private- Partnerships. The peer-advisors took part in the group discussion and collected information used in the CHD process. A report on the meeting with more information and attendance list is attached in Annex 5.

    Following the stakeholder meeting a specific CHD session was held (September 18-19, 2023) where DCCMS staff members were consulted on different elements of the CHD report.

Main DCCMS experts: Lucy Mtilatila, Amos Mtonya, Charles Vanya, Clement Boyce, Hussein Milanzi.

Peer-advisors: Kristine Gjesdal, Elinah Khasandi Kuya, Jórunn Harðardóttir, Teferi Dejene Demissie.

3) Bi-weekly meetings have been held when possible with DCCMS, peer-reviewers and the implementing entity (UNDP) to discuss the progress of SOFF reporting, including the CHD report.

   Main DCCMS expert: Amos Mtonya

   Peer-advisors: Kristine Gjesdal, Elinah Khasandi Kuya, Jórunn Harðardóttir

   Implementing entity (UNDP): Rabi Narayan Gaudo, Ted Nyekanyeka

4) Peer-advisors and designated SOFF staff at DCCMS have also been in email correspondence regarding different issues and data sharing of additional information throughout the report writing.

Annex 2 Urgent needs reported

The recommendations outlined in each chapter pertaining to elements 1-10 are essential steps aimed at improving DCCMS services and advancing the department's maturity to a higher level.

The following recommendations have been assessed as the most promising in addressing the critical needs identified in this report:

1. Improvement of the **governance structure** of DCCMS by establishing Meteorological act and policy with clear mandates for different stakeholders.
2. Address the **financial challenges** and opportunities for funding for proper management of DCCMS. This will enhance regular **recruitment of competent staff** at DCCMS including having capacity to acquire, maintain and effectively manage DCCMS infrastructure.
3. Observational data is essential for the hydrometeorological value chain, priority should thus be put on having a **functional and sustainable observational infrastructure** at DCCMS including station maintenance and calibration, data quality control and data management practices including a **holistic ICT infrastructure** and services fit for acquisition and archiving, processing and automated data transmission in real time via WIS 2.0.
4. Essential work is needed to align **warnings and forecasts systems with new standards and procedures** such as Weather App, CAP warnings, Impact Based Forecasts (IBF), and probabilistic forecast options.
5. Effective **formal/contracted collaborations with relevant stakeholders** both for service delivery and maintenance and operations observation network. Emphasis should be on sustainability of these partnerships, and they have to be both fit for purpose and fit for budget for DCCMS.
6. Operationalize the **National Framework for Climate Services** (NFCS) user platform that will enhance user engagement and co-production of climate services.
7. Considerable efforts are required to **ensure the dissemination of information, warnings, and forecasts** to the entire society, spanning from governmental stakeholders to end users in rural and urban areas.

Annex 3 Information supplied through WMO

- WMO Global GBON gap Analysis
- WMO Monitoring System Data
- WMO Hydrology Survey
- Data from the Checklist for Climate Services Implementation
- WMO Projects documentation

Annex 4 List of materials used

The references are listed by each chapter/element in the order they are referred to.

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Annex 5 Report of SOFF stakeholder meeting

MINISTRY OF NATURAL RESOURCES AND CLIMATE CHANGE
DEPARTMENT OF CLIMATE CHANGE AND METEOROLOGICAL SERVICES

REPORT ON

SYSTEMATIC OBSERVATIONS FINANCING FACILITY (SOFF) STAKEHOLDERS CONSULTATION WORKSHOP

JOINT ACTIVITY WITH THE NORWEGIAN METEOROLOGICAL INSTITUTE AND ICELANDIC MET OFFICE

September 2023

Introduction:
Malawi through the Department of Climate Change and Meteorological Services (DCCMS) is applying for support from the World Meteorological Organization (WMO) facilitated systematic observations financing facility (SOFF) which is aimed at supporting surface and upper air observations in countries in order to ensure the regular and continuous availability of observation data globally. SOFF support will ensure that Malawi has surface and upper air stations that comply to the requirements of the Global Basic Observation Network (G-BON) in terms of the frequency of reporting observations and meteorological parameters being observed. These observations are important for the effective operations and output from numerical weather modelling centres that are part of the Global Data-processing and Forecasting System of WMO. DCCMS is being supported by National Meteorological Institute of Norway (Met Norway) as the Peer Advisor, Icelandic Met Office on the Country Hydromet Diagnostics, and UNDP Malawi as the implementing entity.

As part of SOFF preparations, a stakeholders' workshop was jointly organized by DCCMS and Met Norway with the aim of sensitizing stakeholders as partners in climate services delivery and SOFF and to discuss opportunities for arrangements that would complement SOFF as one means of sustaining weather monitoring and climate services delivery by DCCMS. The meeting was held on 18 September, 2023 at Capital Hotel, Lilongwe. Invited stakeholders included government ministries, departments and agencies; the academia, development partners and civil societies. These were from climate sensitive sectors such as agriculture, disaster risk management, energy, fisheries, water resource management, telecommunications and transport.

The Workshop Presentations and Group Work:
It was officially opened by the Director of Climate Change and Meteorological Services. Presentations were made on (i) weather and climate services by DCCMS including its current human and infrastructural status and challenges, (ii) Introducing SOFF, its processes and Malawi's SOFF status by Elinah Khasandi Kuya of Met Norway, and (iii) the country hydromet diagnostics by Jórunn Harðardóttir of Icelandic Met Office.

Groups assignments followed during which the stakeholders were divided into three groups to discuss the issues below:

1. Engagement of stakeholders in the service delivery

- Can DCCMS provide new, changed and better service tailored to the needs of stakeholders?
    - What do you need?
    - What can they provide?
    - Opportunities for co-financed services?

2. Dissemination of the forecasts and warnings

- How can improved cooperation between sectors enhance dissemination to the public?
- What is needed to enhance such cooperation?
- What are the challenges and priorities for sustainable climate services

3. Opportunities for PPP (Public-Private-Partnerships)

The discussions from the groups were presented and summarized as below;

1. Engagement of stakeholders in the service delivery

- Stakeholders are fine with the current services being provided by DCCMS; however there is a concern that there is limited awareness on the services, they can also benefit more from services and products that are tailored to specific sectors. Service agreements and increased coordination between DCCMS and stakeholders was recommended.
- On new and better services, platforms for engagement and research were recommended as means of improving the understanding of users' needs.
- Engagements would also help to understand more on the willingness of stakeholders to pay for services as well as co-financing of some services. Some recommendation on co-financing included co-production and co-managing of some resources such as data.
- It was also felt that an improved observation network would help DCCMS to provide better area specific services.
- Services needed by stakeholders included timely and more accurate weather information, (ii) improved micro-scale services for insurance, and (iii) improved and automated means of data and information access.

2. Dissemination of the forecasts and warnings

- Recommendations on improved cooperation to enhance dissemination of weather and climate information included (i) cooperating with the media (community radios, hosts of media platforms, extension services partners (agriculture, fisheries) as means of disseminating information, (ii) parliamentarians as means of lobbying for more funds and (iii) the local communities who need timely and accurate disseminated information.
- In order to enhance the cooperation, groups recommended (i) designing projects that are more inclusive, (ii) lobbying for political support to enhance cooperation in dissemination, (iii) establishing relevant working groups, SOPs for engagement and adherence to policies and strategic frameworks.
- Observed challenges to sustainable climate services included (i) use or adoption of technologies for communication and dissemination (mobile and internet services), (ii) inadequate capacity to provide information in several languages, (iii) vandalism and high cost of monitoring equipment and, (iv), limited knowledge at all levels. Recommendations include improving on coordination, data sharing and assurance of data quality; procurement of sensible equipment, etc.

3. Opportunities for PPP (Public-Private-Partnerships)

- Proposed recommendations for PPP included partnerships in data management (repositories) for hydro-met; partnerships with media for subsidized rates to information dissemination, and mobile service providers on utilization of technologies.
- Also recommended are the partnerships with institutions to identify value addition needs for demanded climate services to enable cost recovery operations, and to also undertake the cost-benefit analysis of climate services and use in justifying for resources needs.

Way Forward:

Appreciating the contributions and recommendations that were made by stakeholders, there is a need for continued unilateral and multilateral engagements with potential partners in order to realize the sustainability of climate services. There is potential for partners to help with managing stations and ensuring their G-BON compliance. DCCMS will need to be engaging partners actively.

The Program for SOFF Stakeholder Consultation is provided below:

Time	Activity	Who?
08:15 - 08:45	Registration	DCCMS
08:50	Introductions	ALL
09:00	Opening remarks and meeting objective	Director DCCMS/ MET Norway
09:00-10:00	Presentation1: SOFF (what it is ; SOFF processes; Malawi SOFF status	DCCMS/ MET Norway
10:00-10:30	Presentation2: DCCMS Overview: human, infrastructure; services; alliances	DCCMS
BREAK		
11:00-11:30	Presentation 3: Country Hydromet Diagnostics	Iceland Met Office
11:30-12:30	Plenary	DCCMS/
LUNCH		
13:30-15:30	Role of stakeholders in SOFF and sustainability of climate services - hosting of monitoring systems - communication - GBON compliance - co-benefiting (e.g., tailoring of products; data sharing; real-time access)	Groups work/ Plenary Led by Dr Kamdonyo
15:30-16:00	Way forward	DCCMS
16:00	Closing remarks	Director DCCMS
16:10	Logistics	

List of participants is given below:

No	Name	Affiliation
1	Dr. Lucy Mtilatila	DCCMS
2	Hussein Milanzi	DCCMS
3	Clement Boyce	DCCMS
4	Amos Mtonya	DCCMS
5	Charles Vanya	DCCMS
6	Blessings Phariwa	EGENCO
7	Demdrich Frederich	NCJ
8	Donald Kamdonyo Dr.	Kamdonyo & Associates
9	Malazi Mkandawire	MUST
10	Llloyd Phaphira	NASFAM
11	Maurice Makuwira	Department of Fisheries
12	Clement Shama	Farm Radio Trust
13	Paul Malekano	Ministry of Natural Resources and Climate Change
14	Chrispine Jangale	Economic Planning & Development

15	Abel Chiwatakwenda	LUANAR
16	Joseph Kanyangalazi	DLRC
17	Divine Jere	EP&D (M&B)
18	Maxon Ngochera Dr.	Fisheries
19	Ruttia Kayange	Forestry
20	Maggie Munthali	MWAPATA
21	Ida Mwato	Crop Development
22	Precious Phiri	YCD
23	Julius Ngóma	CISONECC
24	Joel Nyirongo	TNM
25	Edwin Zawanda	DoDMA
26	Elemess Kawerenga	Civil Aviation
27	Rodrick Kunkwezu	DWR
28	Micious Matsitsa	MACRA
29	Kefasi Kamayo	LRCD
30	Doshaine Kadokera	DAES
31	Teferi Demessie	Norwegian Meteorological Institute
32	Elinah Khasandi Kuya	Norwegian Meteorological Institute
33	Kristine Gjesdal	Norwegian Meteorological Institute
34	Jórunn Harðardóttir	Icelandic Meteorological Office, Iceland
35	George Samboh	WAGTECH
36	Faith Teleka	FAO
37	Tautvydas Juskauskas	UNICEF
38	Mphanda Kabwazi	World Bank
39	Isaac Ng’ambi	Go Link Enterprise
40	Koidi Taguchi	WFP
41	Margaret Mugo	FAO
42	Caroline Jehmlich	GIZ
43	Inga Dóra Pétursdóttir	Icelandic Embassy
44	Reynir Bragi Ragnarsson	Icelandic Embassy
45	Loncy Banda	DCCMS
46	Kassim Mwamadi	DCCMS
47	Ganizani Makina	DCCMS
48	Nancy Wasili	DCCMS
49	Kingsley Fumulani	DCCMS