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World Meteorological Organization
Organisation météorologique mondiale
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Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
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Annex: 1 (available in English only)

Subject: Information about the commencement of the demonstration phase of the Southern African Development Community Regional Climate Centre

Dear Sir/Madam,

I am pleased to inform you of the significant progress in implementing the Regional Climate Centre (RCC) concept within the Southern African Development Community (SADC) region. The SADC Climate Service Centre (SADC-CSC), hosted by the Botswana Department of Meteorological Services, is positioned to serve as a single multifunctional World Meteorological Organization (WMO) RCC, delivering mandatory products and services to the SADC region.

I am delighted to announce that the SADC-CSC launched its demonstration phase on 18 June 2024 as a WMO RCC. Throughout this phase, the SADC-CSC will start providing relevant climate products and services to the Members of the SADC region as defined in the WMO Integrated Processing and Prediction System (WIPPS) *Manual on the WIPPS* (WMO-No. 485). This will enable SADC-CSC, upon the successful completion of the demonstration phase, to be designated as a WMO RCC.

More information about the SADC-CSC activities and services can be found in the Implementation Plan (see annex).

All products and services provided by SADC-CSC, including the consensus statements from the Southern African Regional Climate Forum, are accessible through the web portal.

I warmly invite all National Meteorological and Hydrological Services of countries and territories within the SADC-CSC domain to actively engage in the demonstration phase by: (i) accessing and using RCC products to support national climate services; (ii) applying RCC products and services to meet national needs; (iii) supporting the generation of RCC products and services by sharing national data and expertise; and (iv) providing feedback to help SADC-CSC further refine and enhance its offerings.

Thank you for your continued cooperation and support to WMO activities.

Yours faithfully,

Ko Barrett

Ms Ko Barrett
for the Secretary-General

To: Permanent Representatives of Members with WMO: Angola, Botswana, Comoros, Democratic Republic of Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, United Republic of Tanzania, Zambia, and Zimbabwe (limited distribution)

cc: President of WMO Regional Association I, President of SERCOM and President of INFCOM

DRAFT RCC IMPLEMENTATION PLAN

FOR

SOUTHERN AFRICA DEVELOPMENT COMMUNITY (SADC) CLIMATE SERVICES CENTRE(CSC)

Regional Integrated Multi-Hazard Early Warning System (RIMES)

Version 1.0, November 2023

Table of Contents

Executive Summary

Under the leadership and guidance of the World Meteorological Organization (WMO) and with the support of the ClimSA Project, significant progress has been achieved to propose and designate the Southern African Development Community Climate Services Centre (SADC CSC) as the WMO Regional Climate Centre (RCC) for the SADC region. It is anticipated that the demonstration phase for establishing the SADC CSC as the RCC for the SADC region will commence by the end of 2023, concurrently with the submission of a letter of intent to Regional Association I (RA I).

Regional Climate Centers (RCCs), as endorsed by the WMO, are centers of excellence with the primary role of enhancing the ability of WMO members within specified regions to provide top-tier climate services to their national stakeholders and users. The core offerings from RCCs include climate datasets, monitoring tools, and long-range forecasts. Structurally, RCCs represent the intermediate layer in WMO's three-tier operational framework. This system is designed to bolster the capability of National Meteorological and Hydrological Services (NMHSs) in generating and disseminating up-to-date and best climate information and products for climate services. RCCs play a critical role in the capacity building of NMHSs and sustainable development within countries. The implementation of RCCs is ongoing across all of WMO's regional associations.

The SADC CSC, in its role as an RCC, will primarily serve the National Meteorological and Hydrological Services (NMHS) of the 16 SADC member states. Additionally, it will collaborate and work in tandem with other RCCs across the African continent. To aid the SADC CSC in meeting the prerequisites of WMO's RCC, progressing to the RCC demonstration phase, and ultimately achieving designation as a WMO-approved RCC, SADC CSC Atkins Technical Assistance and RIMES have implemented various initiatives as in the list below. Subsequent to these efforts, this implementation plan has been developed.

- Reviewing and evaluating the priorities for SADC Climate Services Centre on the core functions of CSC as a potential WMO Regional Climate Centre – Final Task 1 and 2 report (SADC ClimSA TA, 2022a)
- Stocktake of the climate services system at SADC CSC – Final report (SADC ClimSA TA, 2022)
- Concept note for setting up priorities on the core functions of CSC as a potential WMO Regional Climate Centre (SADC ClimSA TA, 2022)
- Concept note for the development of climate products at SADC CSC (SADC ClimSA TA, 2023)
- Roadmap for Objective Seasonal Forecast implementation at SADC CSC (SADC ClimSA TA, 2023)
- Stocktake of the climate service systems at SADC Member States NHMSs (SADC ClimSA TA, 2023)
- Assessment of National Hydrological and Meteorological Services in the Southern African Development Community (SADC) Region for Regional Climate Centre (RCC) Services (RIMES, 2023)

It is crucial to consider not only the technical requirements and functions of the SADC CSC as an RCC but also the underlying reasons that have prompted the initiation of this role. The SADC member states face an increased risk of adverse effects from climate change, given their high exposure to extreme weather events and reliance on climate-sensitive sectors vulnerable to climate-related impacts. Effectively mitigating these risks requires the National Meteorological and Hydrological Services (NMHS) to deliver high-quality, reliable, and timely climate services.

This, in turn, enables stakeholders and users to make well-informed decisions and engage in strategic planning based on up-to-date and accurate climate information. However, the disparate capacities of NMHSs have impeded the generation and provision of user-relevant and effective climate services, particularly at sub-seasonal and seasonal scales where uncertainties are higher.

To address these challenges, the WMO advocates for the further strengthening of regional centers such as the SADC Climate Services Centre (CSC) to be designated as an RCC by WMO. This recognition acknowledges the pivotal role of the SADC CSC in providing seamless technical support to NMHSs in the region. Being designated as an RCC would enable the SADC CSC to serve as a center of excellence, enhancing the capacity of NMHSs in the region to deliver optimal climate services to national users, including climate datasets, monitoring products, and long-range forecasts.

This Implementation Plan has been developed by RIMES in consultation with SADC CSC. It is based on findings from a survey of regional requirements, consultations with SADC CSC, and reports of SADC CSC Atkins TA. It is designed to be a living document, adjusted and updated as needed during the evolution of the RCC. The demonstration phase is anticipated to commence at the end of 2023, following the submission of the intent letter to RA I and the presentation of the plan to member states' NMHSs, RA I, and the WMO Executive Council.

Acronyms

ACP	African, Caribbean and Pacific Group of States
CDMS	Climate Data Management System
CLIMSA	Climate Services and Related Application Programmes
ClimSA TA	CimSA Technical Assistance Program
ECMWF	European Centre for Medium-Range Weather Forecasts
EU	European Union
FMI	Finnish Meteorological Institute
GDPFS	Global Data-processing and Forecasting System
GPCs	Global Producing Centers
LRF	Long-Range Forecasting
NCOF	National Climate Outlook Forum
NMHS	National Meteorological and Hydrological Services
OSF	Objective Seasonal Forecasts
RAs	Regional Associations
RCC	Regional Climate Centre
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
SADC	Southern African Development Community
SADC CSC	SADC Climate Service Centre
SARCIS-DR	Southern African Regional Climate Information Services for Disaster Resilience Development
WMO	World Meteorological Organization

1. Introduction

This document describes the implementation plan to transition the SADC Climate Services Centre (CSC) to become a WMO-designated Regional Climate Centre (RCC).

RCCs, as endorsed by the World Meteorological Organization (WMO), are centers of excellence whose primary role is to enhance the ability of WMO Members within specified regions to provide top-tier climate services to their national stakeholders and users. The core offerings from RCCs include climate data sets, monitoring tools, and long-range forecasts[1].

Structurally, RCCs represent the intermediate layer in WMO's three-tier operational framework. This system is designed to bolster the capability of National Meteorological and Hydrological Services (NMHSs) activities in generating and disseminating up to date and best climate information and products for climate services. RCCs play a critical role in the capacity building of NMHSs and sustainable development within countries. WMO has also designated Global Producing Centres for Long-Range Forecasts (GPCLRFs) that supply a range of global long-range forecasting products, and these centres play a pivotal role in supporting both RCCs and NMHSs. Implementation of RCCs is ongoing across all of WMO's regional associations.

Both RCCs and GPCLRFs are foundational elements of the WMO's Global Data Processing and Forecasting System (GDPFS). Their roles and the criteria for their designation are elaborated upon in the GDPFS Manual (WMO No. 485). Furthermore, by assisting NMHSs, RCCs and GPCLRFs become vital operational units within the Global Framework for Climate Services (GFCS) and the Climate Services Information System (CSIS).

In the context of the SADC region, the SADC CSC intends to serve as a WMO RCC by regionalizing global products and creating innovative regional climate information and products, introducing software, models and tools for regional and national analyses and applications, and contributing to the capacity building and sustainable development of the NMHSs of SADC Members States.

Prior to the initiatives undertaken by RIMES and the Atkins Technical Assistance Team, the SADC Climate Services Centre conducted a Strategic Plan for its development as a Regional Climate Centre[2] (RCC) under the World Meteorological Organization (WMO) in 2016. It's noteworthy that despite this effort, no formal letter of intent was submitted to Regional Association I (RA I) or the WMO. As a prompt action, the SADC CSC can take the initiative to submit a letter of intent to RA I to officially express its intention to become a WMO RCC.

2. SADC CSC as potential WMO RCC candidate

2.1 Background of SADC CSC

The Southern African Development Community Climate Service Centre (SADC CSC) was established in 1990 originally as the Drought Monitoring Centre in response to the region's need for better climate information, given the region’s vulnerability to climate change and climate variability. The primary objective of SADC CSC is to bolster the capabilities of NMHSs personnel through training in climate prediction, as well as to provide authoritative regional forecasts and advisories at seasonal to sub-seasonal scales. SADC CSC maintains a network of

[1] WMO Regional Climate Centres, https://public.wmo.int/en/our-mandate/climate/regional-climate-centres
[2] Nyenzi(2016). A STRATEGIC PLAN FOR THE DEVELOPMENT OF SADC CLIMATE SERVICES CENTRE AS A WORLD METEOROLOGICAL ORGANIZATION REGIONAL CLIMATE CENTRE

partnerships with national, regional and international climate centres and cooperating partners. It also produces advisories and publications relating to floods, droughts, climate variability and hazardous weather phenomena such as tropical cyclones.

In terms of the current climate services to NMHSs in the region, the Centre offers a range of tailored climate products. Noteworthy among them are the seasonal probability forecasts for precipitation. However, there are evident gaps and areas of improvements. While there's an operational website in place, its efficacy is not measurable due to a missing user tracking system. Additionally, challenges exist in the harmonization of long-range forecast verification with the WMO standards, irregular updates to bulletins and climate products on the website, and limited human capacity.

SADC CSC, despite its challenges, holds significant potential to be a candidate for the World Meteorological Organization (WMO) Regional Climate Centre (RCC) designation. It is already implementing many of the services that are listed by WMO as Mandatory functions for an RCC. These include Operational Activities for LRF such as “Generate regional and sub-regional tailored products, relevant to RCC User needs, including seasonal outlooks etc.”, “Generate consensus statement on regional or sub-regional forecasts.”, “Provide on-line access to RCC products/services to RCC Users”, and “Assess use of RCC products and services through feedback from RCC Users”. Additionally, Operational Activities for Climate Monitoring have been implemented by SADC CSC, including “Perform climate diagnostics including analysis of climate variability and extremes, at regional and sub-regional scales” – which are produced once a year to contribute to the status of African Climate; “Establish an historical reference climatology for the region and/or sub-regions”, and “Implement a Regional Climate Watch” - with a number of climate watches available on the SADC CSC website. Training in the use of operational RCC products and services has also been well implemented by SADC CSC, with several regional training workshops having been run by SADC CSC, and annual training on the seasonal forecasting process being provided by SADC CSC to NMHSs.

However, SADC CSC is not yet providing several mandatory RCC functions, and, at a minimum, SADC CSC will need to upgrade its services in order to provide the full set of WMO-established mandatory RCC functions. Therefore, the SADC CSC has to ensure that the high priority gaps and challenges are addressed during the demonstration phase as outlined in this implementation plan towards achieving a fully designated WMO RCC status. The Table one provides an overview of SWOT analysis of SADC CSC.

Table 1 SWOT analysis of SADC CSC

Strengths	Weaknesses
- Established in response to the region's acute climate vulnerabilities. - Robust network of partnerships at multiple levels. - Modern infrastructure, including High Performance Computer (HPC) - Access to a plethora of datasets, including those from Global Producing Centre (GPCs).	- Infrequent updates to climate products. - Limited human resources - Limited website visibility and user interaction.

Opportunities	Threats
- Institutional Support from SADC Secretariat. - Potential for additional staff numbers through secondments, project staff, and internships - Possibility for expansion to autonomous Centre with precedence of other SADC Centers of Excellence	- **Consistent vulnerability of the region to climate adversities.** - **Underutilization of Centre's data access and computing capabilities.**

2.2 Structure of SADC CSC as WMO RCC candidate

Within the organizational structure of the SADC Secretariat, SADC CSC is defined as a centre of excellence under the SADC Secretariat in Gaborone. It is hosted by the Botswana Department of Meteorological Services (BDMS). The SADC Secretariat's main functions are strategic planning, coordination, and management of SADC programmes, as well as implementing decisions on SADC policy. SADC CSC falls under the Directorate of Infrastructure, and is headed by the Senior Programme Officer for Meteorology (SPO-Meteorology), who reports to the Director of Infrastructure. The SPO-Meteorology takes the dual function of contributing to the SADC Secretariat's policy facilitation role, as well as providing leadership and coordination for SADC CSC's operational functions. SADC CSC has a 5 staff positions for in its organogram - one administrative and four technical positions:

- Senior Programme Officer - Meteorology (SPO; doubles as SADC CSC lead)
- Programme Officer - Climate Database and IT (PO-CDIT)
- Programme Officer - Climate Modelling (PO-CM)
- Programme Officer - Climate Diagnostic and Monitoring (PO-CDM)
- Programme Officer - Climate and Seasonal Monitoring (PO-CSM)

The position of Senior Programme Officer is currently vacant, with recruitment in progress, while the four technical positions are filled. The four technical positions align closely with three of the four categories of WMO-specified mandatory RCC functions, as shown below. The fourth category, training, is cross-cutting and can be provided by all the four officers.

- Operational Activities for LRF (PO-CM, PO-CSM)
- Operational Activities for Climate Monitoring (PO-CDM)
- Operational Data Services, to support operational LRF and climate monitoring (PO-CDIT)
- Training in the use of operational RCC products and services (cross-cutting – all positions)

The five categories of highly recommended functions are also partially covered by the 5 staff positions as follows:

- Climate Prediction and Climate Projection (PO-CM, PO-CSM)
- Non-operational data services (PO-CDIT)
- Coordination Functions (cross-cutting – all positions)

- Training and Capacity building (cross-cutting – all positions)
- Research and Development (cross-cutting – all positions)

The tasks required to run the functions of an RCC are significant, and, in many RCCs, are typically spread over several departments with several staff members attending to these positions, or in the case of an RCC Network, several institutions fulfill the RCC functions. To effectively provide RCC functions given the comparatively small workforce, SADC CSC will need to undertake significant streamlining of activities, including leveraging on a high level of automation, in order to maximize available human resources. The staffing requirements necessary to fulfill each of the mandatory functions are detailed in the Atkins report titled "A Roadmap Towards Commencement of the WMO Regional Climate Centre Demonstration Phase".

Additionally, in the short term, SADC CSC will need to leverage its network of partners and service providers to strengthen its staff complement and effectively provide all the functions required for RCC services. This will include secondments from SADC NMHSs and other specialist climate institutions (including academia), contracts with service providers, and project staff employed in SADC CSC through projects that directly strengthen the RCC functions. Over the longer term, in order to become a highly effective RCC with the capacity to consistently deliver quality regional climate services to the SADC region, it is recommended that SADC CSC eventually transitions to a semi-autonomous Centre of Excellence, with a strong complement of climate scientists, technicians, data analysts, and communications specialists – an approach that is used with many climate centres around the world. SADC already has established similar autonomous centres of excellence, including the Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) in Gaborone, Botswana, and the SADC Plant Genetic Resources Centre (SPGRC) in Lusaka, Zambia.

2.3 Interface with RCC end users

National Meteorological and Hydrological Services (NMHSs) are primary RCC end users, and a strong interface between the RCC and NMHSs is essential to enhance NMHSs' ability to reach their stakeholders effectively. This collaboration leverages the RCC's specialized climate knowledge and the NMHSs' understanding of regional and local conditions, ultimately resulting in more effective climate information dissemination and disaster risk management. The interface will need to have multiple dimensions as indicated below:

Technology and Tools Support: Providing NMHSs with access to appropriate climate services software and hardware, for data collection, analysis, and modeling.

Capacity Building and Training: Developing and offering training programs specifically designed for NMHSs, covering advanced meteorological and climate science, data collection and analysis, forecasting techniques, and the use of RCC-generated products.

Data Sharing and Integration: Establishing seamless data-sharing mechanisms between the RCC and NMHSs. This will ensure that NMHSs have access to the latest and most relevant climate data, which is essential for accurate forecasts and assessments.

Regular Communication and Feedback Channels: Maintaining open and frequent communication channels with NMHSs. This includes regular meetings, workshops, and feedback sessions to address any challenges or requirements that NMHSs may have.

Regular Assessments and Quality Assurance: Conducting periodic assessments of NMHSs' operations and providing constructive feedback on areas for improvement to ensure that the NMHSs meet the highest standards of quality and accuracy in their climate services.

The SADC CSC currently sustains a network of partnerships with national, regional, and international climate centers, as well as collaborating with various partners. Notably, it plays a significant coordinating role in SARCOF for the SADC region for the generation and dissemination of seasonal forecasts in the region in collaboration with NMHSs and other partners. It also produces advisories and publications relating to floods, droughts, climate variability and hazardous weather phenomena such as tropical cyclones, that are used by NMHSs, ultimately reaching varying level of users in the member countries.

2.4 Interface with Global Producing Centres

The RCC's role, among other things, is to serve as a bridge between global climate centers (GPCs) and the regional member countries in the use and submission of feedback on the GPC climate products. The primary use of GPCs data by SADC CSC is through online downloads of the GPCs products and graphics. The main exception to this trend is MFI – SADC CSC has engaged with MFI through EUMETSAT activities. Additionally, MFI has also previously had commercial arrangements with SADC CSC through the sale of an HPC to, and associated installation of the ARPEGE model at SADC CSC HQ, and access to various MFI data products. OACPS has attempted to facilitate interactions between ECMWF and RCCs in Africa, including SADC CSC, with limited success.

In order to improve the level of interaction between SADC CSC and GPCs, the following measures are proposed for interfacing with GPCs:

- Direct Data Exchange Channels: Establish direct data exchange links, possibly digital APIs or FTP servers, for real-time and historical data. This will ensure that the SADC region has access to the latest global climate forecasts and data.
- Feedback Mechanisms: Based on the survey, no formal feedback mechanisms exist between the Centre and GPCs. A two-way feedback system should be set up to continuously improve the reliability and accuracy of the forecasts and assessments provided. This mechanism will facilitate the SADC CSC to relay feedback about GPC products' relevance and accuracy in the regional context.
- Capacity Building: Organize joint workshops, training sessions, and seminars with GPC experts to build the capacity of the SADC CSC staff. This will also provide an opportunity to better understand the methodologies and models used by GPCs and adapt them to regional needs.
- Joint Research and Development: Foster joint R&D initiatives to address specific climate challenges in the SADC region, leveraging the expertise and resources of both the SADC CSC and GPCs.
- Integration of GPC Forecasts: As the survey mentioned, SADC CSC currently uses precipitation, temperature, and SST forecasts from GPCs. The integration of these forecasts should be enhanced, ensuring that they are tailored to the SADC region's specifics and needs.

- Regular Communication Channels: Set up regular communication channels, such as monthly or quarterly virtual meetings, to ensure both entities are aligned in their initiatives and to address any challenges promptly.
- Attendance in GPC Forums: Ensure that representatives from SADC CSC attend major GPC forums, workshops, and conferences to stay updated with global advancements and bring back knowledge to the regional level.

3. Promoting Research and Development in the SADC region

Research and Development (R&D) is pivotal for the improvement of climate science and climate services, particularly in regions which grapple with multiple climate-related challenges, such as the SADC region.

SADC CSC is currently undertaking a number of activities to promote and facilitate R&D in the SADC region. Firstly, aspects of a climate Research and Development agenda are achieved through the continentally coordinated Climate Outlook Forum for RCCs. This initiative, initiated by ACMAD, fosters a synergistic environment where GPCs contribute current innovative approaches, facilitating a dynamic cross-fertilization between RCCs during discussions. SADC CSC also contributes to studies of regional climate variability and change, predictability and impact through analyses and contributions it makes to the State of Climate for Africa, coordinated by the WMO RA I office in collaboration with AUC and ACMAD. SADC CSC is also helping develop consensus practices to handle divergent climate information for the Region. Through the COF processes, efforts are made to develop consensus approaches which are being documented through the ClimSA programme and improvements are envisaged including the adoption of Objective Seasonal Forecasting (OSF) approaches. Under the ClimSA programme, a road-map is being developed to guide full implementation of OSF through

Further, SADC CSC developed the Climate Forecasting Tool (CFT), a seasonal forecasting tool that uses Artificial Neural Networks (ANN) to produce seasonal forecasts by modelling the relationships that exist between drivers and the regional climate. Through the ClimSA project efforts are underway to further refine and validate the CFT. CSC is also promoting studies of the economic value of climate information through the ongoing ClimSA SEB training. Efforts are in place organize analysis meetings with SADC Member States to produce regional pathways of the economic value of climate services in the region.

To further improve R&D efforts in the region, SADC CSC should adopt a number of approaches to bolster its efforts to support R&D, both at regional and national level:

Facilitate Collaborative Platforms:

- Establish regular regional R&D symposia to foster collaboration and share best practices.
- Initiate collaborative online platforms where researchers can exchange ideas, methodologies, and findings in real-time.

Financial Support for Capacity Building:

- Develop a dedicated R&D fund to support in-house and collaborative research projects.

- Partner with international climate agencies and donors to create scholarship programs for young researchers in the region.

Strengthening Partnerships with Academic Institutions:

- Foster partnerships with regional and international universities for joint research projects and exchange programs.
- Collaborate with institutions to develop curriculum and training programs tailored to the region's climate challenges.

Enhance Proxy Climate Data Usage:

- Organize workshops on the effective utilization of proxy climate data in long-term climate studies.
- Invest in technologies and tools that amplify the collection, analysis, and dissemination of satellite-observed data.

Sector-specific Application Research:

- Engage with sector-specific stakeholders to ascertain their climate information needs.
- Collaborate with organizations like ACMAD to develop sectoral climate products and services.

Promote Economic Value Studies of Climate Information:

- Conduct studies to quantify the economic benefits of timely and accurate climate information in sectors like agriculture, health, and infrastructure.
- Collaborate with economists and policymakers to embed climate considerations in regional economic planning.

Focus on Localized Research:

- Support NMHSs in downscaling global climate models to produce localized forecasts and scenarios.
- Facilitate community-based research initiatives that tap into indigenous knowledge and practices.

4. Detailed Description of Proposed RCC Functions

4.1 Status of implementation of mandatory RCC functions

The tables in the Annex I provide a detailed description of the products and services currently generated and provided by SADC CSC compared to the capacity required by WMO RCC. The tables were developed with inputs from the CSC TA, Atkins Report- Reviewing and evaluating the priorities for SADC Climate Services Centre on the core functions of CSC as a potential WMO Regional Climate Centre – Final Task 1 and 2 report and further validated by RIMES consultant in the region with SADC CSC.

4.2 RCC functions required to meet the needs of NMHSs in the SADC Region

This section outlines the full set of Proposed RCC functions that SADC CSC should provide in order to meet the needs of NMHSs as determined in a survey of NMHSs across the SADC region.

4.2.1 RCC Mandatory functions

SADC CSC will work towards providing the following functions and services:

Operational Activities for LRF

- Assist Member NMHSs increase frequency, skill and spatial resolution of LRF
- Standardize regular update schedules, possibly adopting a quarterly model.
- Develop forecasts for additional parameters such as onset and cessation of rainfall
- Develop procedures and guidelines for producing tailored forecast applications and additional parameters
- Develop procedures and guidelines for producing OSF

Operational Activities for Climate Monitoring

- Expand the availability of tools for assessing climate diagnostic products.
- Enhance capacity to generate locally relevant indices that are not readily available such as the Subtropical Indian Ocean Dipole (SIOD), as well as regional and local climate drivers such as the Angola Low
- Provide climate diagnostic products such as Temperature Anomalies, Precipitation Patterns, Atmospheric Circulation Patterns, Drought Monitoring, Extreme Event Attribution, Climate Mode Indices and Climate Model Evaluations

Operational Data Services, to support operational LRF and climate monitoring

- Assist NMHS to perform assessment of GPC products,
- Assist NMHSs get improved access to online GPC products
- Provide training in the production of gridded climate datasets
- Provide support for climate database and data archiving services
- Develop quality-controlled regional climate datasets and share with NMHSs
- Improve accessibility of SADC CSC online products and services

Training in the use of operational RCC products and services

- Carry out survey to identify precise training needs per NMHS for each of the four WMO Mandatory RCC functional areas:
    - Climate database, quality and archiving (CDMS)
    - Climate diagnostics using national and regional climate datasets
    - Generation of regional and sub-regional tailored products
    - Seasonal forecasting, interpretation, and verification
- Develop training programs to cover the identified training requirements

- Implement training programs to capacitate NMHSs using the developed programs

4.2.2 RCC Highly recommended functions

Currently, the SADC CSC does not provide/implement most of the WMO RCC highly recommended functions. Some of the activities that SADC CSC can implement after fulfilling all the RCC mandatory functions are listed below. The needs were expressed by the NMHSs during the need assessment survey.

Climate Prediction and Projection:

- Develop regional downscaled climate change scenarios
- Develop programs to assist NMHSs to access and utilize WCRP-CMIP climate model simulations, with a focus on NMHSs requiring this assistance

Non-operational Data Services

- Develop inhouse or regionally available expertise in commonly used CDMS in the region, particularly Climsoft.
- Provide climate database and archiving services for those countries that require the service.
- Develop and sustain programs to address challenges that NMHSs face in undertaking data rescue operations, particularly lack of human resources and equipment necessary.

Coordination Functions

- Facilitate cooperation between relevant NMHSs in the area of data sharing, especially those facing shared transboundary climate-related challenges.

Training and Capacity Building

- Facilitate professional capacity building of NMHSs, especially in generating user-focused products.

Research and Development

- Support capacity building in research and development.
- Motivate for and promote climate research opportunities and collaborations for and between NMHSs and international partners including GPCs, academic institutions and other relevant institutions.

5. Timeline

Timeline description (activities with number of months) for progression towards RCC designation

The timeline towards RCC designation will primarily be determined by fulfilment of RCC mandatory functions that SADC CSC is not yet providing. It is estimated that between November 2023 and December 2024, all outstanding RCC functions and activities required to provide a full suite of mandatory RCC functions can be satisfactorily covered including addressing issues like developing a clear organizational structure. Additionally, roles and responsibilities of CSC staff members to carry out its core functions and staff shortage issues should be addressed. It is recommended that the changes to CSC operations adhere to, and be guided by the findings of the CSC TA Atkins reports: (a) Reviewing and evaluating the priorities for SADC Climate Services Centre on the core functions of CSC as a potential WMO Regional Climate Centre – Final Task 1 and 2 report (2022), and (b) A roadmap towards commencement of WMO Regional Climate Centre demonstration phase (2023)

Table 2 Timeline for progression towards RCC designation

Activities	2023		2024												Months
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Submission of letter of intent to RA I and Presentation of Implementation Plan to SADC NMHSs															3
Operational Activities for LRF															
Provide feedback on LRF products to GPCs upon request by GPCs															6
Start operationally generating quantitative LRF forecasts															12
Start verification of RCC quantitative LRF products, including the exchange of basic forecasts and hindcast data															7
Begin generating regular 2-m mean temperature consensus forecasts at least once a year															7
Ensure regular online access to up-to-date RCC products and services															10
Ensure new HPC hardware and software operational and producing regular, up-to-date RCC products and services, with relevant tech support															14
Ensure at least 1 SADC CSC staff proficient in operation of HPC for generation of RCC products and services															10
Ensure optimal level of automation of data processing to ensure regular and timely update of RCC products and services															8
Establish arrangement with WMO RA1 for annual reporting that will include assessment of use of RCC products and services															6
Operational Activities for Climate Monitoring															
Undertake monthly climate diagnostics analysis and produce monthly climate diagnostics bulletin with at least temperature (mean, minimum and maximum) and precipitation															10
Incorporate one or more additional climate diagnostics that were identified as NMHS priorities															6
Operational Data Services, to support operational LRF and climate monitoring															
Begin producing and providing daily, quality controlled gridded regional climate datasets for temperature (mean, min, max) and precipitation															6
Implement at CSC the most commonly used CDMS in the region															4
Develop expertise in the use of the most commonly used CDMS in the region															7
Assess NMHS' need for, and provide climate database and archiving services for NMHSs, as appropriate (as indicated by 6 SADC countries)															11
Training in the use of operational RCC products and services															
Compile and provide an online repository of manuals and other resource for training materials that RCC provides for its users															12
Structural changes for sustainable RCC operation															
Define clear organizational structure as it pertains to RCC functionality															3
Define roles and responsibilities of CSC staff members as pertaining to RCC functions															3
Provide a clear plan on how RCC will operate efficiently with limited staff numbers (compared to conventional RCC structures), including how recruited project staff, secondments from NMHSs, internships to supplement existing staff levels, and proposals for transition towards semi-autonomy															3

6. Conclusions

In light of the critical importance of reliable climate services for the SADC region and the vital role played by RCCs globally, this implementation plan sets forth a comprehensive approach for the establishment and advancement of the SADC CSC as a WMO-designated RCC. The need for an RCC in the SADC region, as underscored by the manual on GDPFS, is both timely and essential to bolster resilience against increasing climate vulnerabilities.

This plan has highlighted the foundation of the SADC CSC, its history of offering climate services, its strengths and weaknesses, and its potential to elevate itself to an WMO-designated RCC candidate.

The proposed structural adaptations for SADC CSC to transition into an RCC were outlined, highlighting the requisite manpower, infrastructure, and the harmonious interplay with global, regional, and national entities.

A clear timeline for the demonstration phase was delineated, ensuring that the transition to an RCC is systematic, accountable, and adheres to WMO standards. Emphasis was placed on creating effective interfaces with end-users of the RCC and the Global Producing Centres (GPCs), which is instrumental for delivering climate services that are both globally informed and regionally relevant.

The plan elucidated on the advancements and research initiatives that the SADC CSC should champion. This underscores the Centre's commitment to staying at the forefront of climate science and ensuring that its offerings are continuously refined and relevant.

A detailed dissection of the proposed functions of the RCC was presented, rooted in data collected from consultations with SADC CSC, as well as results of a survey of NMHS gaps and needs for WMO RCC functions. These functions serve as the pillars upon which the SADC CSC RCC will stand and operate.

Annex I: RCC Mandatory Function- Actual Capacity Required by WMO RCC Versus Existing Capacity of SADC CSC

The degree of implementation based on the WMO's criteria for the mandatory functions of Regional Climate Centres are ranked by Samuel (2021) as following, and have been updated based on recent consultations with SADC CSC:

- Implemented: Fulfils all requirements of the criteria
- Partially implemented: Fulfils some of the requirements of the criteria
- Not implemented: Does not fulfil any of the requirements of the criteria

1. Operational Activities for Long Range Forecasts (LRF)

Actual Capacity Required as per WMO GDPFS (2021)		**Existing Capacity of SADC CSC**			
Function/Activity/Criteria	**Product/Service**	**Product/Service Status**	**Areal covera**	**Means of service provision**	**Remarks**
Interpret and assess relevant LRF products from Global Producing Centres (GPCs), distribute relevant information to RCC Users; and provide feedback to GPCs	***Product:*** Assessment of the reliability and outcomes of products from GPCs-LRF or Lead Centre(s) for LRFMME, including the reasoning (make use of verification metrics as defined in *Guidance on Verification of Operational Seasonal Climate Forecasts* (WMO-No. 1220)), for the region of interest, in the form of texts, tables, figures, etc. ***Element:*** 2-m mean temperature, total precipitation ***Update frequency:*** Monthly or at least quarterly	**Status:** partially implemented **Product:** None			SADC CSC does assess the reliability and outcomes of GPC or LC products, but they are not incorporated in consensus seasonal forecast if the outputs are in opposition with the statistical forecast.
Generate regional and subregional tailored products, relevant to RCC	***Product:*** Probabilities for tercile (or appropriate	**Status:** partially implemented	SADC	http://csc.sadc.int	The products are not periodically updated on the website.

user needs, including seasonal outlooks	quantile) categories for the region or subregion ***Element:*** 2-m mean temperature, total precipitation Output type: Rendered images (maps, charts), text, tables, digital data ***Forecast period:*** one month up to six months **Update frequency:** Ten days to one month	**Products:** Monthly and Seasonal probability (tercile), 2-m mean temperature and total precipitation.			
Generate consensus statement on regional or subregional forecasts (A collaborative process involves discussion with experts in the region (e.g., through Regional Climate Outlook Forums (RCOFs) and teleconferencing). Consensus is both the agreed process and its joint conclusion, and the consensus can be that there is limited skill in the prediction for a region or subregion)	***Product:*** Consensus statement on regional or subregional forecast ***Element:*** 2-m mean temperature, total precipitation Output type: Report ***Forecast period:*** A climatologically significant period (from one month to one year) ***Update frequency:*** At least once per year (to be defined by the region)	**Status:** partially implemented **Products produced:** Seasonal precipitation consensus forecast. Updated two times a year and the products are posted on the CSC website.	SADC	http://csc.sadc.int	No guideline and tools to support objective seasonal forecast
Perform verification of RCC quantitative LRF products, including the exchange of basic forecasts and hindcast data	***Products:*** Verification datasets (e.g., SVSLRF scores, Brier skill score; relative operating characteristic (ROC); hit rate skill score) ***Element:*** 2-m mean temperature, total precipitation	**Status:** partially implemented **Products:** verification datasets (skill score; Hit Rate skill score) for monthly and seasonal 2-m mean temperature and total precipitation			Only probabilistic LRF products currently produced by CSC Verification not harmonized with WMO methodology

Provide online access to RCC products and services to RCC users	***Product:*** An online data/information portal	**Status:** partially implemented **Product:** website operational for dissemination of products	SADC	http://csc.sadc.int	Most products are not regularly updated. Limited automation to push products to website. No system to track website traffic metrics or receive website users' feedback Process of engaging website developer to revamp the website is currently underway
Assess use of RCC products and services through feedback from RCC users	***Product:*** Analysis of feedback (which is made available using a template) ***Update frequency:*** Annually, as part of a regular reporting of RCCs to WMO RAs	**Status:** partially implemented **Product:** analysis of feedback from users during the regional climate outlook			Lack of regional feedback system. Analysis reports on users' feedback obtained during SARCOFs are not up to date. Limited incorporation of user requirement in the development of improved or new services

2. Operational activities for climate monitoring

Actual Capacity Required as per WMO GDPFS (2021)		**Existing Capacity of SADC CSC**			
Function/Activity/Criteria	**Product/Service**	**Product/Service Status**	**Areal coverag**	**Means of service provision**	**Remarks**
Perform climate diagnostics, including analysis of climate variability and extremes, at the regional and subregional scales	***Products:*** Climate diagnostics bulletin including tables, maps and related products ***Element:*** Mean, maximum and minimum temperatures, total precipitation; other elements	**Status:** partially implemented **Products:** Monthly, dekadal and pentadal total precipitation.	SADC	http://csc.sadc.int	No climate diagnostics bulletins are not up to date. Temperature diagnostics not produced

	(especially Global Climate Observing System (GCOS) essential climate variables) to be determined by region ***Update frequency:*** Monthly	Products are posted on the website			
Establish a historical reference climatology for the region and/ or subregions	***Product:*** Database of climatological means for various reference periods (e.g., 1931–1960; 1951–1980; 1961–1990; 1971–2000) Spatial resolution: By station ***Temporal resolution:*** Monthly at a minimum ***Elements:*** Mean, maximum and minimum temperatures; total precipitation; other elements (especially GCOS essential climate variables) to be determined by region ***Update frequency:*** At least 30 years, preferably 10 years	**Status:** implemented **Products:** reference climatology (1961-1990 and 1981-2010) for mean, max, min temperature and total precipitation available on the website	SADC	http://csc.sadc.int	No available dataset to update the reference norm for the current period (1991-2020)
Implement a regional climate watch	***Products:*** Climate advisories and information for RCC users **Update:** Whenever required, based on the forecast of significant regional climate anomalies	**Status:** partially implemented **Products:** climate advisories and watches are posted on the website (heat and heavy precipitation alerts)	SADC	http://csc.sadc.int	Climate watch products are provided on the website, but climate advisory bulletins are not up to date.

3. Operational data services, to support operational LRF and climate monitoring

Actual Capacity Required as per WMO GDPFS (2021)		Existing Capacity of SADC CSC			
Function/Activity/Criteria	**Product/Service**	**Product/Service Status**	**Areal coverage**	**Means of service provision**	**Remarks**
Develop quality-controlled regional climate datasets, gridded where applicable	***Products:*** Regional, quality-controlled climate datasets, gridded where applicable, following SERCOM/SC-CLI guidance on procedures for quality control and assurance ***Elements:*** Mean, maximum and minimum temperature, and total precipitation, at a minimum ***Temporal resolution:*** Daily ***Update:*** Monthly	**Status:** Not implemented **Products:** None			• Develop expertise in climate data analysis and services • Begin producing and providing daily, quality controlled gridded regional climate datasets for temperature (mean, min, max), precipitation, and any other relevant datasets
Provide climate database and archiving services, at the request of NMHSs	***Products:*** National databases with metadata, accessible to the NMHS in question (backup service, development site, etc.) ***Elements:*** As determined by NMHS ***Update:*** At the request of NMHS	**Status:** Not implemented **Products:** None			The SADC CSC has an operational climate database management system, Lack of institutional agreement/policy on data sharing between SADC CSC and the NMHS needs to be addressed • Implement at CSC the most commonly used CDMS in the region Assess NMHS' need for, and provide climate database and archiving services for NMHSs,

					as appropriate (as indicated by 6 SADC countries)

4. Training in the use of operational RCC products and services

Actual Capacity Required as per WMO GDPFS (2021)		**Existing Capacity of SADC CSC**			
Function/Activity/Criteria	**Product/Service**	**Product/Service Status**	**Areal coverage**	**Means of service provision**	**Remarks**
Provide information on methodologies and product specifications for mandatory RCC products, and provide guidance on their use	***Products:*** Manuals, guidance documents and information notes ***Update frequency:*** When methods/products are revised, introduced or discontinued	**Status:** implemented **Products:** Methodology and manuals for the seasonal and sub-seasonal forecast	SADC		Compile and provide an online repository of manuals and other resource for training materials that RCC provides for its users, particularly those related to the mandatory RCC products
Coordinate training for RCC users in interpretation and use of mandatory RCC products	***Products:*** Survey and analysis of regional training needs, and proposals for training activities	**Status:** partially implemented **Product:** User training are conducted during SARCOF and various other regional workshops that have been held recently	SADC		Detailed survey and analysis of regional training needs should be carried out, documented, and used to inform program and proposals for training activities.

Annex II: Consultations with SADC CSC in preparation for Implementation plan

A series of consultations were held with SADC CSC staff members, providing information on the status of SADC CSC operations, as pertaining the the WMO-specified mandatory and highly recommended RCC functions. The first of these consultations was held on 8 August, and resolved on the need for a detailed survey questionnaire to be shared with SADC CSC, in order to provide a detailed update on the status of SADC CSC operations.

A survey questionnaire was subsequently shared with SADC CSC, which provided a detailed response that informed this implementation plan. The questionnaire was designed to evaluate the readiness of the SADC CSC towards achieving WMO RCC designation. It covered a wide range of topics, including the WMO RCC mandatory and highly recommended functions. The questionnaire delved into specifics such as the parameters assessed, the format and frequency of assessments, feedback mechanisms, production of regional climate forecasts, their verification processes, development of consensus forecasts, the use of Climate Data Management Systems (CDMS). The questionnaire also addressed the CSC's online presence and the challenges it faces in maintaining an updated website, as well as the frequency of updating key climate data and advisories. It seeks information on the feedback mechanisms used to assess the utility of the CSC's products and services. Training and capacity-building initiatives were assessed in the questionnaire, including the types of training provided, the formats used, and the documentation and guidance materials produced. It also explored the CSC's involvement in climate prediction and projection activities, non-operational data services, and coordination functions aimed at enhancing collaboration among National Meteorological and Hydrological Services (NMHSs).

Moreover, the questionnaire delved into the CSC's research and development activities. It concluded with a set of optional questions about the structural, procedural, and policy-related aspects of the CSC, such as its foundational objectives, stakeholder engagement, funding resources, technical expertise, and staffing structure.

After the results of the SADC CSC report had been received, as well as a separate NMHS survey assessing the needs and gaps of NMHSs in the SADC region had been analyzed, a second consultation with SADC CSC was held on 18 October 2023. This second consultation discussed the requirements for drafting an implementation plan, and clarified responses from the original survey. Issues discussed during the second consultation included the nature of working arrangements of SADC CSC with GPCs and NMHSs, SWOT analysis of SADC CSC, automation requirements in light of current organizational structure.

Follow-up phone calls were made to provide additional clarifications as needed.

Finally, SADC CSC reviewed and validated this implementation plan before finalization.