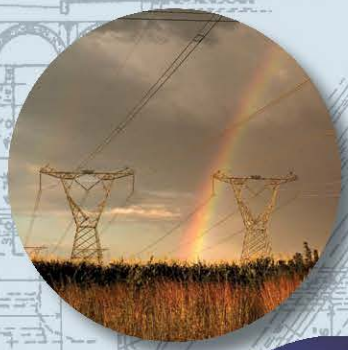
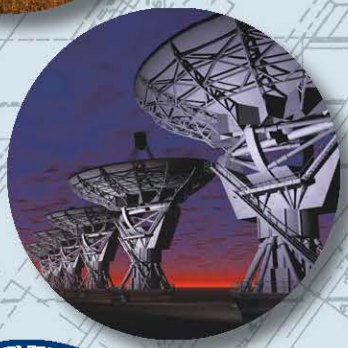


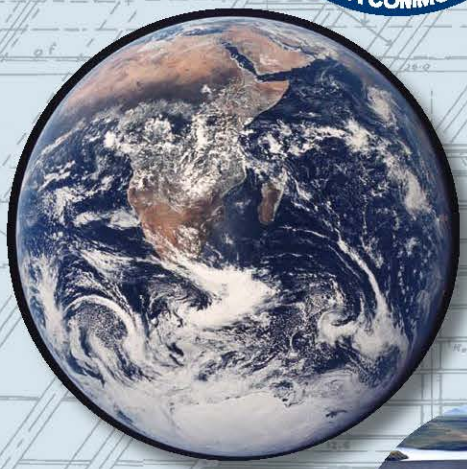


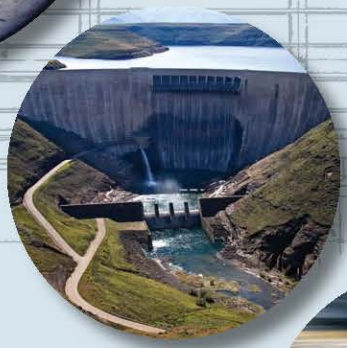
SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
SADC
TOWARDS A COMMON FUTURE

Regional Infrastructure Development Master Plan

Meteorology Sector Plan

August 2012





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Abbreviations

ACMAD	African Centre for Meteorological Applications and Development
AFTN	Aeronautical Fixed Telecommunication Network
AGM	Annual Global Monitoring
AMDAR	Aircraft Meteorological Data Relay
AMESD	African Monitoring of the Environment for Sustainable Development
ARS	Automatic Rainfall Stations
AU	African Union
AUC	African Union Commission
AWOS	Automating Weather Observation Station
AWS	Automatic Weather Station
CLIDATA	Climate Data
CLICOM	Climate Computer
ClimDev (Africa)	Climate Development for Africa Programme
CoE	Centre of Excellence (in satellite training)
COMESA	Common Market for Eastern and Southern Africa
CPC	Climate Prediction Centre
CSC	Climate Services Centre
BMS	Botswana Meteorological Service
CGMS	Coordination Group of Meteorological Satellites
CTBTO	Comprehensive Nuclear Test Ban Treaty Organization
DWA	Department of water Affairs
DM	Data Management
DMC	Drought Monitoring Centre
EAC	East African Community
ECMWF	European Centre for Medium Weather Forecasting
ECOWAS	Economic Community of West African States
EU	European Union
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organization
FFGS	Flash Flood Guidance System
FINNIDA	Finnish Development Agency
FMI	Finnish Meteorological Institute
GDP	Gross Domestic Product
GDPS	Global Data Processing and Forecasting System
GEF	Global Environment Fund
GFCS	Global Framework for Climate Services
GOS	Global Observation Systems
GTS	Global Telecommunication System
HIV/AIDS	Human Immune-Deficiency Virus/Acquired Immune-Deficiency Syndrome
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ICPAC	IGAD Climate Prediction and Applications Centre
IGAD	Inter-Governmental Authority in Development
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organization
ITCS	Inter-Tropical Convergence Zone
IWM	Integrated World Weather Watch Monitoring
LDC	Least Developed Countries
LMS	Lesotho Meteorological Service
LND	Lightening Detectors Network
MASA	Meteorological Association of Southern Africa
MDGs	Millennium Development Goals
MDCCMS	Malawi Department of Climate Change and Meteorological Service
MMS	Mauritius Meteorological Services
MSG	Meteosat Second Generation
MTN	Main Telecommunication Network
MTR	Mid-Term Review

NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
NDPN	National Development Plan of Namibia
NMC	National Meteorological Centre
NMS	National Meteorological Service
NWP	Numerical Weather Prediction
PALOP countries	Portuguese Speaking African Countries
PIDA	Project for Infrastructure Development in Africa
PRs	Permanent Representatives
PUMA	Preparation for the Use of Meteosat Second Generation in Africa
PWS	Public Weather Service
QMS	Quality Management System
RA1	Regional Association 1(Africa)
RANET	Radio and Internet Communication System
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Station Network
RCC	Regional Climate Centre
RECs	Regional Economic Communities
RIC	Regional Instruments of Cooperation
RICC	Regional Instrument Calibration Centre
RTH	Regional Telecommunication Hub
RTC	Regional Training Centre
RISDP	Regional Indicative Strategic Plan
RSMC	Regional Specialised Meteorological Centre
RMC	Regional Meteorological Centre
RMSN	Regional Meteorological Support Network
RMTC	Regional Meteorological Training Centre
SADC	Southern African Development Community
SADCC	Southern African Development Coordination Conference
SAMPRO	SADC Meteorology Project
SAFFGS	South Africa Flash-Flood Guidance System
SATCC	Southern Africa Transport and Communications Commission
SARCOF	Southern Africa Regional Climate Outlook Forum
SAWS	South African Weather Service
SCOM	Sub-sectoral Committee on Meteorology
SIGMET	Significant Meteorological Information
SMM	Special MTN Monitoring
SMS	Swaziland Meteorological Services
SSA	Sub-Saharan Africa
SP	Sub Project
SVB	Supervisory Board
SWFDP	Severe Weather Forecast Demonstration Project
SWFS	Severe Weather Forecast System
SYNOP	(Surface Synoptic Observations) is a numerical code used for reporting weather observations made by manned and automated weather stations.
TDCF	Table Driven Code Format
TMA	Tanzania Meteorological Agency
UNECA	United Nations Economic Commission of Africa
UNEP	United Nations Environmental Programme
UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UTC	Coordinated Universal Time
WAFC	World Area Forecast Centre
WB	World Bank
WCC-3	World Climate Conference-3
WFP	World Food Programme
WIS	WMO Information System
WHO	World Health Organization
WMC	World Meteorological Centre

WMO	World Meteorological Organization
ZESCO	Zambia Electricity Supply Company
ZMS	Zimbabwe Meteorological Service

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Executive Summary

Purpose and objective

The purpose of the sector plan is to have a coordinated modality to ensure that meteorological services play an effective role in the socio-economic development of SADC countries, the protection of life and property and the sustainable protection of the environment in Member States. Policies specific to the meteorological sector are well documented in the SADC Protocol. The plan is in line with the SADC Protocol on Transport, Communications and Meteorology which spells out that "***Member States shall develop a harmonised meteorology policy which facilitates regional co-operation, strengthens national capacity and ensures compliance with their international commitments".***

The overall objective of the Meteorology Sector Chapter of the SADC Regional Infrastructure Development Master Plan (RIDMP) is to outline strategies for strengthening of the Meteorology Infrastructure and Services to ensure the sector contributes effectively to the development goals of SADC as spelt out in the RIDMP and the SADC Protocol on Transport, Communication and Meteorology, focusing on observation networks, telecommunications and data exchange, data processing and data management, weather and climate prediction and capacity building for service delivery. The plan also provides guidance of how the strategic objectives will be achieved on various time scales ranging from short to medium (5) years timeframe to the long (15) year timeframe.

The plan provides a roadmap on how the long-term goals, the programmatic goals and the specific strategies should be pursued in line with the SADC long-term plans, the MASA Strategic plan 2011-2015 and WMO strategic plan (2012-2015).

The plan takes into account the evolving needs, requirements and challenges of SADC National Meteorological Services (NMSs) based on the sector diagnostic study findings namely: Strengthening of observational network, including Automatic Weather Stations (AWSs), Radar and remote sensing instruments; Upgrading of Data Base management including Data Rescue; Calibration of Instruments at national and regional level; Training of Class I meteorologists and in Numerical Weather Prediction; Modernisation of real time Data processing and Forecasting, post-processing and service production systems; Improved capacity for generation of tailor made sector specific products; Improved capacity for climate modelling including assessment to high resolution climate scenarios; Improvement of Aviation Weather Services including ISO certification and Modernisation of telecommunications including implementation of Table Driven Code Format (TDCF) in line with WMO-WIS/ Global Telecommunication System (GTS). Other challenges include the strengthening of regional centres such as the SADC Climate Service Centre (CSC), the Regional Instruments Centre and the Regional Meteorological Training Centre to ensure they meet their mandates.

Status of Infrastructure of SADC National Meteorological Services and Regional Units

In view of the increasing adverse impacts of severe weather and extreme climate associated with climate variability and change, the Meteorological Services in SADC are currently faced with high demand for timely and quality information, services and products. The social and economic value of weather and climate information is derived from the influence of this information on decisions made by users in the sectors sensitive to weather and climate conditions, with the value tending to increase with the quality, accuracy, timeliness, location specificity and user-friendliness of the information. NMSs require adequate infrastructure for observations, data processing and exchange and dissemination as well as trained personnel to achieve this. However, inadequate observational station network due to lack of instruments, shortage of trained personnel,

telecommunications systems, data processing and information dissemination facilities are major drawbacks. The infrastructure and facilities have continued to deteriorate leading to great difficulties in giving weather and climate services in the region to meet national and regional needs.

The seriousness of the level of inadequacy of observational data in SADC is evident from the latest WMO Annual Global Data Monitoring results carried out in October 2010 and from October 2010 to April 2011 where it comes out clearly that SADC's performance is by far below the global average. Availability of TEMP data is worst with the global average at 71%, Africa 26% and SADC 9%.

The situation is also bad in other infrastructure components that support data exchange, data processing, forecasting and data management and public weather systems. Available information indicates that, over the years, data availability in RA I which includes the SADC countries has not been satisfactory. The non-availability of data has largely been attributed to the shortcomings in the implementation and efficiency of the Global Telecommunications System (GTS) and Global Observation System (GOS) in the Region.

The deficiencies in the collection and retransmission of meteorological data and products not only affects meteorological services in the SADC region, but the entire globe, in regard to aviation safety, marine safety, road safety, general public safety, safety of property, climate change monitoring and detection with socio-economic implications, food security, disaster reduction, poverty reduction, conservation of biodiversity and economic growth, amongst many other weather and climate-related activities.

Over years the performance of the CSC has been deteriorating to the extent that currently many of the planned activities have not been implemented due to acute shortage of resources both financial and human. There is also inadequate infrastructure in form of computing hardware and software for operational purposes. The SADC CSC has endeavoured to meet its mandate through various activities including coordination of the Southern Africa Regional Climate Outlook Forum (SARCOF); however its efforts have been hampered by lack of a sustainable adequate funding mechanism to run the operations. There is an urgent need to address these shortcomings so that the CSC can attain the expected level of service provision to the region.

The Regional Instruments Centre in Gaborone and the RMTC in Angola are important institutions for calibrations of instruments and training of professional staff to ensure quality of instruments and competence of personnel respectively. However the functioning of the two institutions is not satisfactory thus the need for immediate interventions to ensure they meet expectation of stakeholders.

Strategy for Addressing Gaps and Expected Results by Year 2027

SADC NMSs have the potential to provide information and services to decision makers and the general public that could improve agricultural production, food security, health, water resource management, and marine safety. However most of the NMSs in SADC lack the necessary infrastructure, tools, and trained staff that could efficiently provide the above information. In most of the countries, the NMSs do not have enough human resources to perform these tasks. Their observation networks need to be expanded and upgraded. The telecommunication infrastructure available to the NMSs does not support adequate transfer of data inside or outside the countries. Many do not have dependable access to the internet to consistently reach out to users for feedback on their products.

A number of strategies are recommended in this sector Master Plan, to address major challenges in current Policies and Regulatory Framework to ensure the sector fulfils its mandate as follows: Strengthening Institutional Capacity building to drive the transformation process of NMSs into semi/autonomous entities; Development of model policy and legal framework for the sector at national and regional level; Enhanced funding of NMSs including reduction of dependency on the central treasury through cost recovery strategies in the meteorological services operations; Development of regulatory framework for the meteorology sector; Enhancement of institutional capacity building and human resource development nationally and regionally.

Strategies are recommended to ensure availability of effective and motivating institutional arrangements that facilitate all key players of the sector fulfil their mandate as follows: Funding base of the regional institutions and NMSs strengthened through enhancing the status of the organisations and improved financial management; Human resources of the regional institutions and NMSs strengthened to ensure improved services; Networking and cooperation between NMSs as well as with SADC's relevant organisations improved and processes for active sharing of data and experiences developed; Management, planning, operational and maintenance practices improved in the NMSs to ensure efficient use of resources and quality services for the key customers.

Implementation Strategy

A comprehensive implementation strategy will have to be implemented in order to realise the goals and strategies outlined in this Master Plan. A summary of the Prioritised list of projects and the corresponding resource requirements amounting to US$ 116,144,000 is given below as follows: A project focusing on Strengthening of the Meteorological Observation Network in the SADC region (US$ 81,579,000); A project focusing on Improvement of Meteorological Telecommunications and communication systems for rapid data collection, exchange and dissemination of data and information (US$4,230,000); A project aiming at the improvement of level of technical capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services (US$8,440,000); A project focusing on Improving the understanding of economic benefits and effective use of climate information and products through collaboration with stakeholders (US$2,155); A project for strengthening institutional capacity of the NMSs to provide relevant, reliable and timely climate and weather services (US$10,770,000); A project for strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RMTCs, RICC) to function as efficient regional coordination, development, services and dissemination centres (US$8,970,000). Partnerships with other relevant and interested stakeholders in the implementation of these strategic activities are highly recommended.

Financing and funding sources

The potential financing and funding sources include the Member States themselves; international funding agencies including the World Bank, African Development Bank, European Union among others; and bilateral arrangements between SADC Member States and other developed countries. The private sector will also have to be sensitised to contribute to supporting some of the activities. SADC may consider convening an Investor/Donor conference for the sector. Collaboration of SADC, the World Meteorological Organisation (WMO) and the Meteorological Association of Southern Africa (MASA) is considered critical for the success of this endeavour.

1 Introduction

1.1 Sector Purpose and Objectives of the Sector

The purpose of the sector is to ensure there is a coordinated manner for ensuring that meteorological services in the region play an effective role in socio-economic development of SADC countries, the protection of life and property and the sustainable protection of the environment from adverse impacts of climate variability and change.

The overall objective of the Meteorology Sector Chapter of the SADC Regional Infrastructure Development Master Plan (RIDMP) is to outline strategies for strengthening of the Meteorology Infrastructure and Services to ensure the sector contributes effectively to the development goals of SADC as spelt out in the RIDMP and the SADC Protocol on Transport, Communication and Meteorology, focusing on observation networks, telecommunications and data exchange, data processing and data management, weather and climate prediction and capacity building for service delivery. The plan also provides guidance of how the strategic objectives will be achieved on various time scales ranging from short to medium (5) years timeframe to the long (15) year timeframe. Figure 1 below provides the Meteorology sector Vision 2027.

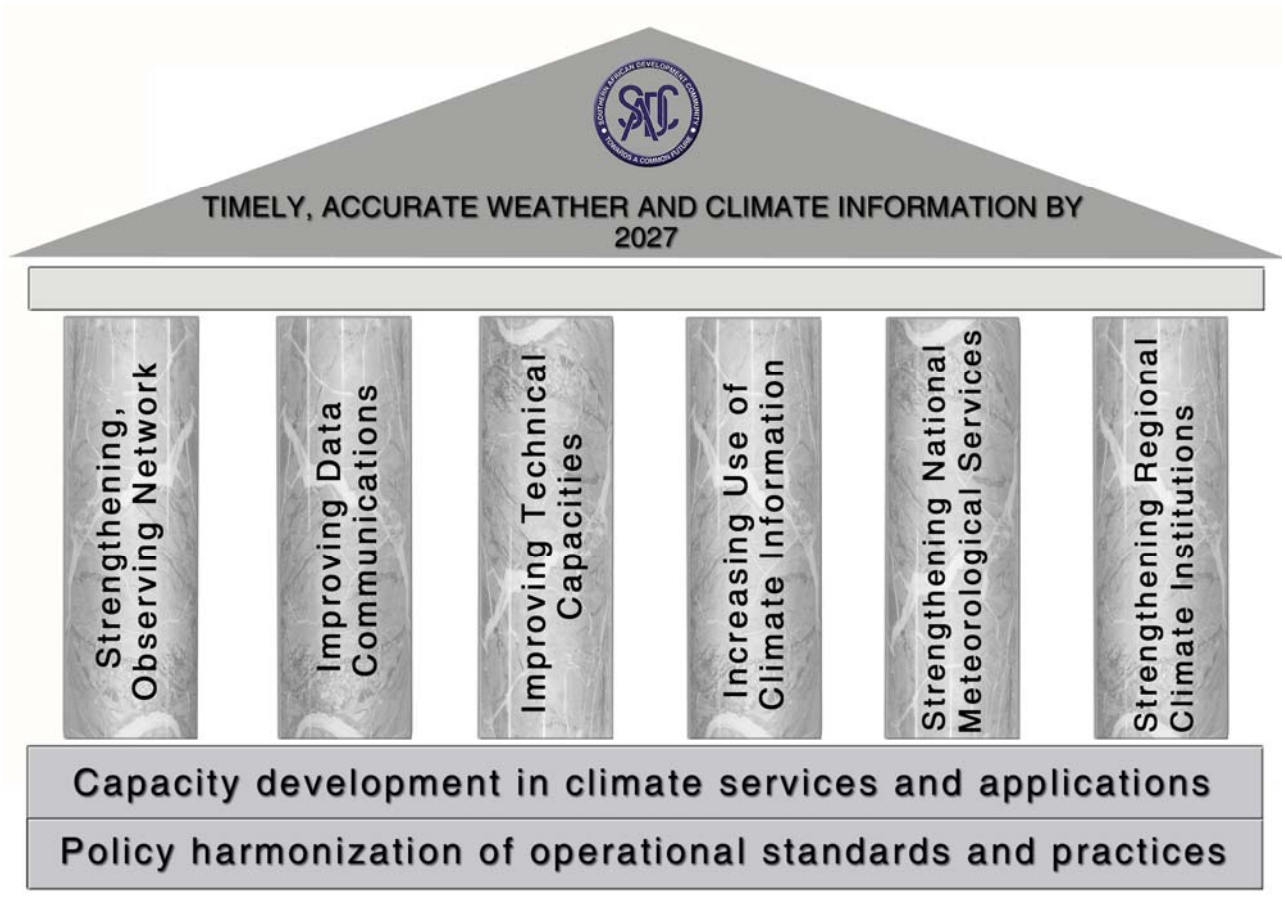

Figure 1: SADC Meteorological sector vision 2027

1.2 Policy/Legal Basis Guiding Sector

1.2.1 Regional Indicative Strategic Development Plan -RISDP

The aim of the RISDP is to provide strategic direction with respect to SADC programmes and activities, and to align the strategic objectives and priorities of SADC with the policies and strategies for achieving its long-term goals. The RISDP is indicative in nature, mainly outlining the necessary conditions that should be realised towards achieving those goals. In order to facilitate monitoring and measurement of progress, it sets targets and timeframes for goals in the various fields of co-operation. The purpose of the RISDP is to deepen regional integration in SADC. It provides SADC Member States with a consistent and comprehensive programme of long-term economic and social policies. It also provides the Secretariat and other SADC institutions with a clear view of SADC's approved economic and social policies and priorities.

The SADC-Regional Infrastructure Development Master Plan (RIDMP) is a Strategic Framework document which guides the implementation of efficient, seamless and cost-effective trans-boundary infrastructure networks in an integrated manner in all the sectors which constitute the SADC Regional Infrastructure Programme. It defines SADC's strategy in terms of content and constitutes a basis for priority, implementation strategy as well as the modus operandi for its implementation. The Framework provides guidance forecast for both requirements and implementation roadmap over a duration of fifteen (15) years with a span of five (5) years starting from the year of 2012, as follows: Short-term 2017, Medium-term 2022 and Long-term 2027.

The objective of the Meteorology Sector chapter of the RIDMP is to outline the strategic goals for the sector and provide a clear explanation of how the long-term goals, the programmatic goals and details the specific strategies that are to be pursued in line with the SADC long-term plans, the MASA Strategic plan 2011-2015 and WMO strategic plan (2012-2015).

The plan takes into account the evolving needs, requirements and challenges namely: Strengthening of observational network, including AWSs, Radar and remote sensing instruments; Upgrading of Data Base management including Data Rescue; Calibration of Instruments at national and Regional level; Training of Class I meteorologists and in Numerical Weather Prediction; Modernisation of real time Data processing and Forecasting, post-processing and service production systems; Improved capacity for generation of tailor made sector specific products; Improved capacity for climate modelling including assessment to high resolution climate scenarios; Improvement of Aviation Weather Services including ISO certification and Modernisation of telecommunications including implementation of TDCF in line with WMO-WIS/GTS. Other challenges include the strengthening of regional centres such as the SADC Climate Service Centre, the Regional Instruments Centre and the Regional Meteorological Training Centre to ensure they meet their mandates.

1.2.2 Protocols and Other Documents and Statutes

1.2.2.1 The SADC Protocol on Transport, Communications and Meteorology

The SADC Protocol on Transport, Communications and Meteorology, which came into force in 1998, provides the legal and broad policy framework for cooperation, and defines the strategic goals for the transport, communications and meteorology sectors.
The SADC Protocol on Transport, Communications and Meteorology (to be referred as SADC Protocol on Meteorology) elaborates the regional plans for the meteorological sector. Through this protocol, SADC Member States acknowledge that they are members of the WMO and,

through their national meteorological service; they constitute an integral part of the regional and global system or network of the WMO programmes and structures, in particular the World Weather Watch programme. Therefore Member States shall, within the regional and international co-operative system of the WMO, provide adequate legal frameworks and appropriate financial support to the national meteorological services to facilitate the establishment of an integrated network of observation, data processing and communications systems and enhance the provision of meteorological services for general and specialised applications in the region and internationally.

Furthermore the Protocol highlights the challenges in current policies and strategies for the meteorology sector as: Institutional capacity building to drive the transformation process; Development of model policy and legal framework; Reduction of dependency on the central treasury through cost recovery strategies in the meteorological services operations; and Specification of frequency bandwidth requirements for high fidelity transfer of meteorological information.
In the SADC Protocol on Meteorology, the Member States of SADC committed themselves to cooperation and harmonised development in the field of meteorology. The Protocol aims to achieve its meteorology objectives through:

- Establishing an integrated network of observation, data processing and communication systems;
- Enhancing the provision of meteorological services for general and specialised applications in the region and internationally, considering the feasibility of a selective commercialisation of specific services;
- Fostering sustainability through resource planning; and
- Ensuring the scientific and technical potential of specialised services at national centres is optimally utilised, especially in agrometeorological aspects of food, early warning, remote sensing, data archiving, drought monitoring, seasonal outlooks and climate analysis.

1.2.2.2 The Meteorological Association of Southern Africa

The Meteorological Association of Southern Africa (MASA) has been constituted by the Permanent Representatives (PRs) to WMO within the SADC sub-Region by signing of the relevant constitution. MASA has the function of a steering institution to facilitate speedy improvement of relevant meteorological activities for the SADC region. The MASA Secretariat is located on a permanent basis within the South African Weather Service, Pretoria, following an offer by the Republic of South Africa to host it.

2 Situation Analysis

2.1 Current Sector Status

2.1.1 Introduction

NMSs are essentially meant to provide services which will support the economies and ensure safety of lives and property of societies in Member countries.

On the global perspective the application of meteorological services has made a significant contribution to the improvement of the economies of countries and to safety of life and property of the public. Statistics from the Centre for Research on the Epidemiology of Disasters for the period from 1980 to 2007 reveals that over 90 per cent of all disasters were related to natural hazards, 71 per cent of the casualties and 78 per cent of the economic losses were caused by weather-, climate- or water-related hazards such as tropical cyclones and storm surges, droughts, floods or disease epidemics and insect infestations. It is noted that there has been significant reduction in losses of life and an increase in economic losses during the period 1956–2005 are evident from Figure 2. This is attributed largely due to advances in the monitoring and early warning systems made by NMSs and other stakeholders, but nonetheless these advances are not fully utilised by NMSs in developing and Least Developing Countries (LDCs) due to many challenges ranging from inadequate meteorological infrastructure to inadequate personnel resulting into shortcomings in service delivery.

It is also noted that despite the progress in improving services, many societies are increasingly vulnerable to natural hazards and national economies are becoming more sensitive to climate variability and change, as severe weather and extreme climatic events are occurring with greater frequency and intensity. The losses of life, the number of people affected and the economic losses associated with natural hazards are more severe for the developing countries, which includes most countries in the SADC Region, than for developed economies. This provides a strong argument and justification for improving weather, climate and related water, environmental services, as well as communications and emergency response activities, particularly in developing and Least Developed Countries (LDCs), Small Island Developing States (SIDS) and other vulnerable countries. It is noteworthy that most countries in the SADC fall under this category.

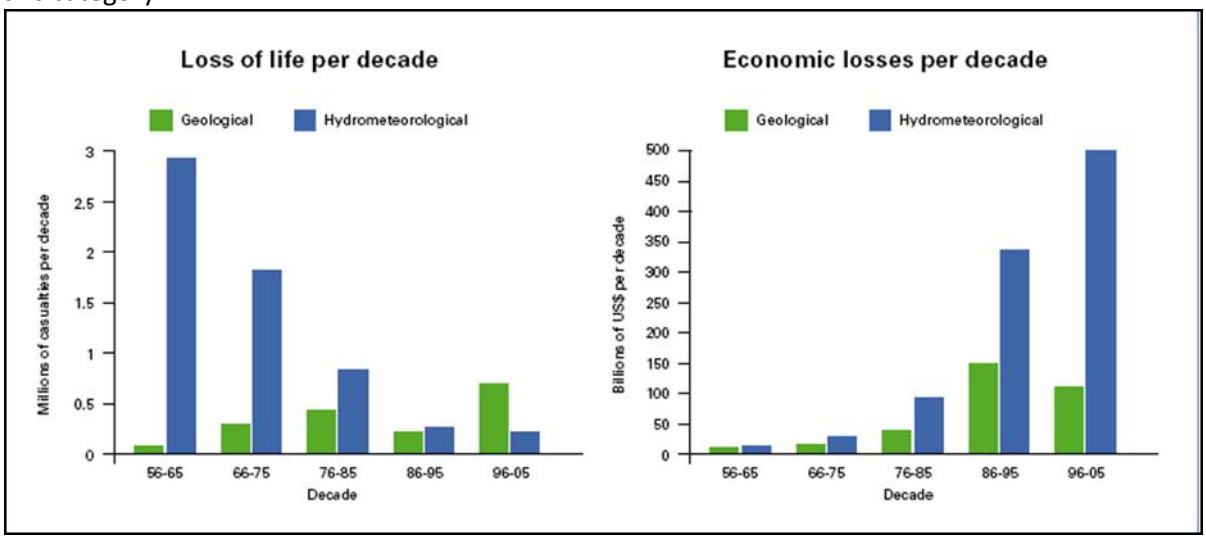

Figure 2: Decadal trends in natural hazard impacts over the 50 years indicating a decline in loss of life (left) and a rise in economic losses (right) associated with hydrometeorological hazards (Golnaraghi, M., J. Douris and J.B. Migraine, 2009)

2.1.2 Status of National Meteorological Services Infrastructure in the SADC

In most of the SADC countries the National Meteorological Services, under National Parliamentary acts, are responsible for maintaining meteorological observation networks, provision of meteorological information and climate services and monitoring of national climatic conditions. People in Southern Africa are most vulnerable to vagaries of severe weather and extreme climate whose impacts affect a range of social, political, economic and ecological factors. Meteorological Services play a strategic role in the social and economic development of the region. Weather and climate information and products provide useful inputs into sectors such as agriculture; livestock development and food security; road, air and maritime transport; health and public safety; tourism, building and construction industry; disaster management; environment and water resources management etc. The need for meteorological services in support of the various sectors will be even higher in the future due to the challenges emanating from negative impacts of climate variability and change which are predicted to affect more least developed and developing countries. In order to develop strategies for coping, adaptation and mitigation of the impacts of climate change policy makers will need accurate climate data and derived information. The provision of weather information and advisories to the various sectors of the economy is, therefore, a service that partner states have committed themselves to support.

The Meteorological Services in SADC are currently faced with high demand for timely and quality information, services and products. However, inadequate observational station network due to lack of instruments, shortage of trained personnel, telecommunications systems, data processing and information dissemination facilities are major drawbacks. The infrastructure and facilities have continued to deteriorate leading to great difficulties in giving weather and climate services in the region to meet national and regional needs.

Each NMS in SADC has peculiar needs and challenges. However with regards to infrastructure the following major challenges are noted:

- Many NMSs in SADC lack adequate observation network of both surface and upper air stations as well as remote sensing such as Radar networks;
- Lack of modern telecommunications infrastructure for efficient exchange of data and products in conformity with the WMO WIS;
- Lack of efficient data management systems and real-time data processing facilities including forecasting and dissemination systems; and
- Inadequate trained personnel.

The Meteorological services are also facing several challenges in the provision of services to the various social and economic sectors. These challenges include:

- Lack of appreciation of the strategic and critical roles of meteorological contribution to the national social economical development;
- Diminishing government financial budgetary support;
- Inability to comply with quality assurance framework like ISO 9000 for the provision of aeronautical meteorological services for international air navigation;
- Keeping up-to-date with the ever changing technology due to limited resources;
- Increasing demand by users in industry due to the need to minimise weather related losses;
- Inability to train, recruit and retain qualified human resources and to keep pace with new developments;
- Monitoring, detection and prediction of climate change;

- Inadequate capacity to generate sector specific information and its dissemination;
- Inadequate capacity to monitor and evaluate effectiveness of utilisation of weather and climate information;
- Provision of accurate and timely medium range to long-term (1 to 3 months) prediction as inputs for early warning for food security and mitigation of the impacts of natural disasters such as droughts and floods; and
- Inadequate modelling capacity of regional weather, climate and climate change scenario development.

The seriousness of the level of inadequacy of observational data in SADC is evident from the latest WMO Annual Global Data Monitoring results carried out in October 2010 and from October 2010 to April 2011 where it comes out clearly that SADC's performance is far below the global average. It is also below the average of Region 1 (Africa). For example for SYNOP the global average is 80% compared to 57% for Africa and 39% for the SADC NMSs. Availability of TEMP data is even worse with the global average of 71%, Africa 26% and SADC 9%. Details of data availability are given in Table 1.

Table 1: Availability of SYNOP, TEMP and CLIMAT Reports at MTN Centres from RBSN Stations

WMO REGION	SYNOP	TEMP	CLIMAT
1 AFRICA	57	26	33
SADC REGION	39	9	19
2 ASIA	89	80	84
3 S. AMERICA	65	50	79
4 N AMERICA	95	89	85
5 AUSTRALASIA	82	67	82
6 EUROPE	73	79	95
7 SPEC STNS	97	56	86
ALL REGIONS	80	71	73

Source: AGM-IWM-SMM: October 2010 - April 2011

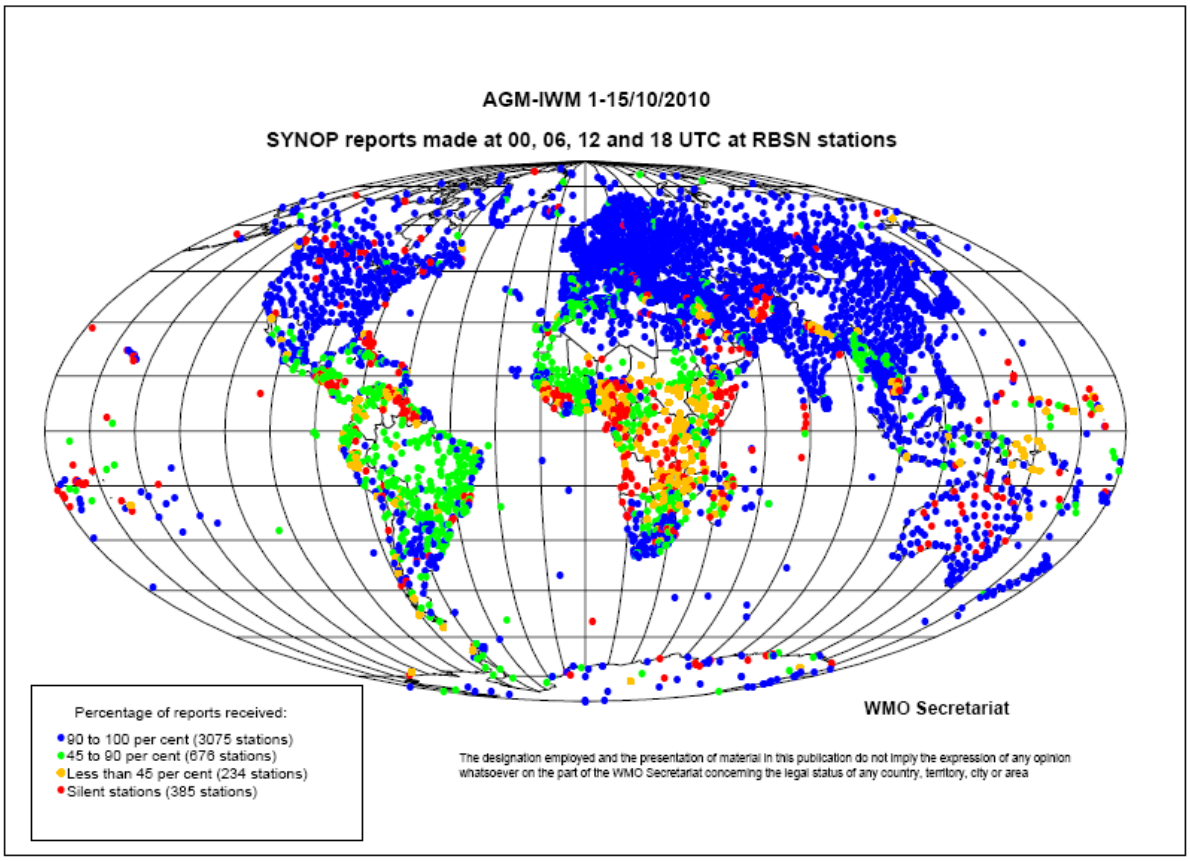

Figure 3: Availability of SYNOP Reports at MTN Centres from RBSN Stations
Source: AGM-IWM-SMM 1 -15 October 2010

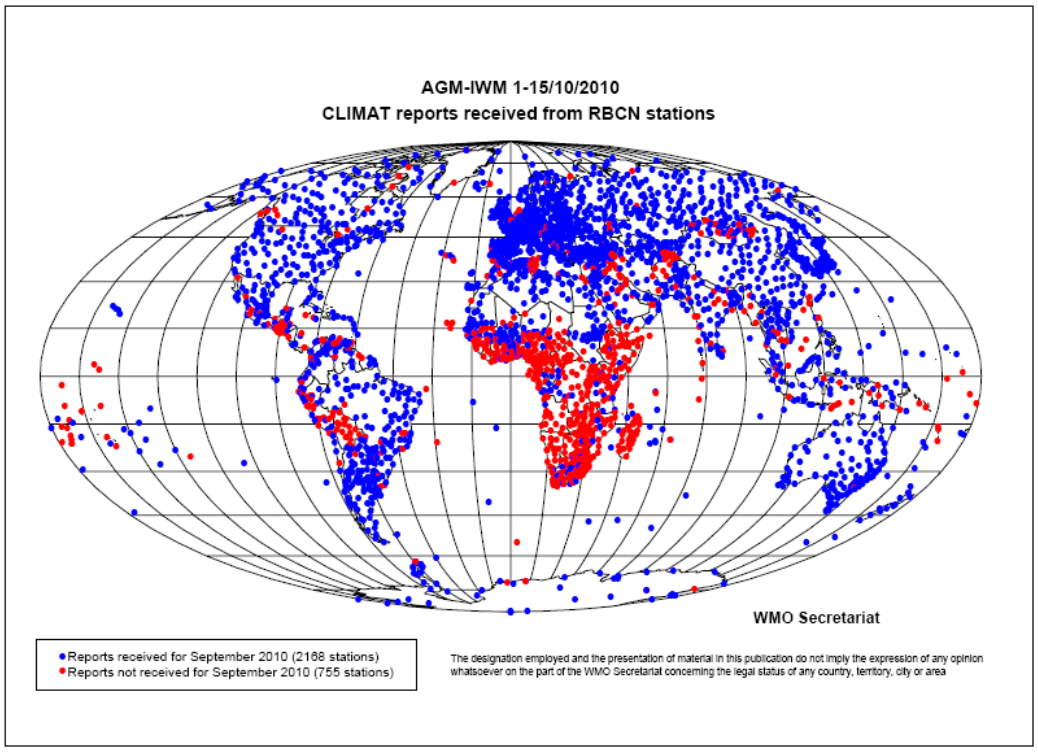

Figure 4: Availability of CLIMAT Reports at MTN Centres from RBSN Stations
Source: AGM-IWM-SMM 1-15 October 2010

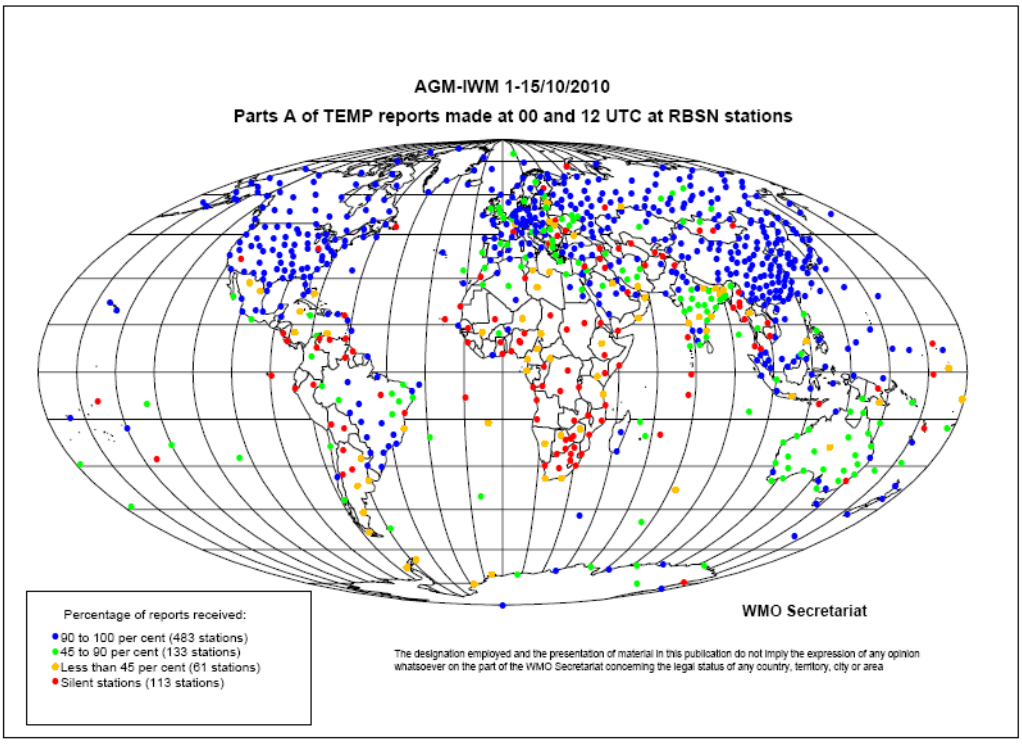

Figure 5: Availability of TEMP Reports at MTN Centres from RBSN Stations
Source: AGM-IWM-SMM 1-15 October 2010

The situation is also bad in other infrastructure components that support data exchange, data processing, forecasting and data management and public weather systems. The WWW's AGM and SMM have, over the years, indicated that data availability in RA I, which includes the SADC countries, has not been satisfactory. The non-availability of data has largely been attributed to the shortcomings in the implementation and efficiency of the Global Telecommunications System (GTS) and Global Observation System (GOS) in the Region.

Previous efforts by WMO and individual NMSs have provided significant improvements in the Global Observation System (GOS), Global Telecommunications System (GTS), Global Data Processing and Forecasting System (GDPS), Public weather Services (PWS) and Data Management (DM). However, there are still countries in the SADC region that have significant deficiencies in the operation and maintenance of these programmes. Many NMSs have inadequate capacity in these areas and the situation is exacerbated by the acute shortage of trained manpower.

The deficiencies in the collection and retransmission of meteorological data and products not only affects meteorological services in the SADC region, but the entire globe, in regard to aviation safety, marine safety, road safety, general public safety, safety of property, climate change monitoring and detection with socio-economic implications, food security, disaster reduction, poverty reduction, conservation of biodiversity and economic growth, amongst many other weather and climate-related activities. The wide extent of the effects is a result of interdependence of the global weather and climate patterns. Poor and uneven distribution of data globally leads to bias in model results and erroneous weather and climate simulations and forecasts.

Many NMSs have inadequate capacity in these areas and the situation is exacerbated by acute shortage of trained manpower. However available reports and documents highlight the status and major challenges facing individual NMSs as summarised in the following sections.

Status of NMSs in Member States

Most of the SADC NMSs face acute shortage of technical personnel, infrastructural set up and other technical capacities. A brief status at SADC NMSs is given below:

2.1.2.1 Angola

The war in Angola had serious impacts on its performance as a result of which there is urgent need for modernisation and strengthening of the Observation Network operated by INAMET, including alternative ways of communicating the data. For the NMS (INAMET) to operate effectively development areas were prioritised as: Development of administrative capacity; Modernisation and strengthening of observational network; Improvement of telecommunications network; and Upgrading of database management systems and training of technical personnel including Class I Meteorologists.

2.1.2.2 Botswana

The Botswana Meteorological Services (BMS) provides national weather and climate forecasts and other services in the country. The BMS hosts the Climate Services Centre, the Regional Instruments Centre and the AMESD Regional Implementing Centre. The major challenges in maintaining observation networks are human and technical resources (replacement parts, personnel, etc.) and financial resources. BMS also lacks equipment to measure solar radiation. BMS needs to train technical staff in areas such as Numerical Weather Prediction, climate modelling, modelling and data management. Building modelling capacity at BMS to generate climate change scenarios is one of the most urgent issues which can benefit many sectors. Other issues include modernising equipment for observational, transmission, analysis and disseminating facilities, as well as training relevant personnel. Priorities for development were given as: Building capacity for numerical weather prediction; Modernisation of observation network, including remote sensing instruments; Strengthening of Regional Instrumentation Calibration Centre; and Upgrading of database management system and environmental monitoring.

2.1.2.3 Democratic Republic of Congo

The National Meteorological Service (METTELSAT) is the NMS for the DRC. It runs a Forecasting Division which is equipped with: PUMA satellite receiving system, SYNERGIE, MESSIR-VISION and MESSIR-COM, all in good working condition. There are also two functioning AWSs. About 20 other AWSs have been acquired and are in the process of being installed. Climsoft and excel are used for data management.

Major challenges for the Service are indicated as: Improvement of climate stations network; Government funding for running the Services and implementation of development projects; and Lack of adequate qualified personnel. METTELSAT, formerly designated by WMO as a Regional Calibration Centre for Africa (RA I) has over the years not been fully functional due to lack of financial resources. Other priorities include: Training of technical staff including Class I Meteorologists; Modernisation and expansion of observation network, including remote sensing equipment; Improvement of Aviation Weather Services; Forecasting, post-processing and service production systems; and Basic instrument calibration facility and Climate database facility.

2.1.2.4 Lesotho

Lesotho Meteorological Services (LMS) is the NMS for Lesotho mandated to provide weather and climate services as well as other applications services. The main development needs are:

Modernisation of observation, communications and forecasting equipment including satellite receiving equipment. It also prioritises the need for basic instrument calibration capacity and development of skills in data management.

2.1.2.5 Malawi

The Malawi Department of Climate Change and Meteorological Service (MDCCMS) is the NMS providing meteorological and climatological services to the Malawi society. The functions of MDCCMS are: To establish, equip, maintain, and where necessary, to staff a network of meteorological stations; to arrange for rapid collection and redistribution of weather and climate reports in accordance with the regulations of the World Meteorological Organisation (WMO); to produce weather forecasts and climate predictions; to process meteorological and climate change data and information into publications, reports and bulletins; to provide meteorological and climate change services; to promote and advance meteorological and climate change science by means of research and investigation; and to implement WMO programmes and those of other related international organisations.

The main development needs that need to be addressed for MDCCMS are indicated as follows: Shortage in trained manpower; Deficiencies in the basic meteorological infrastructure; Modernisation of observation network including remote sensing equipment such as weather radar; Improvement of telecommunications; Improvement of the forecasting, post-processing and service production system. Improvement of instrument calibration facility and the climate database management facility; Training of technical staff including Class I Meteorologists and environmental monitoring; Improved skills in wind and solar energy mapping and implementation of QMS framework for provision of Aeronautical Meteorological Services; Improved skills in lightning occurrence analysis and mapping; Capacity to run climate models and in downscaling climate change scenarios from global/regional models to national scale, capacity to run an operational high resolution Limited Area Model and Capacity for Numerical Weather Prediction (NWP).

2.1.2.6 Mauritius

The Mauritius Meteorological Services (MMS) is the NMS mandated for provision of weather and climate services to the population of Mauritius. The department has had high visibility in Mauritius due to its continued role of providing timely warnings for tropical cyclones over the southwest Indian Ocean to the Mauritius community and the SWIO Tropical Cyclone Committee members. It is noteworthy that the MMS is already ISO certified.

The Department identifies its priority development to focus on: Information on lightning occurrence; Capacity to run an operational high resolution Limited Area Model; Capacity to run high resolution climate models; and Capacity building in downscaling from global/regional models to island scale. Others are: Updating of Climate database facility; Basic instrument calibration facility; and Weather radar. Furthermore MMS has its own specificities, challenges and requirements. Apart from financial issues, difficulties are felt due to lack of human resources to develop and work on the above mentioned programmes.

2.1.2.7 Mozambique

INAM is the NMS mandated for provision of weather and climate services to the people of Mozambique. The service has had assistance in the development of its infrastructure following the devastating floods caused by tropical cyclones in 2000. Despite these improvements the INAM requires attention in the following areas: Strengthening the Observation Network (ground and Upper air) and acquisition of one radar; Improvement of telecommunications, Climate

Database Facility and Assessment to high resolution climate scenarios; Weather Service Production System and Upgrading of IT systems; Training on aviation and marine forecasting; Implementation of QMS and Basic instrument calibration facility; Improving the capability for post processing of NWP products and other information to generate products and services including Early Warning Information; and Capacity building in modelling and prediction of climate variability and change as well as impact assessment.

2.1.2.8 Namibia

The Namibia Meteorological Service is responsible for the provision of weather and climate information, data and advice for the protection of lives and property of the Namibian citizens and beyond. There are eight (8) manned synoptic stations and forty seven (47) automatic weather stations meant for surface observations fairly distributed across the country. There are three upper air weather stations located at Walvis Bay, Windhoek and Keetmanshoop whereas another one will soon be installed at Grootfontein. The Service has two key sub divisions i.e. operational service and advisory services. The first one is primary responsible for the provision of aeronautical meteorological services to the aviation industry and the collection and processing of climate data using CLIDATA and CLICOM systems for data verification and archiving. Sub division advisory Services is responsible for research, acquisition and maintenance of meteorological instruments and equipment as well as for the acquisition and interpretation of remotely sensed data. It is the mandate of the NMS to provide services and advice to agriculture, fisheries, forestry, environment (particularly on climate change issues) and many other socio-economic sectors. The NMS plays a critical role in the provision of early warning services during severe weather phenomena such as floods, droughts and cyclones. The key development areas identified under the National Development Plan of Namibia (NDPN) are the extension and strengthening of observation networks, acquisition of weather radars for the monitoring of hazardous weather, installation of lightning and air quality detection equipment, construction of meteorological office buildings, restructuring of the NMS, and development and enactment of a Meteorological Service Act, development of maritime meteorological services, and training of staff members.

2.1.2.9 Seychelles

The Seychelles National Meteorological Services is responsible for provision of weather and climate services including issuing warnings on tsunami and the occurrence of tropical cyclones. The Service has a good observation network on the main Island but has an inadequate staff level. It has an upper air station and sea level measuring equipment. The following areas of development are prioritised by the NMS: Strengthening of marine weather service; Staff training (Class II); Basic instrument calibration facility; and Automatic Weather Stations and Assessment to high resolution climate scenarios.

2.1.2.10 South Africa

The South African Weather Service (SAWS) is a modern weather service, with a good observation network and infrastructure. The SAWS network comprises 230 Automatic Weather Stations (AWS), 130 Automatic Rainfall Stations (ARS), 14 Radar (9 S-Band and 5 C-Band), 24 Lightning Detection Sensors, 13 Upper Air stations and 7 Air Quality stations. The SAWS AWS and ARS are developed and manufactured in-house. ICT infrastructure includes the OPMET database and supercomputer for running high resolution models. SAWS hosts a number of regional centres including the Flash Flood Guidance System in Southern Africa, the Severe Weather Forecast System (SWFS) and Centre of Excellence (CoE) in satellite training. SAWS is also an RSMC, RMTC and RTH as appointed by WMO. The SAWS has also been ISO certified with effect from October 2011.

Despite its superior facilities relative to other NMSs in the SADC, SAWS identifies some development needs for sustaining and improvement of its services as: Establishment of the WMO Regional Training Centre to function optimally; Staff exchange programmes on skills transfer and implementation of programmes of actions with higher learning institutions; Acquisition of additional LDN components and extension of the South African LDN to the SADC region; Acquisition of new generation of AWSs and radiation sensors, as well as soil parameter measurements; Establishment of Meteo-Ocean infrastructure; Enhancement of Southern African Flash-Flood Guidance (SAFFG) System; Establishment of the Severe Weather Forecasting Demonstration Project (SWFDP) SADC desk; Capacity building for the Regional advisory Centre for the provision of ICAO SIGMET; Acquisition of a new High Performance Computer to improve the resolution of the models that can be run; Acquisition of AMDAR Humidity probe/sensors for enhancement of the programme; Capacity building for the competencies required for personnel providing services to international air navigation; Climate and agrometeorological applications for various sectors including the socio-economic sector; and Research applications on air quality.

2.1.2.11 Swaziland

Swaziland Meteorological Service (SMS) is Swaziland's national meteorological service providing weather and climate services. The current meteorological observation network consists of about 80 stations. Swaziland has no upper air sounding station.

The SMS has mobilised funds for a regional lightning detection system sensor, a forecasting system, a database management system and 15 automatic stations (one at the airport and 14 in other places around the country). The major challenge is that none of these systems have backups.

The SMS is currently facing an acute shortage of professional staff. It identifies the following priority development areas: Training of manpower both for forecasting and maintenance of equipment; Modernisation of observation network, including increasing number of AWSs; Forecasting, post-processing and service production system; Numerical modelling (especially for estimation of wind power potential) capacity; Basic instrument calibration facility; and Assessment to high resolution climate scenarios.

2.1.2.12 Tanzania

Tanzania Meteorological Agency (TMA) is a semi autonomous government Agency mandated to fulfil national requirements for weather and climate services in the United Republic of Tanzania. It has better manning levels of trained staff than most NMS in SADC. Despite the presence of good manpower, TMA lacks adequate modern equipment for its optimal capacity utilisation for improvement of services. TMA is still using a database management system called Climate Computer (CLICOM) but wishes to migrate to WMO recommended software such as CLIDATA. TMA has one Doppler weather radar and plans to install a total of seven countrywide. From 2008 to 2010 TMA collaborated with WMO to successfully implement a Quality Management System (QMS) framework for provision of Aeronautical Meteorological Services, becoming the first NMS in sub-Sahara Africa to be ISO certified for this service provision. TMA shares its expertise in this area with other Partner States in SADC, the rest of Africa, and beyond.

The following areas of development were prioritised by the TMA: Modernisation and expansion of observation network, including, AWS, radar and remote sensing equipment; Upgrading of climate database management system; Improvement of telecommunications systems; Strengthening of marine weather service; Improvement of forecasting, post-processing and

service production system; Climate change modelling capacity; Improving aviation weather services; Assessment of solar and wind power potential; and Data Rescue.

2.1.2.13 Zambia

The Zambia Meteorological Department (SMD) was established on 1 January 1967 as a specialised agency under the then Ministry of Power, Transport and Works and later under the Ministry of Communications and Transport. It is now under the Ministry of Transport, Works, Supply and Communication. It is the primary provider of meteorological services in Zambia. It has offices in the 10 provinces and some districts, and it is responsible for providing weather and climate information to the public and various sectors of the economy. SMD is also the custodian of the official records of Zambian weather and climate.

SMD operates a network of 41 full-time weather stations which are inadequate relative to the size of the country. These are supplemented by a network of voluntary stations (mainly rainfall stations) run by various organisations that include the Department of Water Affairs (DWA), Zambia Electricity Supply Cooperation (SESCO), Mines, schools and Churches. Currently SMD has inadequate numbers of trained personnel especially at professional level. No upper air stations are being operated. SMD and the Danish Meteorological Institute (DMi) are implementing a twinning project valued at Danish Kroner 5,000,000 launched in March 2010.

The prioritised areas of development by the SMD are as follows: Modernisation and expansion of observation network, including remote sensing equipment; Improvement of telecommunication systems including Table Driven Code Format training; Improvement of Aviation Weather Services - importantly Quality Management System (QMS) implementation; Assessment to high resolution climate scenarios; Basic equipment calibration facility; Climate data base management facility; and Training of class I Meteorologists.

2.1.2.14 Zimbabwe

The Meteorological Services Department (MSD) is a government entity currently institutionalised within the Ministry of Transport, Communications and Infrastructural Development. Since 2004, the MSD has been operating under the Meteorological Services Act which empowers it to operate on a cost recovery basis in order to generate extra revenue for its development. The Department operates a network of 64 meteorological stations country wide. However, the rainfall network has several hundred stations under the voluntary programme. In addition, the MSD is the country's official authority on seismological monitoring and reporting as well as the technical executing agency in terms of the Comprehensive Nuclear Test Ban Treaty Organisation (CTBTO) in Zimbabwe.

The Department contributes to the protection of life and property, socio-economic decision-making as well as playing a pivotal role in strategic national security issues such as water, health, transport, agriculture and food security by providing customer and stakeholder-driven quality meteorological, climatological and seismological products and services.
In order to resolve the challenges it has, the Department developed a five-year strategic plan which covers the following among others:

- Upgrading the meteorological and seismological network (AWOSs, AWSs, Weather radars, meteorological Instruments, and seismometers);
- Introduction of ground based national cloud seeding at provincial level;
- Installation of wind sounding equipment and hydrogen plants for upper air;

- Continuation of the provision of decent government offices and staff accommodation and a 50 bed hostel block;
- Meteorological and seismological modelling and agrometeorological farm extension programme;
- Capacity development for the Department; and
- Continuing education in HIV/AIDS awareness.

2.1.2.15 Summary of capacity development needs within the NMSs

Using various sources of information a summary of prioritised development needs by the SADC NMSs is presented in Table 2 below:

Table 2: Summary of capacity development needs by SADC NMSs

COUNTRY/ CHALLENGE	Obs Networks Including AWS, Radar, Buoys	Telecoms Network Including TDCF	Data Processing and Forecasting systems	Data Base Management Including Data Rescue	Instruments Calibration	Generation and dissemination of Sector Specific Products	Climate modelling	AviMet. Including ISO Certification	Environmental Monitoring	Training Class 1 meteorologists and NWP
	1	2	3	4	5	6	7	8	9	10
Angola	x	x		x	x		x			x
Botswana	x	x	x	x	X		x		X	x
DRC Congo	x		x	x	X					x
Lesotho	x		x	x	X					
Malawi	x	x	x	x	X		x	x	X	x
Mauritius	x	x		x	X		X			
Mozambique	x	x	x	x	X	x	x	x		x
Namibia	x			x	x	x	x	x	x	x
Seychelles	x				X	x		x		
South Africa	x	x	x	x		x			X	x
Swaziland	x		x		X	x	X			x
Tanzania	x	x	x	x		x	X		x	x
Zambia	x	x	x	x	X		X	x	x	x
Zimbabwe	x		x		x		X		x	x
Total	**14**	**8**	**10**	**11**	**12**	**6**	**10**	**6**	**7**	**11**
%NMSs	100	57	71	79	86	43	71	43	50	79

Legend: X implies an NMS identifies the item among the 10 top development priorities
Blank implies the NMS did not identify the item among 10 development priority

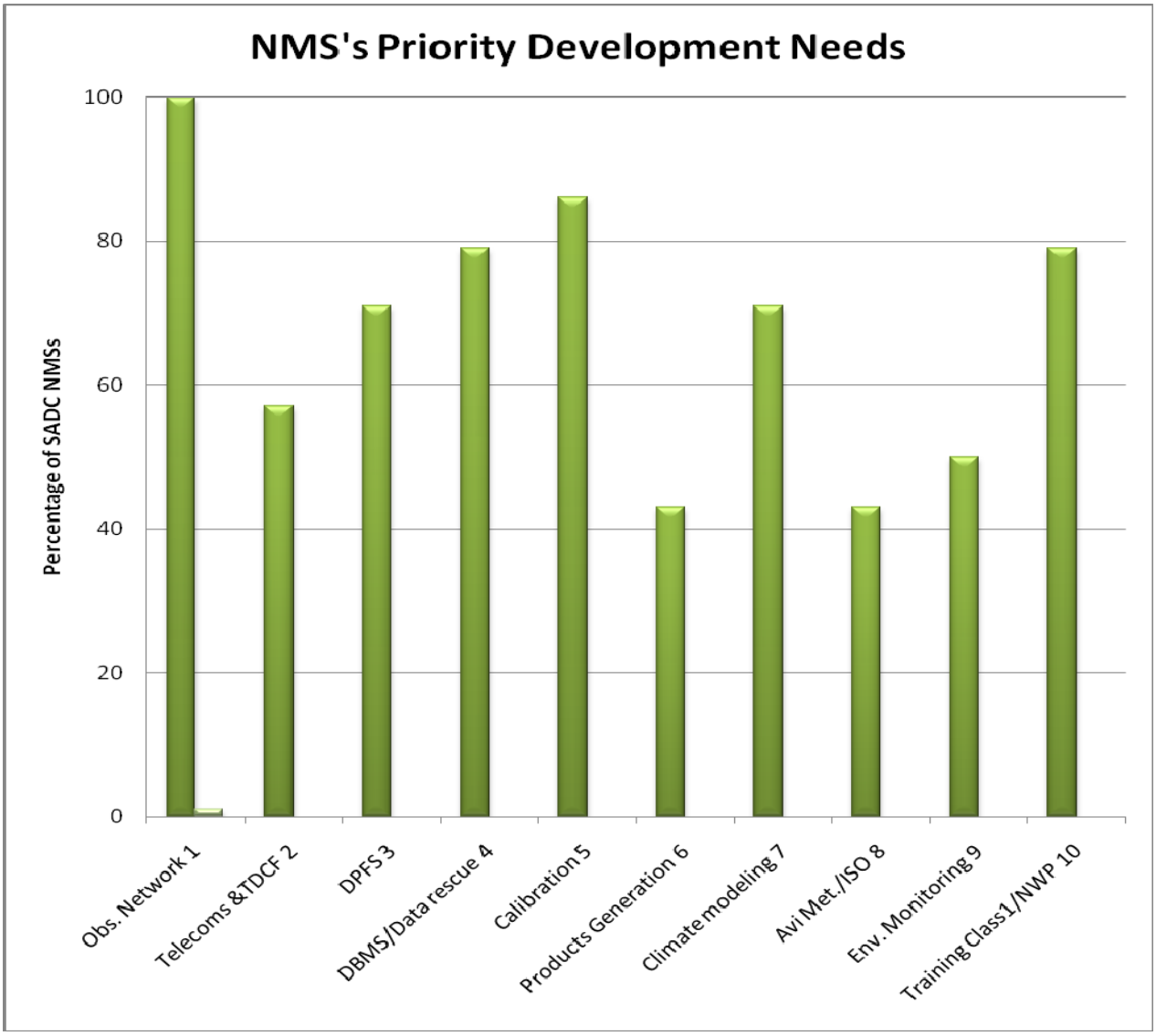

Figure 6: **Prioritised development needs of SADC NMSs**

Based on the analysis of challenges indicated in Table 2 and Figure 6 above, it is noted that most NMSs in the SADC prioritise their development requirements in the following order:

- Strengthening of observational network, including AWSs, Radar, TEMP (Upper air) and remote sensing instruments;
- Upgrading of data base management including data rescue;
- Strengthening of the RICC in Gaborone, Botswana for best practices;
- Training of technical personnel;
- Modernisation of real time data processing and forecasting, post-processing and service production systems;
- Improved capacity for climate modelling including assessment to high resolution climate scenarios;
- Modernisation of telecommunications including TDCF;
- Improved capacity for generation of tailor made sector specific products;
- Improvement of Aviation Weather Services including ISO certification;
- Capacity for environmental monitoring; and
- Maintenance of infrastructure.

Other priorities which are of regional focus and dimension are identified as:

- Establishment of the WMO Regional Training Centre for English speaking countries;
- Acquisition of additional LDN components and extension of the South African LDN to the SADC region;
- Enhancement of Southern African Flash-Flood Guidance (SAFFG) System;
- Sustaining the Severe Weather Forecasting System (SWFS) including establishing SADC desk; and
- Capacity building for the Regional Advisory Centre for the provision of ICAO SIGMET.

2.1.3 Status of Regional Meteorological Facilities and Infrastructure

The main objective of Regional Centres is to utilise pooled resources in support of National Meteorological Services (NMSs) to produce some products and services that would be difficult for each individual NMS to be able to produce due to high cost of equipment and lack of adequate human resource capacity. Several initiatives have been made to establish Regional Meteorological facilities as described in the following sections.

2.1.3.1 SADC Climate Services Centre (CSC)

2.1.3.1.1 Status

The Climate Services Centre (CSC) (formerly known as the Drought Monitoring Centre (DMC)) was originally created by the African Governments in collaboration with the World Meteorological organisation (WMO) in response to the frequent devastating droughts in the region during the 1970s -1980s. Through the realisation that a regional centre was a more cost-effective and efficient instrument for monitoring, diagnosing and making predictions of the climatic conditions, two centres were established in Harare and Nairobi in 1989 to service the SADC and IGAD regional economic community Member States. The Harare Centre became operational in 1991. The original funding was provided by United Nation Development Programme (UNDP) with WMO as the Executing Agency. With the realisation of the importance of the then DMC to the region, the need to institutionalise it for the purposes of sustainability became clear, and SADC took over the then DMC from April 2002.

Mandate

The DMC was mandated to contribute to the early warning and mitigation of adverse impacts of severe extreme weather and extreme climate events on key socio-economic sectors of all the countries in the SADC region. It carried its mandate through development, generation and dissemination of meteorological, climatic, other environmental and hydro-meteorological products. The principal goal of the SADC CSC is to contribute to the reduction of negative impacts of adverse weather and climate conditions such as drought, floods and other extreme events on sustainable socio-economic development, and to the rational use, conservation and protection of national resources in the SADC sub-region. The main target beneficiaries are the professionals of NMHSs and climate applications specialists from diverse end-users who are expected to apply climate and hydro-meteorological information and products in the various weather-sensitive economic sectors such as agriculture, health, energy, water resource management, disaster management, transport (both in water, surface and aviation) and others. Decision-makers and policy-makers in various government departments, the private sector and Non-Governmental Organisations (NGOs) use the products and services to devise strategies to mitigate the impacts of climate extremes. Other beneficiaries include regional specialised SADC and international institutions.

The aims of the CSC include:

- Providing, on a regular and timely basis, weather and climate advisories in particular, with advance warnings on droughts, floods, etc., or absence thereof;
- Producing reference tools for better use and sustainability of environmental and natural resources;
- Increasing the capacities of professional and technical staff in the National Meteorological and Hydrological Services (NMHS) and Early Warning Systems to monitor and forecast drought, floods etc., and to meet user requirements through training;
- Development of climate databanks and archiving of global, regional and national quality controlled climate data;
- Conducting training and capacity building activities in the generation and application of climate products; and
- Organising the climate outlook forum (SARCOF) for the SADC region, thus enhancing the interactions with the users through regional user workshops and application pilot projects. One of the main activities that is successfully implemented is the organising of the climate outlook forum (SARCOF) mostly done in collaboration with the NMHSs, the WMO and other development partners. These have assisted to some extent in training of national climate scientists and professionals from key user sectors in seasonal forecasting techniques and interpretation of products respectively.

Relocation

In August 2006 the SADC Council made a decision to re-locate the Centre to Gaborone, Botswana. At the time it was highly regarded, providing a leadership role on the world stage. It even became a model of the GFCS and the Regional Climate Centre, pioneering the world-famous Regional Climate Outlook Forums (as SARCOF).

The decision to relocate was implemented in April 2007 and the Centre was housed at the Botswana Meteorological Department in Gaborone. In September 2010 the Centre was renamed as SADC Climate Services Centre (CSC) following the WMO World Climate Conference-3 (WCC3-WMO) Declaration "to establish a Global Framework for Climate Services to strengthen production, availability, delivery and application of science-based climate prediction and services". SADC Ministers responsible for Meteorology and MASA meetings had called for the strengthening of the DMC and the expansion of its activities in order to better prepare the region to deal with impacts of climate variability and climate change. Thus, the under-capacitated CSC would result in far-reaching consequences such as failure of the SADC region to prepare itself adequately for disaster risk reduction. This would reverse the progress so far made in socio-economic development. An increasing number of socio-economic sectors in the region require frequent advice on the current state and application of climate services and information to adapt or mitigate impacts of climate change. The standards set at Harare by 2007 before relocation should be improved in Gaborone due to the expanded mandate and scope of work of the Centre. It is, therefore, imperative that the infrastructure and staff levels are improved in order for the CSC to function efficiently and play an effective role in the socio economic development of SADC Member States.

Constraints

However, over the years, the performance of the CSC has deteriorated, to the extent that currently many of the planned activities have not been implemented, due to an acute shortage of resources both financial and human. At present, the equipment of the CSC consists of only two computers, a printer and a scanner. The staff consists of only one temporary attached Climate Expert and one senior Climate Expert whose duties also include administrative work as a SADC

contact point in Meteorology. Experience has shown that there are cases when development partners have funds that enable them to provide support for others, e.g. SARCOF activities as well as other pivotal activities, but because of the current elaborate internal clearance procedures of the SADC Secretariat it has been difficult, if not impossible, for development partners to provide those funds to the CSC.

This has curtailed the effectiveness of CSC in discharging its mandate. Some level of semi-autonomy at SADC CSC for scientific programmes, particularly in terms of establishing and strengthening partnerships, is bound to allow it to perform better in this regard. This is the case with other scientific institutions in other RECs, e.g. ACMAD (Africa-wide) and ICPAC which have the same mandates as SADC CSC. Semi-autonomy is necessary to ensure the effectiveness and efficiency of the CSC scientific programmes which are so crucial in developing products that become decision tools. It is imperative that the CSC is able to participate in international climate science programmes so that, consistent with its mandate, it is able to provide the necessary leadership to the meteorological community of the Member States. Cooperating partners prefer to engage the CSC on scientific programmes as it is more cost-effective to do so, instead of engaging with individual Member States. However, the current elaborate internal procedures at SADC Secretariat tend to render such cooperation with scientific and climate research institutions difficult to implement expeditiously.

In contrast, the Inter-governmental Authority on Development (IGAD) Climate Prediction and Applications Centre (ICPAC) in Nairobi, Kenya was created with a similar mandate but has more than 10 professionals and a wealth of modern equipment. Elsewhere in Africa and indeed, the global climate centres have even better facilities that enable them to meet and discharge their mandate effectively. These sister institutions have greater flexibility in entering into partnerships with advanced climate centres, research institutions and other international organisations; affording them the ability to provide effective leadership in climate science, practice and applications to Member States in respective RECs. This has enabled these centres to serve their sub-regions well. It is, therefore, imperative to provide similar operational arrangements at the CSC.

2.1.3.1.2 Future development initiatives

There is need to address the constraints being faced by the CSC in order for it to achieve its mandate, effectively, efficiently in order for the SADC region to derive maximum benefits by applying climate information and prediction services in all socio-economic sectors. There are a number of initiatives aiming at enhancing the capacity of the CSC, namely:

- The **ClimDev-Africa project** has plans to support the CSC); and
- The **Southern Africa Meteorology Project (SAMPRO) project,** sponsored by the Government of Finland, has plans to support programmes and work in partnership with the Centre.

Recommendations

SADC CSC has also been identified as the candidate for the proposed WMO Regional Climate Centre (RCC) for the SADC region and this proposal was endorsed by the SADC Ministers responsible for Transport and Meteorology. Due to increasing demands on industry because of important developments such as climate change and its impacts on socio-economic development there is a need to improve the number of staff at the CSC. Data types are also increasing: global and regional sea-surface temperature and atmospheric data, and remotely-sensed data need to be continuously captured and archived. The generation and dissemination of associated products requires support by additional technical assistants. Failure to implement this will compromise the

efficient and effective operation of the CSC, eventually damaging its visibility to stakeholders. Notwithstanding, there are ever-growing demands by Member States on the products and services of the CSC, particularly during the rainy season. There is, therefore, need to make interventions so that the CSC achieves its goals.

The following are some of the interventions recommended for improved performance of the CSC:

- SADC in collaboration with MASA and SADC NMSs establish a mode of funding for the sustainable running of optimum operations at the CSC;
- SADC CSC be transformed into a semi-autonomous institution under SADC to allow it to execute its management and operations with SADC keeping eyes on but managing at arm's length thus reducing bureaucracy and enhancing efficiency;
- Improved computing capacity in the form of clusters of high speed and appropriate memory capacity and suitable software to enable it to run regional climate and dynamic numerical prediction models as well as perform data management for the region and also to address climate change impacts on the economies;
- Enhanced internet connectivity with efficient bandwidth and other forms of advanced communication facilities for smooth operations and connection with advanced regional and global centres and NMSs;
- Recruitment of at least 10 professionals in climate science and specialised applications areas for research and development and routine generation and dissemination of products;
- Recruitment of support staff in administration, computing and data management to ensure smooth management;
- Improved facilities including infrastructure for training of climate scientists, applications specialists and end user groups in seasonal forecasting as well as users on interpretation of products; and
- Enhanced interaction with regional and global centres to achieve international best practices in generation and application of climate products.

2.1.3.2 The SADC Regional Instrument Calibration Centre (RICC)

The Centre is located at the premises of Botswana Meteorological Services in Gaborone. The facility was created for use as a common facility for calibration of meteorological instruments in the region. There is good justification for this centre to be supported as one of regional meteorological facilities.
In practice the time used to calibrate instruments is relatively short and therefore, if well equipped, the centre could adequately serve several NMSs in the SADC region. Furthermore, the necessary calibration equipment is relatively expensive for each NMS to afford. For example good basic calibration instruments for calibration of temperature, humidity and air pressure can cost in excess of US$400,000.

Calibration of meteorological instruments is essential for all NMSs for ensuring accuracy of measurements and conformity with WMO standards for operation and maintenance of meteorological instruments. Calibration of instruments is one of the mandatory requirements for the implementation of QMS for provision of aeronautical meteorological services to International Air Navigation whose deadline, set by ICAO, is November 2012. Most NMSs in SADC have not adhered to this to date, and there is an urgent need to take the necessary steps to enforce this important requirement.

It is observed however, that in spite of the good intentions for its creation the RIC currently does not meet its mandate due to old calibration equipment which was acquired in 1993 as a part of the FINIDA/SATCC/WMO project.

For the RICC to be able to perform its mandate it is recommended that improvements be made as follows:

- There is need to equip the centre with modern calibration instruments and tools by replacing the aged and outdated equipment that was purchased more than 10 years ago;
- The centre should have adequate, well trained staff to run the calibration operations of the centre;
- Capacity building of staff should be encouraged through the implementation of expert visits relating to calibration and maintenance of meteorological instruments;
- SADC or MASA assist to develop mechanisms such as an MoU which will enable NMSs of Partner States to access the services of the RICRIC without having to pay taxes on entry or on departure for instruments calibrated at the Centre; and
- The modus operandi of the Centre should be well defined to ensure its sustainability in support of NMSs in the region. MASA should explore ways of ensuring its modernisation and sustainability.

2.1.3.2.1 Future development initiatives for the RICC

There are plans to strengthen the RICC operations through the SAMPRO project. There are no other known initiatives to fund the centre. It is recommended that other funds be sourced to support the efforts of the Botswana Government to ensure that the RICC is fully operational for the benefit of the region.

2.1.3.3 Regional Meteorological Training Centre (RMTC)

In the SADC Region there has been only one Regional Meteorological Training Centre which is located in Angola. The centre is designated by WMO as a Centre for Class II and Class III meteorologist training in Africa. However the new guidelines of WMO have removed Class II training, thus leaving the centre with only class III training, mainly for the Portuguese speaking countries namely Cape Verde, Guinea Bisau, Mozambique and Sao Tome and Principe. Unfortunately the current status of the Centre is not good due the destruction caused by the civil war. Construction of the new RMTC at INAMET HQ started in 2010 and has not yet been finalised. Currently there is a plan to have it upgraded to include training of Class I meteorologists. Recently SAWS has also been granted the RMTC status and will be in a position to service the SADC English speaking countries.

The setting up of the RMTC in the SADC needs to take into consideration the current trend in the region whereby a number of institutions of higher learning are establishing degree programmes in meteorology. In this process it is recommended that, for better use of resources, duplication of institutions with similar functions in the region be avoided as much as possible.

2.1.3.3.1 Future Development Initiatives

The government of Angola is committed to supporting the Centre. The SAMPRO has prospects of supporting training activities in the region.

It is recommended that the Angolan Government, SAMPRO project and other sources of funds be made available to revive and sustain, where appropriate, the operations of this important training facility for the region.

2.1.3.4 Centre of Excellence for Satellite Meteorology Training

Satellite information forms part of the data necessary for operational weather and seasonal forecasting and research for the NMSs and other users in the region. The South African Weather Service (SAWS) is a WMO Centre of Excellence (CoE) for Satellite Meteorology. The centre is working within the framework of the WMO/Coordination Group for Meteorological Satellites (CGMS). The centre plays an important role in training activities and it is vital to ensure that these services are improved according to emerging technologies and sustained.

2.1.3.5 University Training in Meteorology in the SADC

University level training in Meteorology and related applications sciences is essential for producing graduates capable of performing operational activities and research in the NMSs. Currently University level education in subjects related to Meteorology is conducted at Universities in South Africa, Tanzania, Zimbabwe, DRC and Mozambique. It is noted however that except for South Africa the courses are not comprehensive in meeting the guidelines of WMO for training of Class I meteorologists. No university has a fully fledged department specialising in Meteorology, necessitating countries to pay dearly for training of meteorologists outside the countries and the SADC Region. They also lack facilities for specialised research and the curricula lack content on evolving demands such as climate change science and management, which is essential to prepare graduates capable of managing climate change. The majority of Member States in the SADC have limited numbers of professional Meteorologists and most of those available are doing administrative work, leaving a big gap in personnel requirements for operations and research.

In order to ensure that human resources capacity in meteorology meets the increasing demands, it is recommended that the region puts mechanisms in place tasking some universities with the responsibility of introducing training for meteorologists at WMO Class I level and other related applications to degree level.

2.1.4 Meteorological Research

Meteorological research is very important for improving and enhancing the understanding of the behaviour and origins of weather and climate systems in the sub-region. The National Meteorological Services, due to its limited capacity, is more involved in operational activities and conducts only limited meteorological research. Although there are some universities in the sub-region that conduct research, the interaction of these institutions with the NMSs is very limited. This situation needs to be improved through enhanced interaction between research institutions of high learning and NMSs, so that capacities in meteorological research are strengthened.

Furthermore the SADC CSC, as a regional CoE in the provision of climate services, needs to establish good working links with institutions of higher learning in the region so that experts from these institutions can collaborate with it in carrying out meteorological research relevant to the region.

2.2 Enabling Environment and Institutional Arrangements

The enabling environment and institutional arrangements for the development and implementation of the plan constitutes many factors such as the legal Regional Instruments of Cooperation (RIC) composed of regional policies, strategies, protocols and plans as well as factors pertinent at international and national level, as elaborated in the following sub-items.

2.2.1 International

2.2.1.1 The Role of the World Meteorological Organisation

Global meteorological activities are coordinated by the World Meteorological Organisation (WMO) which is based in Geneva, Switzerland. The WMO is a specialised, inter-governmental agency of the United Nations (UN) with 189 Member States and sets the global standards with respect to observational network design, measurements of different meteorological and hydrological parameters, codes, data processing and communication and coordination of these. The WMO also helps to build the capacity of NMSs through provision of training opportunities and meteorological equipment. Further fields of coordination by the WMO are Climate Research, such as international research campaigns in close cooperation with universities and other organisations. Under the global coordination of the WMO, Regional Economic Communities (RECs) are also active in the field of meteorology and are fostering international socio-economic cooperation among the states within their region. SADC represents 15 countries in Southern Africa which are all Members of the WMO.

For operational purposes, the WMO has divided the world into six regions. Regional Associations have been established to represent the specific regional requirements within the WMO. The organisation and protection of regional interests of the African NMSs within the WMO is done by the Regional Association (RAI). RAI is not a standing committee, but holds meetings with representatives from all NMSs of the African region to agree upon items relevant to the whole region. Each Regional Association, apart from technical meetings, holds general meetings every four years, attended by all heads of NMSs to chart out strategies for implementing programmes. SADC participation at WMO RAI activities and events is very important. It is expected that the WMO will play a significant role during the implementation of this plan.

2.2.1.2 Other organisations which work closely with NMSs include the United Nations Framework Convention on Climate Change (UNFCCC) which deals with policy matters related to climate change, and ICAO which deals with matters related to Meteorological Services for Air Navigation. Some NMSs are national focal points for the UNFCCC and are mostly designated authorities for provision of meteorological services for international air navigation to ICAO. IOC UNESCO works closely with NMSs, particularly on matters pertaining to the occurrence of earthquakes and tsunami events.

2.2.2 Regional Instruments of Cooperation (policies, strategies and plans)

Regional co-operation and integration in Southern Africa owes its origin to historical, economic, political, social and cultural factors that have created strong bonds of solidarity and unity among the people of Southern Africa.

In July 1979, at a Conference in Arusha, the Southern African Development Coordination Conference (SADCC) was launched, including the nine majority-ruled states of Southern Africa – Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe. These met at Summit level in April 1980 in Lusaka, Zambia to approve the establishment of SADCC and declared their commitment to pursue policies aimed at economic liberation on the basis of the sustainable integrated development of their economies (RISDP, 2010).

The Declaration "Towards the Southern African Development Community", adopted in Windhoek, Namibia, on 17 August 1992, by Heads of State or Government of Southern African States, calls upon all countries and people of Southern Africa to develop a vision of a shared future, a future within a regional community. This shared vision is centred on the common values and principles and the historical and cultural affinities that exist between the peoples of

Southern Africa. To this effect the SADC Mission statement, as spelt out in Article 5 of the Treaty is: **"To promote sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper co-operation and integration, good governance, and durable peace and security, so that the region emerges as a competitive and effective player in international relations and the world economy."**

2.2.2.1 Policies

Policies specific to the meteorological sector are well documented in the SADC Protocol. The Protocol reads that "**Member States shall develop a harmonised meteorology policy which facilitates regional co-operation, strengthens national capacity and ensures compliance with their international commitments":** (SADC Protocols, 2010). It spells out that Member States shall have to:

- Improve existing meteorological infrastructure and equipment and develop new infrastructure, where required to establish an integrated regional system;
- Collaborate in developing frameworks for the provision of meteorological services on a national basis to promote regional co-operation and complementarity;
- Within the framework of the general objectives of the WMO, expand the Regional Meteorological Support Network (RMSN);
- Take the necessary measures to strengthen and rehabilitate national and regional meteorological centres within the framework of the WMO Regional Association I, develop a co-operation framework and strengthen weather and climate monitoring systems, and improve public and specialised weather services and promote sustainable development with the emphasis on climate change and protection of the environment;
- Develop programmes to train operational meteorologists, research meteorologists and instrument maintenance technicians for both conventional meteorological and computer-based electronic equipment in conformity with the WMO Education and Training Long Term Plan; and
- Develop programmes to strengthen meteorological research capacity in the region.

Occurrence of frequent and high impact droughts and excessive rains in recent years have helped to improve the profile of Meteorology in the region. Thus serious implementation of the SADC Protocol on Meteorology has recently been embarked upon in the following areas:

- Satellite-based information-gathering infrastructure in all the countries; and
- Development of an appropriate policy and legal framework to address cost recovery strategies and improve regional telecommunications networks for timely information sharing.

Some of the challenges in current policies and strategies for the meteorological sector include:

- Institutional capacity building to drive the transformation process;
- Development of model policy and legal framework;
- Reduction of dependency on the central treasury through cost recovery strategies in the Meteorological services operations; and
- Specification of data bandwidth requirements for high fidelity transfer of Meteorological information.

2.2.2.2 Strategies

The broad strategies of the SADC as contained in the Treaty are to:

- Harmonise political and socio-economic policies and plans of Member States;
- Encourage the peoples of the Region and their institutions to take initiatives to develop economic, social and cultural ties across the region, and to participate fully in the implementation of the programmes and projects of SADC;
- Create appropriate institutions and mechanisms for the mobilisation of requisite resources for the implementation of programmes and operations of SADC and its institutions;
- Develop policies aimed at the progressive elimination of obstacles to the free movement of capital and labour, goods and services, and of the peoples of the region generally, between Member States;
- Promote the development, transfer and mastery of technology;
- Improve economic management and performance through regional cooperation;
- Promote the coordination and harmonisation of the international relations of Member States; and
- Secure international understanding, cooperation and support, and mobilise the inflow of public and private resources into the region.

The specific strategies for the meteorological sector would require Member States to:

- Co-operate in the planning and development of infrastructure, co-ordinating plans to acquire equipment, and promoting system interoperability;
- Liaise in developing appropriate legal frameworks for their meteorological services which promote operational autonomy and financial self-sufficiency, co-operate in devising adequate institutional and organisational structures, and collaborate in developing and improving their operational capabilities;
- Provide adequate funding for meteorological services, and strengthening national meteorological centres in each state;
- Designate a national meteorological centre or centres to serve as a regional meteorological centre to execute meteorological services of regional importance, linking the remaining national meteorological centres in the region to regional centres thus enhancing the operational capabilities of the RMSN, and minimising duplication of activity between national meteorological centres;
- Strengthen the observation network by filling gaps in the synoptic surface, upper air and climatological networks, and making greater use of new technology, especially satellites and other remote sensing applications;
- Increase liaison with users and increase their capability to tailor, package and deliver services; and
- Strengthen the capabilities of national meteorological centres in climate applications and advice.

2.2.2.3 Existing Sector Plans /Master Plans

2.2.2.3.1 The SADC Protocol

The SADC Protocol on Transport, Communications and Meteorology (to be referred as the SADC Protocol on Meteorology) elaborates the regional plans for the meteorological sector. Through this protocol, SADC Member States acknowledge that they are members of the WMO and, through their national meteorological service, they constitute an integral part of the regional and global system or network of the WMO programmes and structures, in particular the World

Weather Watch programme. Therefore Member States shall, within the regional and international co-operative system of the WMO, provide adequate legal frameworks and appropriate financial support to the national meteorological services to facilitate the establishment of an integrated network of observation, data processing and communications systems and enhance the provision of meteorological services for general and specialised applications in the region and internationally.

2.2.2.3.2 The SADC RISDP

The SADC Regional Indicative Strategic Development Plan (RISDP) aligns the strategic objectives and priorities with the policies and strategies to be pursued towards a diversity of those goals over a period of fifteen years. It is designed to provide strategic direction with respect to SADC programmes, projects and activities. It is indicative in nature and outlines the necessary conditions that should be realised towards the attainment of SADC's regional integration and development goals. In other words, it is not a prescriptive or a command-type plan. However the meteorological sector is covered very briefly within the RISDP.

A number of Member States have enacted, through their national parliaments, national legal frameworks on their National Meteorological Services thus enhancing the mandates of providing their services to various sectors.

2.2.2.3.3 The SAMPRO Project

The Government of Finland decided in 2009 to support, through its SADC Meteorology Project (SAMPRO), the development of meteorological (and Hydrological) services in the SADC region. The project will cooperate with the meteorology organisations of SADC as well as with the national meteorology services (NMS) of its 15 member countries. In this framework the Finnish Meteorological Institute, together with the Meteorological Association of Southern Africa (MASA), have been implementing a one-year project targeted at preparing a comprehensive Project Plan for future Finnish support in the meteorological sector, in collaboration with the SADC. Some initial capacity building activities were also carried out during the planning process. After an appraisal, the initial draft Project Document (PD) was revised and is currently under review. Finland’s development policy puts emphasis on climate and environment with a focus on climate change adaptation.

2.2.2.3.4 Draft RIDMP

SADC is currently formulating its Regional Infrastructure Development Master Plan and it is undergoing a review process. The Master Plan is being developed for key sectors including the meteorology sector. This will be the first time a Master Plan is developed for this sector.

2.2.2.4 Links with other RECs/Continental

Regional Economic Communities (RECs) are active entities in the field of meteorology and are fostering international socio-economic cooperation among the states within their region. Under the global coordination of the WMO the RECs contribute significantly to the development of the meteorological sector in their countries. SADC represents 15 countries in southern Africa and COMESA represents 19 countries in eastern and southern Africa. Eight countries are members of both SADC and COMESA, namely Democratic Republic of Congo, Madagascar, Malawi, Mauritius, Seychelles, Zambia, Zimbabwe and Swaziland.

The meteorological sector in SADC countries interacts closely with the Inter-Governmental Authority on Development (IGAD) meteorological sector through the interaction of the SADC

Climate Services Centre (CSC) with the IGAD Climate Prediction and Application Centre (ICPAC). Meteorologists from SADC countries also attend meteorological training programmes at ICPAC in Nairobi, Kenya and the WMO Regional Training Institute in Nairobi which is hosted by Kenya Meteorological Department. Furthermore some of the SADC meteorological services send their staff for higher training at the University of Nairobi. Similarly, staff from IGAD countries go for high-level training in the SADC countries especially to the universities in South Africa. This exchange of students promotes good working relationship and sharing of knowledge between the sub-regions.

There is also interaction between East African Community (EAC) and SADC. There are a number of activities in meteorology which the two RECs share in common. For example Tanzania is a member of both the East African Community and SADC. Meteorological experts from both SADC and the EAC benefit from the work of ICPAC which is an IGAD centre and also benefit from the WMO Regional Training School in Nairobi, hosted by the Kenya Meteorological Department.

The Conference of Ministers of the United Nations Economic Commission for Africa resolved on behalf of the Member States of the United Nations Economic Commission for Africa, that an African Centre of Meteorological Applications for Development (ACMAD) be established. Its purpose is improving the understanding of atmospheric and climatic processes over Africa, collecting, analysing and disseminating meteorological and hydrological information, providing a meteorological watch and early warning system over Africa, and promoting the training of African scientists and technicians in the application of meteorology for development. ACMAD is a continental institution situated in Niamey, Niger.

At continental level, ACMAD therefore complements SADC initiatives on promoting meteorological activities.
The African Ministers' Conference on Meteorology (AMCOMET) was established in 2010 as a result of a Ministerial Conference held in Nairobi, Kenya to enhance decision making on issues that are related to meteorological applications in socio-economic development in Africa. AMCOMET is a continental ministerial body that will meet at least every two years to review issues on meteorology development in Africa, including the SADC region.

The 12th Assembly of Heads of State and Government adopted Declaration Assembly/AU/Decl.1 (XII) requesting the African Union Commission (AUC) to formulate the Programme for Infrastructure Development in Africa (PIDA), which was officially launched in Kampala, Uganda, in July 2010. PIDA provides new analysis and insights which bring together, under one coherent programme, existing or previous continental infrastructure initiatives such as the NEPAD Short-Term Action Plan, the NEPAD Medium to Long-Term Strategic Framework and the AU Infrastructure Master Plans. It fills in gaps and, based on previous lessons, affords proper weight to the value of local ownership, the necessity of both hard and soft interventions, the need for diverse financing and the importance of sound implementation strategies. Underpinned by an extensive consultation and analytical process, PIDA provides an agenda of sensible, affordable priority projects aligned with Africa's long-term goals. Simply put, PIDA will be different from previous regional infrastructure integration initiatives because it will produce effective investments. PIDA assumes that the average economic growth rate for African countries will be 6% a year between 2010 and 2040, driven by a surging population, increasing levels of education and technology absorption. This growth implies that, over the 30 years to 2040, the GDP of African countries will multiply six fold, and the average per capita income will rise above US$10,000 for all countries. This continuing growth and prosperity will swell the demand for infrastructure, already one of the continents greatest impediments to sustainable development. Assuming that this growth is achieved, Africa's infrastructure needs are starkly apparent.

For the benefit of the region, the SADC meteorological sector needs to actively participate in relevant meteorological activities and events at regional, continental and global levels.

2.2.3 Member States

SADC Member States have used different modalities to establish institutions for provision of meteorological services, mostly through Acts of Parliament. All NMSs provide a good environment for implementation of meteorological programmes. At SADC level they are coordinated by MASA. Additionally national governments continue to provide support to Meteorological programmes through direct funding of the operations of the NMS through budgetary provisions. Furthermore governments support meteorological and related programmes through funding linked to relevant projects. It is recommended that Member States continue to support projects related to this plan to ensure the sector contributes effectively to national development and the safety of life and property of the public.

2.3 Projections and Trends for 2027 (Requirements)

The objective of this section is to: (a) Establish a meteorological sector outlook until the year 2027 for the development of sub-regional meteorological infrastructure that contributes to sub-regional integration; and (b) Identify the specific challenges that SADC Member States will have to address and resolve in the sector so that the expected meteorological infrastructure is attained. The SADC Meteorology Outlook 2027 is based on the conclusions emerging from reviews of: (a) The existing policy framework for the sub-regional meteorology integration; (b) Existing sub-regional infrastructure in place today; and (c) Forecast macroeconomic growth across the sub-region.

2.3.1 Global Trend of Natural Disasters

Disasters related to meteorological, hydrological, and climate extremes are increasing across the African region, exacerbated by unplanned and unregulated land use, lack of environmental controls, poor enforcement of building standards, fast and poorly regulated urbanisation, and other factors that increase the vulnerability of people, property, and infrastructure. Figure 7 shows the increase in the annual frequency of large-scale disaster events in Africa, including the SADC Region, since 1985 (WB/UNISDR, 2007). The SADC Meteorological Sector Outlook 2027 need to address SADC policies and strategies that are of short, medium and long term.

The short- and medium-term aspects should address issues that deal with impacts that are associated with weather and climate variability while the long-term aspects need to address impacts that are associated with adaptation and mitigation of climate change related impacts that will contribute to the sustainable socio-economic development of the region. These aspects need to be addressed if the sector is to effectively contribute to the sustainable socio-economic development of the sub-region. However in addressing these aspects at regional level it will also be necessary for Member States to ensure that mechanisms are put in place at national level, where appropriate, to address these issues.

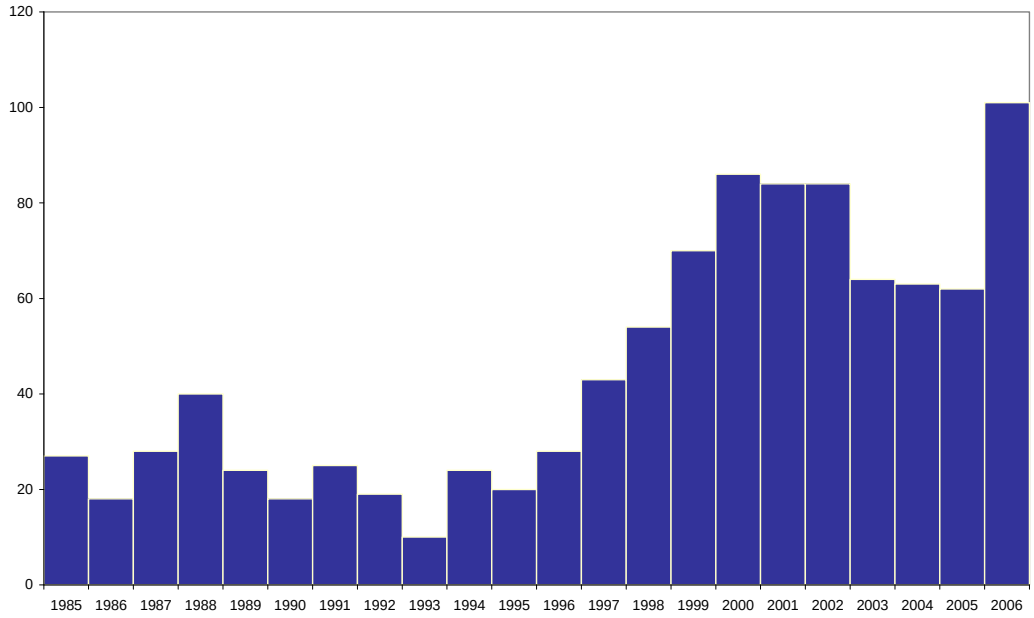

Figure 7: Increase in the Number of Reported Disasters in SSA (EM-DAT, 2010)

2.3.2 Sector Trends

The NMSs have the responsibility of protecting their nation's citizens from atmospheric, hydrologic, and climatologic phenomenon. To meet this responsibility requires an organisation that can perform well in its operations both at national and sub-region level (Jones, 2010).

African NMSs have the potential to provide information and services to decision makers and the general public that could improve agricultural production, food security, health, water resource management, and marine safety. However most of the African NMSs, including those in SADC, lack the necessary infrastructure, tools, and trained staff to efficiently provide the above information. In most of the countries, the NMSs do not have sufficient human resource capacity to perform these tasks. Their observation networks need to be expanded and upgraded. The telecommunication infrastructure available to the NMSs does not support adequate transfer of data inside or outside the countries. Many do not have dependable access to the internet to consistently reach out to users for feedback on their products. Either the countries have higher priorities for which they use their resources or they are satisfied with the level, though low, of services the NMSs provides and are unaware that improved forecasts and warnings could save lives and enhance socio-economic development.

The trend has been for improvement of meteorological and hydro-meteorological observations network, telecommunication infrastructure, use of internet, remote sensing equipment such as rainfall radar and meteorological satellite. In order to improve the quality of data, an effort is being made to reduce human interventions on data observation, quality control and archival stage by introducing automatic systems that will require minimal human intervention.

This effort is being made in order to improve available information that can be used in developing meteorological information and products provided to relevant users. For example Numerical Weather Prediction is the analysis of the atmosphere at 00 UTC using classical synoptic observations like surface observations and upper-air observations (radio-soundings), combined with newer observation technologies like aircraft observations, but typically remote-sensing data, i.e. non *in situ* observations like radar, lidar (based on laser), satellite, lightning detection and others. This analysis is used as input to either a global model (typical grid length approx. 50 km) or local fine-mesh models (typical grid length 5 km or less). The forecast is then

computed on either super-computers (global models) or on simple PC-workstations (local fine-mesh models), the latter operated with limited costs and operational resources. These models provide forecasts of up to 10 days (global models) or around 3 days (local fine-mesh models). It is a recommended procedure to improve the model output by applying post-processing procedures like Model-Output Statistics which adapt the Direct Model output to the local situation (e.g. orographic influence, sea-shore-effects or other small-scale effects).

Meteorological data, especially those observed in previous years, have both spatial and temporal gaps. New methods have been developed that ensure such gaps are filled with reasonable estimates. Climatology is the statistical description of a long time-series of weather parameters like temperature, pressure, wind, precipitation, duration of sunshine and others. These time-series are extended into the past by other sources of information such as tree ring analysis, ice core analysis in Greenland and Antarctica and sediment core analysis in the oceans. Climatology describes the typical annual variation of these parameter (duration and onset of dry and rainy season, annual amount of precipitation, high and low extremes of temperature, probability of extreme weather events (wind speed or precipitation amount exceeding given threshold values) and also long-term trends like global warming, which are in the public interest of all countries worldwide, especially Africa. Climatology is not only based on long-term observations, but also makes use of numerical models (global circulation models with atmosphere-ocean coupling) and thus allows the investigation of the sensitivity of the atmosphere to anthropogenic emissions like CO^2, aerosols or other pollutants

However some countries in the region do not have resources to introduce such technological advances and hence cannot keep up with these trends. A regional approach could be the best way forward. Good examples of such approach are the preparation for use of Meteosat second generation in Africa (PUMA), the African Monitoring of the Environment for sustainable Development (AMESD), Global Monitoring for Environment and Security (GMES), and the Severe Weather Forecasting Demonstration Project (SWFDP). Strengthening the CSC, which is a regional institution, would facilitate better climate information and products for the region.

Future demand will require the meteorological sector to supply more accurate weather and climate information, and outlooks and predictions that support decision making and planning in a sustainable manner. This will require well equipped NMSs and other weather and climate related institutions in the region. In this regard, in September 2009, the WMO and partners organised the World Climate Conference-3 which, through its high-level segment declaration, decided to establish a Global Framework for Climate Services (GFCS) to strengthen the production, availability, delivery and application of science-based climate prediction services. A High-Level Taskforce was established which worked in consultation with all relevant players to assess the current state of global climate service provision and identify opportunities for improvement in terms of future demand and supply of services. Their findings showed that:

- In countries that have effective climate services, these greatly contribute to reduced risks and maximised opportunities associated with climate variability and change. However, there is a significant gap between the supply of climate services and the needs of users. Present capabilities to provide climate services do not exploit all that we know about climate, fall far short of meeting present and future needs, and are not delivering their full and potential benefits. This is particularly the case in developing and least developed countries, which are also the most vulnerable to the impacts of climate variability and change;

- To be useful, climate information must be tailored to meet the needs of users. Existing climate services are not well focused on user needs and the level of interaction between providers and users of climate services is inadequate. Users need access to expert advice and support to help them select and properly apply climate information. Climate services often do not reach "the last mile", to the people who need them most, particularly the community level in developing and least developed countries;
- To support climate services, high quality observations are required across the entire climate system and of relevant socioeconomic variables. While existing capabilities for climate observation provide a reasonable basis for strengthening climate services, commitment to sustaining high quality observations is inadequate and enhancements to existing networks are required, particularly in developing countries. Further effort is also needed by governments and others to overcome the currently significant restrictions concerning sharing of, and access to, climate and other relevant data;
- Effective climate services depend on maximising the potential of existing knowledge, new research developments and strong support from, and strengthened collaboration between, all relevant research communities. Understanding of the climate system is advancing quickly, but is not being effectively translated into services that can inform decision making. In particular, further effort is required to improve our ability to predict climate and help users incorporate its inherent uncertainty into their decision-making; and
- Efforts to provide effective climate services globally will only be successful if capacity is systematically built to enable all countries to manage climate risk effectively. Current capacity building activities to support climate services need to be scaled up and better coordinated. A comprehensive capacity building initiative is needed to strengthen existing capabilities in the areas of governance, management, human resources development, leadership, partnership creation, science communication, service delivery and resource mobilisation.

The WMO, with partners that include United Nations sister organisations and institutions and other relevant research communities, is addressing ways for implementing the recommendations of the GFCS. These recommendations address short- and long-term sustainable solutions for effective delivery of climate services. The long-term solutions will address the 2027 time line of the Master Plan. SADC NMHSs, CSC and other relevant institutions will be expected to participate in the implementation of the GFCS (WMO, 2011). The proposed components of the Framework are as follows:

- The User Interface Platform will provide a means for users, user representatives, climate researchers and climate service providers to interact, thereby maximising the usefulness of climate services and helping develop new and improved applications of climate information;
- The Climate Services Information System is the system needed to protect and distribute climate data and information according to the needs of users and according to the procedures agreed by governments and other data providers;
- The Observations and Monitoring component will ensure that the climate observations necessary to meet the needs of climate services are generated;
- The Research, Modelling and Prediction component will assess and promote the needs of climate services within research agendas; and
- The Capacity Building component will support systematic development of the necessary institutions, infrastructure and human resources to provide effective and sustainable climate services.

2.3.2 Requirements for 2027

The projected requirements for 2027 therefore will dwell on the following aspects:

- Adequate observation network infrastructure for monitoring and analysis of weather and climate data and systems in support of operations; the need for generating weather and climate services in the context of the WWW and GFCS; and the regional need to be moving towards automation of systems;
- Modern telecommunications network infrastructure for rapid collection and exchange of weather and climate data, information and products nationally and internationally;
- Adequate modern technical capacity for real time data processing, forecasting systems dissemination systems to ensure NMSs and regional centres have the capacity to issue timely accurate weather and climate forecasts and related warnings to users;
- Adequate capacity for data management including modern data archival and retrieving systems and product generation tools and software to ensure availability of relevant user-tailored products;
- The Climate Services Information System needs to protect and distribute climate data and information according to the needs of users and according to the procedures agreed by governments and other data providers;
- There is a need for enhanced capacity in Research, Modelling and Prediction for assessing and promoting the needs of climate services at a time when impacts of climate variability and change are likely to be more prevalent; and
- Harmonisation of policy on best practices and standards, including equipment, for easy regional integration.

There is need to have well developed national and regional institutional capacity for provision of effective sustainable weather and climate services.

2.4 Assessment of Gap between Current Situation and 2027 Requirements

2.4.1 Gap Analysis

2.4.1.1 Policy and Regulatory Framework

The current SADC policy documents outline that: Essentially the meteorology sector provides weather and climate information and services to facilitate preparedness against hunger, social displacement/transport calamities, environmental degradation, etc.; the whole region possesses high-level expertise and fairly modern infrastructure for data collection, collation and processing; policy formulation and commercialisation are at an embryonic stage; and the promotion of cost recovery strategies in the delivery of meteorological services is in place.

2.4.1.1.1 Evaluation of Current Policies and Strategies

The increase in the occurrence of high impact droughts and excessive rains in recent years have helped to improve the profile of Meteorology in the region. Thus serious implementation of the SADC Protocol has been embarked upon in the following areas: Satellite-based information-gathering infrastructure in all the countries; and development of appropriate policy and legal framework to address cost recovery strategies and improve regional telecommunications networks for timely information sharing. One of the major constraints facing the meteorology sector at both national and regional level is the inadequacy of human resource capacity to undertake professional assignments at many national and regional institutions.

One of the main achievements has been the formation of MASA which has pursued an active role to ensure there is coordinated implementation of SADC Protocol and strategies at regional as well as national level. A strategic plan is already in place to spearhead this process.

2.4.1.1.2 Regulatory Framework

Traditionally there has not been a clearly defined regulatory mechanism for meteorological services save for the WMO which sets standards and recommended practices for its members to observe and adhere to. However in the wake of competition and quality assurance demands by some major users of meteorological services such as aviation, it is increasingly becoming important to develop regulatory frameworks at both national and regional level. This remains a challenge along with the development of policy and legal frameworks for NMSs. The current situation is that some countries e.g. Tanzania have made good progress in developing policy and reviewing their legal frameworks.

2.4.1.1.3 Challenges in the Current Policies and Strategies

The major challenges in fulfilling the mandate of the Meteorology Sector include:

2.4.1.1.3.1 Constraints in the current Policies

- Lack of institutional capacity building to drive the transformation process;
- Lack of model policy and legal framework for the sector;
- Overdependence on the central treasury, and lack of cost recovery strategies in the meteorological services operations;
- Lack of specification of data bandwidth requirements for high fidelity transfer of meteorological information;
- Lack of off regulatory framework for the sector; and
- Inadequate institutional capacity building and human resource development.

2.4.1.1.3.2 Constraints on implementation of Strategies

Based on various documents and reports e.g. GOPA Report (2010), SAMPRO document (2011) and MASA Strategic plan (2010) the main constraints facing the sector at national and regional level in implementing strategies developed by SADC are listed as:

- Inadequate observational network, including AWSs, Radar and remote sensing instruments;
- Need for upgrading of database management including data rescue;
- Lack of Calibration of Instruments at national and regional level;
- Inadequate training of Class I meteorologists and in Numerical Weather Prediction;
- Deficiencies in real time data processing and forecasting, post-processing and service production systems;
- Low capacity for generation of tailor made sector specific products;
- Lack of capacity for climate modelling including assessment to high resolution climate scenarios;
- Improvement of Aviation Weather Services including ISO certification;
- Lack of modern telecommunications including non-implementation of TDCF in line with WMO-WIS guidelines; and
- Lack of capacity building for air quality monitoring.

Other priorities which are of regional focus and dimension are identified as:

- Establishment of the WMO Regional Training Centre for English speaking countries;
- Enhancement of Southern African Flash-Flood Guidance (SAFFG) System;
- Establishment of the Severe Weather Forecasting Demonstration Project (SWFDP) SADC desk; and
- Capacity building for the Regional Advisory Centre for the provision of ICAO SIGMET.

2.4.1.2 Institutional Arrangements

The status of the functioning of current Institutional Arrangements has been described in detail under item 2.2. It is noted that the key institutions that have direct involvement in the meteorology sector through the NMSs in SADC constitute:

- The World Meteorological Organisation - mandated to coordinate global meteorological activities by collaborating with the NMSs. The WMO has continued to provide support to NMSs in the region particularly in the area of human resource capacity building by assisting personnel in various training programmes. The WMO has also assisted Member States NMSs to obtain equipment and spare parts;
- The SADC - through the Protocol of Transport, Communication and Meteorology, the Member States of SADC committed to cooperation and harmonised development in the field of meteorology;
- The Meteorological Association of Southern Africa (MASA) - which has been formed under SADC umbrella to spearhead development of the meteorology sector in the region; and
- SADC Climate Services Centre - which has been institutionalised to provide climate services in the regional context.

2.4.1.2.1 Evaluation of Current Institutional Arrangements

The WMO has continued to support the Meteorology sector by assisting NMSs in various ways including the purchase of equipment and training of personnel. The WMO has also been instrumental in supporting the formation of the former DMC Harare as well as its operations to date. The SADC is ensuring coordinated development of the Sector through various strategies under the Protocol of Transport, Communications and Meteorology.

The SADC CSC has endeavoured to meet its mandate through various activities including coordination of SARCOF, however its efforts have been hampered by lack of a sustainable funding mechanism to run the operations. There has also been a persistent problem with human resource capacity to run the operations at the centre, as a result of which a lot needs to be done to address these shortcomings so that the CSC can attain the expected level of service provision to the region.

The Regional Meteorological Training Centre in Angola needs to be improved to ensure it provides education and training at the required level, particularly to Portuguese speaking countries of SADC and Africa in general.

Based on the information documented in sections 2.3 and 2.4 above, the gaps that need to be addressed for the 2027 requirements are identified as:

a) Policy and Institutional Capacity Requirements

(i) Institutional Capacity building to drive the transformation process of NMSs into semi-autonomous entities;
(ii) Development of model policy and legal framework for the sector nationally and regionally;
(iii) Development of framework for cost recovery strategies in the meteorological services operations to enhance revenue base in support of smooth operations;
(iv) Specification of data bandwidth requirements for high fidelity transfer of meteorological information;
(v) Development of regulatory framework for the sector;
(vi) Enhancement of institutional capacity building and human resource development nationally and regionally; and
(vii) Enhancement of the capacity (Office space and staff manning levels) of regional centres namely CSC Gaborone, RIC Gaborone and the RMTCs in Angola and the Republic of South Africa.

b) Operational Strategic Requirements

(i) Adequate observation network infrastructure for monitoring and analysis of weather and climate data and systems in support of operations and the need for generating weather and climate services in the context of the WWW and GFCS;
(ii) Modern telecommunications network infrastructure for rapid collection and exchange of weather and climate data, information and products including TDCF in line with WMO-WIS/GTS guidance nationally and internationally;
(iii) Adequate capacity for data management including modern data archival and retrieval systems and products generation tools and software to ensure availability of relevant user-tailored products;
(iv) Need for a fully functional Instruments Calibration facility for use by NMSs of SADC Member States;
(v) Training of Class I meteorologists and in Numerical Weather Prediction;
(vi) Adequate modern technical capacity for real time data processing, forecasting systems dissemination systems to ensure NMSs and regional centres have the capacity to issue timely accurate weather and climate forecasts and related warnings to users;
(vii) Improved capacity for generation of tailor made sector specific products;
(viii) Improved capacity for climate modelling including assessment to high resolution climate scenarios;
(ix) Improvement of Aviation Weather Services including establishment of QMS frameworks and ISO certification;
(x) The Climate Services Information System needed to protect and distribute climate data and information according to the needs of users and according to the procedures agreed by governments and other data providers;
(xi) There is a need for enhanced capacity in Research, Modelling and Prediction for assessing and promoting the needs of climate services at a time when impacts of climate variability and change are likely to be more prevalent;
(xii) There is need for well developed national and regional institutional capacity for provision of effective sustainable weather and climate services; and
(xiii) Enhanced capacity for air quality monitoring.

Other priorities which are of regional focus and dimension are identified as:

(i) Enhancement of Southern African Flash-Flood Guidance (SAFFG) System; and

(ii) Establishment of the Severe Weather Forecasting capability at regional and national levels.

3. Strategic Framework

3.1 Strategy for Addressing Gaps and Expected Results by Year 2027

This chapter highlights various strategies to be implemented in order to ensure the Meteorology Sector contributes effectively in the development programmes of the SADC through implementation of the RISDP. It provides a detailed account of various strategies for addressing gaps and the associated expected results. It further describes the significance of the sector and lists prioritised goals, highlights strategies for addressing gaps in Policy and Regulatory Frameworks as well as Institutional Arrangements. A number of projects and associated interventions are also indicated along with modalities for financing and funding.

3.1.1 Significance of the Sector and Prioritised Goals

3.1.1.1 Significance of the Sector

It is recognised that weather, climate, water and related environmental conditions have a significant influence on the socio-economic development of countries in the SADC. The increase in the population and the extension of human settlements and activities into areas vulnerable to the impacts of weather-, and climate-related disasters make it necessary to improve the capacities of NMSs, to provide better services to reduce disaster risks, and to support national development and life-supporting activities. The increase in the frequency and intensity of natural hazards due to climate variability and change poses critical challenges for many countries.

The social and economic value of weather and climate information is derived from the influence of this information on decisions made by users in the sectors sensitive to weather and climate conditions, with the value tending to increase with the quality, accuracy, timeliness, location specificity and user-friendliness of the information.

Recent statistics from the Centre for Research on the Epidemiology of Disasters for the period 1980 to 2007 reveal that over 90 per cent of all disasters related to natural hazards, 71 percent of the casualties and 78 per cent of the economic losses were caused by weather-, climate- or water-related hazards such as tropical cyclones and storm surges, droughts, floods or disease epidemics and insect infestations. The past 50 years (1956 - 2005) have been associated with significant reductions in loss of life and an increase in economic losses. The warnings formulated from skilful seasonal forecasts can contribute significantly to a reduction in loss of life and property associated with climate-related natural disasters, and also to enhanced productivity in sectors dependent on climate, and to more efficient management of institutions dependent on weather and climate.

The NMHSs, as recognised in the World Meteorological Organisation Convention, are a fundamental part of national infrastructure and play an important role in supporting vital functions of governments. Inadequate infrastructure and limited human resources in some NMHSs, however, especially in developing and least developed countries, are among the factors that limit their capacity to take advantage of advances in science and technology to improve their services.

3.1.1.2 Prioritised Goals

Considering global societal needs and the aims of the RIDMP the Prioritised Goals of the Sector are identified as:

- Providing infrastructure support for regional integration within the context of the regional economic integration agenda;
- Infrastructure provision for poverty reduction through enhanced application of advances in climate sciences;
- Improved protection of life and property (related to the impacts of hazardous weather, climate, water and other environmental events, and increased safety of transport on land, at sea, and in the air); and
- Sustainable use of natural resources and improved environmental quality.

In order to contribute to the realisation of the above goals the SADC Meteorological sector will have to implement strategies focusing on the following priority goals:

- Strengthening of the Observation Network in the SADC region;
- Improvement of Meteorological Telecommunications and communication systems for rapid data exchange and dissemination of information;
- Improvement of technical capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services;
- Improvement of product generation and use through collaboration with various stakeholders; and
- Improvement of regional and national institutional capacities.

3.1.2 Policy and Regulatory Framework

3.1.2.1 Policies

Policies specific to the meteorological sector are well documented in the SADC Protocol. The Protocol reads that **"Member States shall develop a harmonised meteorology policy which facilitates regional co-operation, strengthens national capacity and ensures compliance with their international commitments"** (SADC Protocols, 2010)). It spells out that Member States shall have to:

- Improve existing meteorological infrastructure and equipment and develop new infrastructure, where required, to establish an integrated regional system;
- Collaborate in developing frameworks for the provision of meteorological services on a national basis to promote regional co-operation and complementarity;
- Within the framework of the general objectives of the WMO, expand the Regional Meteorological Support Network (RMSN);
- Take the necessary measures to strengthen and rehabilitate national and regional meteorological centres within the framework of the WMO Regional Association I; develop a co-operation framework and strengthen weather and climate monitoring systems; improve public and specialised weather services and promote sustainable development with the emphasis on climate change and protection of the environment;
- Develop programmes to train operational meteorologists, research meteorologists and instrument maintenance technicians for both conventional meteorological and computer-based electronic equipment in conformity with the WMO Education and Training Long Term Plan; and
- Develop programmes to strengthen meteorological research capacity in the region.

As previously mentioned, the occurrence of frequent and high impact droughts and excessive rains in recent years have helped to improve the profile of Meteorology in the region. Thus serious implementation of the SADC Protocol on Meteorology has recently been embarked upon in the following areas:

- Satellite-based information-gathering infrastructure in all the countries; and
- Development of appropriate policy and legal framework to address cost recovery strategies and improve regional telecommunications networks for timely information sharing.

Some of the challenges in current Policies and related Strategies for the meteorological sector include:

- Institutional capacity building to drive the transformation process of NMSs into semi-autonomous institutions; and
- Development of model policy and legal framework for the sector both at regional and national level.

3.1.2.2 Regulatory Framework Strategies

As previously mentioned, traditionally there has not been a clearly defined regulatory mechanism for meteorological services save for the WMO which sets standards and recommended practices for its members to observe and adhere to. However in the wake of competition and quality assurance demands by some major users of meteorological services such as aviation, it is increasingly becoming important to develop regulatory frameworks at both national and regional level. This remains a challenge along with the development of policy and legal frameworks for NMSs. The current situation is that some countries e.g. Tanzania have made good progress in developing policy and reviewing their legal frameworks. It is therefore recommended that SADC in collaboration with MASA and NMSs develop a harmonised policy for the Meteorology Sector both at national and regional level for easy regional integration.

3.1.2.3 Strategies to Address Challenges in the Current Policies and Regulatory Framework

The following strategies are proposed to address major challenges in the current Policies and Regulatory Framework to ensure the sector fulfils its mandate and to ensure regional integration:

- Strengthening Institutional Capacity building to drive the transformation process of NMSs into semi-autonomous entities;
- Development of model policy and legal framework for the sector at national and regional level;
- Enhanced funding of NMSs including reduction of dependency on the central treasury through cost recovery strategies in the meteorological services operations;
- Development of regulatory framework for the meteorology sector; and
- Enhancement of institutional capacity building and human resource development nationally and regionally.

3.1.3 Institutional Arrangements

A number of institutions play a role in the implementation of the sector programmes. These range from national to global institutions which need to work under motivated institutional arrangements to ensure they contribute effectively to the development agenda of SADC.

The status of the functioning of current Institutional Arrangements has been described in detail in chapter 2. In additional to Member State governments, a number of institutions have continued to play a key role in the development of the sector. The list of the institutions includes:

- The World Meteorological Organisation - mandated to coordinate global meteorological activities by collaborating with the NMSs. The WMO has continued to provide support to NMSs in the region particularly in the area of human resource capacity building by assisting personnel in various training programmes. WMO has also assisted Member States NMSs obtain equipment and spare parts;
- The SADC - through the Protocol of Transport, Communication and Meteorology, the Member States of SADC are committed to cooperation and harmonised development in the field of meteorology;
- The Meteorological Association of Southern Africa (MASA) - which has been formed under SADC umbrella to spearhead development of the meteorology sector in the region;
- SADC Climate Services Centre - which has been institutionalised to provide climate services in the regional context; and
- Other regional centres such as RICC, RMTCs etc. need to have in place well defined modalities of serving the meteorological sector in the region.

A number of strategies need to be instituted to ensure availability of effective and motivating institutional arrangements that facilitate the ability of all key players in the sector to fulfil their mandate as follows:

- Funding base of the regional institutions and NMSs strengthened through strengthened status of the organisations and improved financial management;
- Human resources of the regional institutions and NMSs strengthened to ensure improved services;
- Networking and cooperation between NMSs as well as with SADC's relevant organisations improved and processes for active sharing of data and experiences developed; and
- Management, planning, operational and maintenance practices improved in the NMSs to ensure efficient use of resources and quality services for key customers.

3. 1.4 Projects and interventions

Based on the results of gap analysis and proposed strategies to address sector development needs up to 2027, a number of projects and interventions are proposed as outlined in the following sub-sections. These projects should meet the guidance for prioritisation of meteorology sector projects as given in Annexure IV.

3.1.4.1 A Project and Interventions for Strengthening of the Meteorological Observation Network in the SADC Region

The weather and climate systems monitoring in the sub-region does not meet the requirements of weather and climate monitoring as recommended by the WMO through the World Weather Watch (WWW) and Global Climate Observation Systems (GCOS) of WMO, as outlined in the gap analysis. For the NMSs to effectively carry out their role as national weather and climate monitoring agencies, it is important to strengthen their weather and climate monitoring systems. It is recommended that projects be developed based on strategic goals and interventions as follows:

Strategic goal 1. Strengthening of the Meteorological Observation Networks in the SADC Region
The goal will be implemented through various Strategic Interventions as follows:

- Establish new/revive silent rainfall and climate stations at national level to increase the network available for monitoring climate;
- Expand surface observation network in SADC including over the Indian Ocean and inland lakes;
- Increase the number of the AMDAR aircraft reports;
- Establish/rehabilitate Automatic Weather Observation Stations (AWOSs) and Automatic Weather Stations (AWSs) in data sparse areas, within the manned stations, along the coast, over large lakes, and upgrade the existing ones;
- Deploy fixed and drifting buoys over the SW Indian Ocean and Eastern Atlantic Ocean to enhance safety of navigation and tsunami early warning. Revive silent stations and upgrade outdated upper air stations at various NMSs;
- Develop an MOU to facilitate smooth export and re-importation of instruments to be calibrated between NMSs and RICC;
- Train staff at RICC and NMSs in management, operation and maintenance and calibration of observation instruments;
- Allocate adequate staff to the RICC and avail necessary calibration instruments; and
- Acquire and network weather radars in the SADC Partner States for monitoring real-time weather for public safety and for the safety and efficiency of air transport, and marine navigation among other weather dependent activities.

Expected Results
The expected results following implementation of the above interventions are:

- Increased rainfall and climate database;
- Increased surface observational data from land and water bodies;
- Improved quality of forecasts and warnings and improved availability of upper air data;
- Improved aeronautical forecasts and increased availability of real-time data;
- Improved safety of navigation and tsunami early warning;
- Smooth access of RICC facilities by NMCs;
- Availability of well trained staff in NMSs and RICC in instrument maintenance and calibration;
- Improved data quality from well maintained and calibrated instruments and enhanced capability for calibration of instruments at RICC;
- Availability of radar data and information for now-casting and short range forecasting and warning services; and
- Improved monitoring and forecasting for severe weather events.

3.1.4.1.1 Criteria used to Recommend Stations to meet Requirements for Additional SYNOP, TEMP, CLIMAT, AWOS and LDN Station Networks

The requirements for additional stations is mainly dictated by the fact that to date Region 1 Africa lags very much behind others in terms of density of all types of stations, and worse still even the stations listed in WMO Volume A are either no longer operating or have many problems leading to non exchange of data eventually resulting in them being categorised as silent stations.

Careful consideration was taken of the historical problems that led to poor performance in maintaining station networks by many NMSs in SADC before proposing the establishment of new networks.

The guidance provided in WMO No. 544 Vol.1 and WMO No. 544 Vol. II on the criteria for establishing RBSN and RBCN stations and the recommended requirements for global, regional and national use was also taken into account. According to WMO No. 544 Vol. II Article 1.1.2.3 for Region I Africa, the horizontal distribution of surface stations shall be as follows:

- As an ideal target over land areas, the RBSN should have a horizontal resolution of 150 km for surface and 250 km for upper-air stations;
- As an optimal target over land areas, the RBSN should have a horizontal resolution of 250 km for surface and 500 km for upper-air stations; and
- OK stations are acceptable if at a distance of at least 60 km from the nearest network station.

It is also noted that all other WMO regions have a finer density of networks, particularly for the SYNOP, which targets an optimal horizontal resolution of 150 km and matches the ideal category for region I Africa.

Other considerations include the high cost of running the manned stations in terms of human resource constraints as well as the cost of purchase and maintenance of equipment. There are also high costs associated with constructing office accommodation for the new observatories.

In view of the aforesaid the following proposals are made in terms of:

a) SYNOP stations:

(i) The plan provides for purchase of instruments needed for establishing new stations so that they complement the existing RBSN networks to upgrade them to 150km horizontal resolution;

(ii) In view of the long term time scale of the plan it is also proposed that the Master Plan provides for instruments for full rehabilitation/replacement of 50% of existing RBSN stations in all Member States; and

(iii) Member States are at liberty to increase stations, preferably in conformity with requirements of OK stations, i.e. the stations should be at least 60 km from the nearest stations.

b) Upper Air (TEMP) stations:

(iv) In view of the high cost of purchase, operation and maintenance of Upper Air (TEMP) stations it is proposed that the plan provides for enhancement of a number of stations to meet the requirements of an optimal target of a network of stations at 500 km;

(v) In view of the old age of many upper air stations in SADC it is proposed that the plan provides for the cost required to fully rehabilitate 50% of existing TEMP stations;

(vi) Member States are at liberty to enhance their networks up to the ideal target of horizontal resolution of 250km.

c) AWOS, AWSs and Climat stations:

In proposing the new AWOS stations to be implemented in each country the plan takes into account the necessity to have AWOS at international airports for aviation safety. The AWSs and Climat stations have been recommended taking to account the declining availability of CLIMAT data in most countries to an alarming level of below 30%. In view of this it is proposed that most of the AWS be installed at locations where there are Climat stations so as to extend the continuity of observations.

d) AMDAR:

For AMDAR observations it not easy at present to provide specific numbers since this will be determined by the growth of the aviation industry in Member States. Only an indicative budget has been suggested, mainly for sensitisation and recruitment of airlines as well equipping them where applicable.

e) Lightning Detection Network (LDN):

In the case of LDN the adoption of the earlier proposal in the GOPA report is proposed, which was mainly guided by horizontal separation of stations. It is recommended that Lesotho and Swaziland each have one station.

f) Buoys

In order to ensure safety of marine navigation and efficient operations it is proposed to deploy drifting buoys and fixed buoys in the south western Indian Ocean and eastern Atlantic Ocean. This will also enhance the regional and national tsunami warning systems.

A detailed description of the recommended Implementation Plan for strengthening the SADC Observation Network of stations is given in Annexure II.

3.1.4.2 A Project and Interventions for Improvement of Meteorological Telecommunications and Communication Systems for Rapid Data Collection, Exchange and Dissemination of Data and Information

The status of operation of the Global Telecommunication System (GTS) and the National Meteorological Telecommunication Networks (NMTN) in the SADC Member States, determines the efficiency of data exchange nationally, sub-regionally and internationally. The results of the WMO Annual Global Monitoring (AGM) and the Data Monitoring conducted sub-regionally in SADC on the operation of the WWW indicate shortcomings in the availability of SYNOP, TEMP and CLIMAT data from the RBSN stations in the Member States of the SADC.

The status of operation of the Global Telecommunication System (GTS) and the National Meteorological Telecommunication Networks (NMTN), in the Member States, determines the efficiency of data exchange nationally, sub-regionally and internationally. There are many deficiencies in this system.

There is a need to develop telecommunication facilities by setting out projects for rehabilitation, introducing new technologies and capacity building, with strategies focusing on improvement of telecommunications which include the following:

Strategic goal 2. Improvement of meteorological telecommunications and communication systems for rapid data collection, exchange and dissemination of data and information.

The goal will be implemented through various Strategic Interventions as follows:

- Acquire new and Replace the aging Automatic Message Switching Systems at NMCs;
- SADC and Member States to develop a policy to support the establishment of V-sat Networking for exchange of meteorological data and products in the region;
- Partner States to support NMSs to rehabilitate/modernise National Meteorological Telecommunications Networks for data collection and transmission facilities at NMCs along WMO WIS/GTS guidelines;
- Upgrade/modernise NMS's media systems for information dissemination;
- SADC to support NMSs to implement broadband high-speed Internet access at all 15 NMCs and at the CSC in support of NWP and Climate Modelling and Prediction Services.

Expected Results
The expected results following implementation of the above interventions are:

- Improved efficiency of data exchange between NMSs and other centres on GTS and AFTN;
- Improved access and use of large volumes of data and products through Internet by NMSs and regional centres;
- Improved availability of well packaged policy-relevant and sector-specific products;
- Enhanced accessibility of data and products; and
- Improved quality of PWS products and timeliness of disseminated of data to end users.

3.1.4.3 A Project and Interventions for Improvement of Level of Technical Capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services)

These strategies are needed to ensure that regional institutions and NMSs have adequate capacity in Weather and Climate Applications as well as Public Weather Services. This will foster mechanisms that promote public awareness of the ability of NMSs' to contribute effectively to disaster management, and economic and sustainable development of the Partner States and SADC in general.

Strategic goal 3. Improvement of technical capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services

The goal will be implemented through various Strategic Interventions as follows:

- NMSs and CSC to develop new innovative products, starting as a pilot project at CSC and some NMS, and replicating to others later on;
- SADC and Member States to support training on new product development and packaging techniques involving CSC in collaboration with NMSs and development Partners;
- SADC, MASA and Member States to support acquisition of relevant hardware and software for data analysis and generation of tailored products at CSC and at NMSs;
- Member States to support NMSs to improve Aviation Weather Services including introduction of QMS framework for aeronautical meteorological services and ISO certification;
- Upgrading and modernisation of real time data processing and forecasting, post-processing and service production systems at NMSs and CSC;
- Strengthening of the capacity of NMSs and CSC in Numerical Weather Prediction (NWP) and climate modelling, including assessment to high resolution climate scenarios; and
- Upgrading of Database Management Systems including Data Rescue in NMSs.

Expected Results
The expected results following implementation of the above interventions are:

- Improved availability of well packaged policy-relevant and sector-specific products;
- Enhanced quantity and quality of data at CSC and NMSs;
- Improved quality of aeronautical meteorological services and achievement of ISO certification;
- Improved accuracy and quality of NWP, and climate modelling products; and
- Improved quality and timeliness of forecasts and products issued by NMSs and CSC.

3.1.4.4 A Project and Interventions for Improving the Understanding of Economic Benefits and Effective use of Climate Information and Products through Collaboration with Stakeholders

In order for the policy makers and other users to gain fully from the potential economic benefits of weather and climate services and information provided by regional centres and NMSs, it is important for them to have adequate understanding of the benefits and limitations the producers have. It is therefore recommended to develop projects with strategies addressing this subject as follows:

Strategic goal 4. Improving the understanding of economic benefits and effective use of climate information and products through collaboration with stakeholders

The goal will be implemented through various Strategic Interventions as follows:

- Conduct capacity building workshops involving CSC, NMSs, RMTCs, stakeholders and users of climate information on best practices for effective use of climate information and products; and
- Implement pilot applications projects at CSC and NMS level to demonstrate economic benefits of meteorological services.

Expected Results
The expected results following implementation of the above interventions are:

- Increased awareness of the economic benefits of meteorological services by stakeholders;
- Improved capacity for generation of relevant user friendly tailor made products; and
- Availability of more tailor made products.

3.1.4.5 A Project and Interventions for Strengthening Institutional Capacity of the NMSs to Provide Relevant, Reliable and Timely Climate and Weather Services

In order for the Meteorological Sector to contribute effectively to the development agenda of the SADC it is essential to ensure that the gaps indentified under institutional capacity are addressed. The following strategic interventions are recommended:

Strategic goal 5. Strengthening institutional capacity of the NMSs to provide relevant, reliable and timely climate and weather services

The goal will be implemented through various Strategic Interventions as follows:

- Develop harmonised policy for the Meteorology Sector at regional and national level;
- Develop institutional framework for the transformation of the NMSs to autonomous/semi-autonomous institutions;
- Improve management, planning, operational and maintenance practices in the NMSs to ensure efficient use of resources and quality services to customers;
- Improve human resource capacity (training of Class1 meteorologists especially in NWP) in Member States NMSs to ensure improved services; and
- Improve funding base of the NMSs through strengthened status of the organisations and financial management.

Expected Results
The expected results following implementation of the above interventions are:

- Availability of policy framework for meteorology sector;
- Enhanced efficiency and accountability of NMSs; and
- Improved quality of services delivery by NMSs.

3.1.4.6 A Project and Interventions for Strengthening the Capacity of the Regional Climate and Meteorological Units of SADC (CSC, MASA, and RMTCs, RICC) to function as Efficient Regional Coordination, Development, and Services and Dissemination Centres

It has been noted that a number of gaps exist in the implementation of regional programmes by regional centres in SADC due to various challenges ranging from under-funding to inadequate personnel. A number of strategic interventions are proposed to address the challenges as follows:

Strategic goal 6. Strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RMTCs, RICC) to function as efficient regional coordination, development, services and dissemination centres

The goal will be implemented through various Strategic Interventions as follows:
- Upgrade human resources and infrastructure (office accommodation) of the CSC and RICC to ensure availability of requisite services;
- Support implementation of relevant regional events and networking of providers and users of weather and climate information;
- Develop modalities for improving funding base for the (CSC, and RICC) to ensure efficient functioning of the institutions; and
- SADC, in collaboration with MASA, to develop coordination and management mechanisms to ensure efficient regional coordination and cooperation between meteorological institutions and stakeholders.

Expected Results
The expected results following implementation of the above interventions are:

- Improved efficiency, functioning, and quality of service delivery of institutions;
- Increased awareness and use of services by stakeholders; and
- Improved coordination and cooperation between meteorological institutions and stakeholders.

A summary of the various projects, key strategic interventions and the related expected results is shown in Table 3.

Table 3: Projects/Strategic goals, key strategic interventions, expected results for the SADC Meteorology Sector Master Plan

Projects/Strategic goals	Strategic Interventions	Expected Results
1. Strengthening of the Observation Network in the SADC region	1.1. Revive/establish rainfall and climate stations at national level to increase the network available for monitoring climate and have more data for applications;	1.1.1 Increased rainfall and climate data base

	1.2.	Expand surface observation network in SADC including over the Indian Ocean and inland lakes	1.2.1 1.2.2 1.2.3	Increased surface observational data from land and water bodies Increase surface data for national, regional, and global level Improved forests and warnings
	1.3.	Increase the number of the AMDAR aircraft reports	1.3.1 1.3.2	Improved availability of upper air data Improved aeronautical forecasts
	1.4.	Establish/Rehabilitate Automatic Weather Observation Stations (AWOSs) and Automatic Weather Stations (AWSs) in data sparse areas, within the manned stations, along the coast, over large lakes, and upgrade the existing ones	1.4.1 1.4.2	Increased availability of real-time data Improved quality of forecasts and warnings
	1.5	Deploy fixed and drifting buoys over the SWIO and eastern Atlantic	1.5.1	Improved navigation safety and tsunami early warning system
	1.6.	Revive silent stations and upgrade outdated upper air stations at various NMSs	1.6.1	Improved availability of upper air data
	1.7.	Acquire and network weather radars in the SADC Partner States for monitoring real-time weather for and public safety and for the safety and efficiency of air transport, marine navigation among other weather dependent activities	1.7.1 1.7.2	Availability of radar data and information for now-casting and short range forecasting and warning services Improved monitoring and forecasting for severe weather events
	1.8.	Train staff at RICC and NMSs in management, operation and maintenance and calibration of observation instruments	1.8.1 1.8.2	Availability of well trained staff in NMSs and RIC in instrument maintenance and calibration Improved quality of data from well maintained and calibrated instruments
	1.9.	Allocate adequate staff to the RICC and avail necessary calibration instruments	1.9.1	Enhanced capability for calibration of instruments at RICC
	1.10.	Develop a MoU to facilitate smooth export and re-importation of instruments to be calibrated between NMSs and RICC	1.10	Smooth access of RICC facilities by NMCs
2. Improvement of Meteorological Telecommunications and communication systems for rapid data collection, exchange and dissemination of data and information	2.1	Acquire new and replace the aging Automatic Message Switching Systems at NMCs	2.1.1	Improved efficiency of data exchange between NMSs and other centres on GTS and AFTN
	2.2	SADC and Member States develop a policy to support the establishment of V-sat Networking for exchange of meteorological data and products in the region	2.2.2	Improved access and use of large volumes of data and products through internet by NMSs and regional centres
	2.3	Partner States support NMSs to rehabilitate/modernise National Meteorological Telecommunications Networks for data collection and transmission facilities at NMCs along WMO WIS/GTS guidelines	2.3.1	Increased quantity and timeliness of data collection and exchange by NMSs

	2.4	SADC Support NMSs to implement broadband high-speed Internet access at all the 15 NMCs and at the CSC in support of NWP and Climate Modelling and prediction Services	2.4.1	Enhanced accessibility of data and products
	2.5	Upgrade/modernise NMS's media systems for information dissemination	2.5.1	Improved quality of PWS products and timeliness of disseminated data to end users
3. Improvement of level of technical capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services)	3.1	NMSs and CSC to develop new innovative products, starting as a pilot project at CSC and some NMS, replicating to others later on	3.1.1	Improved availability of well packaged policy relevant and sector specific products
	3.2	SADC and Member States to support training on new product development and packaging techniques involving CSC in collaboration with NMSs and development Partners		
	3.3	SADC , MASA and Member States to support acquisition of relevant hardware and software for data analysis and generation of tailored products at CSC and at NMSs		
	3.4	SADC and Member States to support upgrading of Data Base management systems including Data Rescue in NMSs	3.4.1	Enhanced quantity and quality of data at CSC and NMSs
	3.5	SADC and Member States to support upgrading and modernisation of real time data processing and forecasting, post-processing and service production systems at NMSs and CSC	3.5.1	Improved quality and timeliness of forecasts and products issued by NMSs and CSC
	3.6	SADC, in collaboration with MASA, to strengthen the capacity of NMSs and CSC for Numerical Weather Prediction (NWP) and climate modelling, including assessment to high resolution climate scenarios	3.6.1	Improved accuracy and quality of NWP, Climate modelling products
	3.7	Member States to support NMSs to improve Aviation Weather Services including introduction of QMS framework for aeronautical meteorological services and ISO certification	3.7.1	Improved quality of aeronautical meteorological services and achievement of ISO certification
4. Improvement of products generation and use through collaboration with various stakeholders	4.1	Implement pilot applications project at CSC and NMS level to demonstrate economic benefits of meteorological services	4.1.1	Increased awareness of the economic benefits of meteorological services by stakeholders
	4.2	Conduct capacity building workshops involving CSC, NMSs, RMTCs, stakeholders and users of climate information on best practices for generation and the effective use of climate products and information	4.2.1 4.2.2	Improved capacity for generation of relevant user friendly tailor made products Availability of more tailor made products
5. Improved capacity in the NMSs to provide relevant, reliable and timely climate	5.1	Develop policy for the Meteorology Sector at regional and national level	5.1.1	Availability of policy framework for meteorology sector

and weather services	5.2	Improve funding base of the NMSs through strengthened status of the organisations and financial management	5.2.1	Enhanced efficiency and accountability of NMSs
	5.3	Improve human resources capacity (training of Class1 meteorologists and in NWP) in Member State NMSs to ensure improved services	5.3.1	Improved quality of services delivery by NMSs
	5.4	Improve management, planning, operational and maintenance practices in the NMSs to ensure efficient use of resources and quality services to customers		
6. Strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RMTCs, RICC) to function as efficient regional coordination, development and dissemination centres	6.1	SADC in collaboration with MASA to develop coordination and management mechanisms to ensure efficient regional coordination and cooperation between meteorological institutions and stakeholders	6.1.1	Improved coordination and cooperation between meteorological institutions and stakeholders
	6.2	SADC Support Implementation of relevant regional events and networking	6.2.1	Increased awareness and use of services by stakeholders
	6.3	Improve funding base for the (SCS, MASA, and RICC) to ensure efficient functioning of the institutions	6.3.1	Improved efficiency of functioning and quality of service delivery of institutions
	6.4	Upgrade human resources and infrastructure (office accommodation) of the SCS and RICC to ensure availability of requisite services		
	6.5	Upgrade meteorological and technical (hardware and software) infrastructure at SCS and RICC		
	6.6	Transform SADC CSC into a semi-autonomous institution under SADC		

3.2 Inter-relationship with Other Infrastructure Sectors

SADC NMSs have the responsibility to provide meteorological and climate information and services to decision makers and the general public that could improve, among others, agricultural production, food security, health, water resource management, transport and communication, marine safety and other disaster and risk management related issues that are of a national and regional nature. Meteorological information is important to other sectors as it provides early warning information that helps these sectors plan their activities according to the expected short or long-term weather and climate information. Weather information is useful in planning agriculture production and food security and also in managing hydro-power generation through provision of useful planning information such as the expected seasonal rainfall and evaporation rates over hydro-power generation dams. Long-term climate information is useful in planning major activities such as road and water dam construction. In order for the sector to respond well to the needs of all these sectors in the region, it needs to have an efficient infrastructure that supports provision of meteorological observation , information and products in an accurate and timely manner. Such improved interaction with other sectors results in improved service provision of the other sectors and therefore activities such as improving observation network, computing facilities and human resources in the region are very important.

The SADC Meteorology Sector Master Plan must be developed with the view that it has linkages to Master Plans of other Infrastructure Sectors, especially those that address regional

integration. This calls for Member States to develop harmonised meteorology policies which strengthen national capacity, facilitate regional co-operation and ensure compliance with their international commitments in addressing all relevant issues including those that are related to other sectors. The strategic framework has to be developed in such a way that it enhances the capacity of Member States in the provision of meteorological services for general and specialised applications in the region and internationally. Fortunately this plan was developed concurrently with other SADC infrastructure sectors including Transport, Water, Energy, Tourism, and ICT all of which have close linkages with the meteorology sector in terms of data and service requirements.

During the implementation of the Plan it is expected that Member States shall improve existing meteorological infrastructure and equipment and develop new infrastructure, where required, to establish a modern and technologically equipped integrated regional system. For that purpose Member States shall co-operate: in the planning and development of infrastructure; co-coordinating plans to acquire equipment; and promoting systems interoperability. Therefore in order to address the interests of the infrastructure of other sectors, it will be necessary to involve them in this process so as to ensure that their interests and requirements from the meteorology sector Master Plan are taken on board.

3.3 Risks and Assumptions

For successful implementation of the plan several assumptions are made while at the same time several risks are identified in the case of failure to do so. It is also assumed that the funding to implement the Master Plan will come from Member States, the public sector and development partners.

The SADC countries include many countries that have different national policies, strategies and economic development pathways. Therefore the main risks in achieving Vision 2027 and beyond are:

- Inadequate funding, which will affect the overall operational efficiency and service delivery of the NMSs and regional institutions and sustainability of implemented activities;
- Lack of seriousness by some Member States in implementing the set goals;
- Setting wrong development priorities by Member States;
- Overdependence on donor funding which encourages donors to be prescriptive over programmes of the projects; and
- Inadequacy of service delivery capacity, which will increase the region's vulnerability to the negative impacts of climate variability and climate change.

The assumptions are:

- SADC will fast track setting up policies and strategies for the sector;
- Development Partners will be supportive to both regional and national institutions in terms of funding;
- Developing of regional centres will help to build up services for smaller countries that have less technical capacities;
- NMSs will continue to work and fulfil their respective national requirements, and collaborate with other regional NMSs on matters of regional perspective;
- Enhanced financial support from governments and Development Partners to respective NMSs;

- WMO will continue playing a coordination and supportive role to SADC regional centres and NMSs; and
- SADC will continue playing a supportive and guiding role.

3.4 Preparing for Future Sector Trends (beyond 2027)

Future supply and demand from the meteorological sector will include more accurate and timely weather and climate information, outlooks and predictions that support decision making and planning in a sustainable manner. This will require well equipped and efficient NMSs and other weather and climate related institutions in the region.

As mentioned previously, the Global Framework for Climate Services (GFCS) has already made findings regarding the importance of effective climate services; the need to tailor services for the needs of users; high quality observations across the entire climate system; new research and collaboration between research communities; and the systematic building of capacity. Recommendations have been included in the Sector Master Plan and it is important that this plan be supported for implementation since it takes into account the objectives of the GFCS within the period of Vision 2027 and beyond and builds the foundation for the future.

4. Implementation Strategy

4.1 Implementation Plan

4.1.1 Priority List of Projects and the corresponding resource requirements

A comprehensive implementation strategy will have to be implemented to realise the goals and strategies outlined in this Master Plan. A prioritised list of projects and the corresponding resource requirements amounting to US$ 120,194,000 is given below:

4.1.1.1 Project focusing on strengthening of the Meteorological Observation Networks in the SADC region (US$ 85,629,000)

4.1.1.2 Project focusing on Improvement of Meteorological Telecommunications and communication systems for rapid data collection, exchange and dissemination of data and information (US$4,230,000)

4.1.1.3 Project focusing on Improvement of level of technical capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services (US$8,440,000)

4.1.1.4 Project focusing on improving the understanding of economic benefits and effective use of climate information and products through collaboration with stakeholders (US$2,155)

4.1.1.5 Project for strengthening institutional capacity of the NMSs to provide relevant, reliable and timely climate and weather services (US$10,770,000)

4.1.1.6 Project for strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RMTCs, RICC) to function as efficient regional coordination, development, services and dissemination centres (US$8,970,000)

A detailed Implementation Strategy of Priority Projects showing interventions and associated resource requirements is given in Annexure I to this report. An implementation plan for strengthening of the observational network is detailed in Annexure II. Profiles of ongoing and proposed projects are included in the report as Annexure III. A summary of the Implementation Action Plan for the period 2012 to 2027 is given it Table 4.

Table 4: Summary of Implementation Action Plan 2012-2027

Item	Goal /Project	2012-2017 US$	2018-2022 US$	2023-2027 US$	2012-2027 US$
1	Strengthening of Observation Network	49,242,000	23,208,000	13,179,000	85,629,000
2	Improvement of Meteorological Telecommunications and communications system	2,710,000	980,000	540,000	4230,000
3	Improvement of technical capacities (Data Processing, Management and Forecasting systems)	5,760,000	2,000,000	680,000	8,440,000
4	Improving the understanding of economic benefits and effective use of climate information and products	1,380,000	637,500	137,500	2,155,000
5	Strengthening institutional capacity of the NMSs	7,800,000	1,850,000	1,120,000	10,770,000

6	Strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RMTCs, RICC)	7,870,000	600,000	500,000	8,970,000
Medium/Long Term Total		**74,762,000**	**29,275,500**	**16,156,500**	**120,194,000**
Percentage of Whole		**62.2**	**24.4**	**13.4**	**100**

4.1.2 Implementation Modalities

4.1.2.1 Initial Agreement and Maintaining Commitment of Members

During the implementation stage it will be necessary to reach an agreement on the proposed projects. An initial agreement can be reached through constitutional forums of SADC. The stakeholders' workshop will provide an opportunity for Member States to provide their input and views on the proposed projects. Further to this MASA will have the opportunity to consider the plan and provide views and comments, after which an agreement is expected to be reached. Once agreement has been reached it will be easy for the MASA Members to advise respective governments (Ministers responsible for Meteorology) on the plan and consequently an agreement will be reached at SADC level.

4.1.2.2 Financing Mechanisms in the Sector

The implementation of projects that are proposed for the Master Plan to be realised will require sufficient resources to support them. These resources will require that SADC Secretariat, Member States and other development partners work closely in raising funds. In this regard it is expected that:

(i) Member States will have to allocate funds either from their national budgets or funds obtained from bilateral arrangements with other countries and development partners to support some of the planned national activities.
(ii) The SADC Secretariat, working with some development partners, will have to raise funds to support some of the proposed regional activities.
(iii) In order to raise awareness of the activities and financial requirements of the Master Plan to development partners and other potential investors it will be necessary for the SADC Secretariat to organise, soon after the approval of the Master Plan, an Investor's Forum.

Based on this, the possible financing and funding sources will include potential financing and funding bodies such as the Member States themselves; international funding agencies including the World Bank, African Development Bank, European Union and others; and bilateral arrangements between SADC Member States and other developed countries. Table 5 below indicates some of the potential financing and funding bodies that could be available to support the Meteorology Sector Master Plan.

Table 5: Potential financing and funding stakeholders for regional and national Meteorological Infrastructure

Stakeholders	**Relationship and/or contribution to SADC Meteorology Sector**
Regional Africa I wide level	
United Nations Economic Commission of Africa (UNECA)	Mobilisation of resources from various donors for social and economic development. This will be more crucial in ClimDev Programme
At SADC Regional level	
Regional Economic	Regional coordination of economic development of Member States by way of

Communities (SADC, COMESA)	protocols (including meteorology sector). This includes allocation of financial resources.
WMO Regional Training Centres (RTC)	Skills gap analyses and attendant capacity building and development of NMSs.
At National level	
National Governments (Member States)	Political and financial support & inter-ministerial collaboration. This has an impact on the visibility of, and level of relevance of NMSs at national level. NMSs provide services for the public good, consisting of information essential to address issues affecting all citizens, particularly those that are vulnerable to climate and weather vagaries, and climate change. Governments are expected to invest in upgrading and modernising basic meteorological infrastructure.
National Ministries (Environment, Finance, Health, Agriculture, Energy, Transport including air and marine transport)	These represent meteorologically-related national interests and responsibilities to cushion all citizens from disease, poverty alleviation, natural disasters, pollution, etc. Some of these Ministries are parent ministries of NMSs. They also translate climate information into policy matters. Modalities could be established for the Ministries to fund NMSs through relevant projects.
NMSs	National weather, climate and hydrological experts and designated authorities.
National Universities and Technical Colleges	These are sources of skilled human resources which provide the academic environment for meteorological training and research.
NGOs	These organisations work with local communities in addressing specific and varied interests. Their work is essential to NMSs to help communities to mitigate against and/or adapt to climate change and extreme variability. Some of these entities can use own funds and collaborate with the NMS to achieve certain objectives at grassroots level.
Private Sector	The Private Sector is a driver of economic development and potential sources of financial support. However traditionally this sector has not made a significant contribution to the Meteorology Sector mainly due to lack of proper engagement and awareness of the social and economic benefits of meteorological services to various sectors.
Stakeholders operating at global level	
WMO	The WMO continues to provide significant financial support to the meteorology Sector at both regional and national level. It is expected that the WMO will continue to avail this support to the SADC region.
United Nations (UNDP, WFP, UNEP, FAO, WHO, WB, UNFCCC, GEF, etc.)	These are development partners at national, regional and international levels with specific mandates (social, health, food security, disaster management, etc.). These are potential funding organisations for the sector especially in projects related to dealing with impacts of climate change to the thematic areas of their specialisation.
ICAO, IATA	They require meteorological forecasts and *in situ* observations for operational purposes and flight planning. They represent an important source of revenue for NMSs. Frameworks need to be established to ensure that all NMSs earn an equitable share of the revenue derived from the provision of services to international air navigation.
EUMETSAT	Provides satellite-based meteorological information to NMSs. EUMETSAT has, for many years, continued to provide significant support to NMSs in SADC through various projects such as (PUMA and AMESD).

4.1.2.3 Milestones and Key Steps

The Master Plan it will have to go through the SADC approval process, as indicated in the work plan for its preparation, before commencement. Thereafter the soliciting of funds to support the various activities, both at national and regional level, will begin and implementation will follow. Table 6 below shows the main milestones and key steps that will be followed:

Table 6: Milestones and key steps for implementation of the Sector Master Plan

MILESTONES	KEY STEPS BEFORE IMPLEMENTATION	KEY STEPS AT NATIONAL LEVEL DURING IMPLEMENTATION	KEY STEPS AT REGIONAL LEVEL DURING IMPLEMENTATION
Convening of Meeting of the Cluster of Ministers responsible for Infrastructure Development to consider the Master Plan and Plan of Action	28/ 06/2012		
Consideration of Master Plan by SADC Council of Ministers and Launch of the SADC Infrastructure Master Plan and Plan of Action by Summit	15/08/2012		
Convening of the SADC Infrastructure Investment Summit and Conference	11/2012		
Implementation of the Action Plan	01/2013		
First evaluation and review at national level		12/2015 Report submitted to Minister responsible for sector, MASA and SADC Secretariat	
First evaluation and review at regional level Convene a first regional stakeholders' review meeting			12/2017 Report submitted to both Ministers responsible for the sector and Council of Ministers
Second evaluation and review at national level		12/2018 Report submitted to Minister responsible for the sector, MASA and SADC Secretariat	
Third evaluation and review at national level		12/2021 Report submitted to Minister responsible for the sector, MASA and SADC Secretariat	
Second evaluation and review at regional level Convene a second regional stakeholders' review meeting			12/2022 Report submitted to both Ministers responsible for the sector and Council of Ministers
Fourth evaluation and review at national level		12/2024 Report submitted to Minister responsible for the sector, MASA and SADC Secretariat	
Third evaluation and review at regional level			12/2027 Report submitted to both Ministers responsible for the sector and Council of Ministers

However, it is recommended that the national level evaluation and review meetings are held more frequently or as the need may arise during the Master Plan implementation stage.

4.1.2.4 Monitoring Mechanism for Status of Implementation

In section 3.1.4 above some projects, intervention mechanisms and expected results have been discussed under each strategic goal. In order to monitor the implementation of the activities of the Master Plan projects it is important to indentify performance indicators for each expected result. As part of the monitoring mechanisms, it is important that an evaluation based on these performance indicators is conducted after every five years by the SADC Secretariat to evaluate implementation both at national and regional level. Since implementation of some activities at national level will be ongoing, more frequent evaluation at three year intervals is recommended. The results of these evaluations will provide information on the problems and successes in the implementation of the proposed SADC Regional Infrastructure Development Master Plan and will guide improvement of implementation in the remaining period.

4.2 Critical Factors for Successful Implementation

Successful implementation of the Master Plan will depend on a number of factors relating to SADC internal and external issues. SADC includes many countries that have different national policies, strategies and economic development pathways. Therefore each country will have its own priorities which may not accord with Vision 2027. Global economic development trends will also have a major impact on the implementation of the Master Plan. Against this background, critical factors that will contribute to the successful implementation of the Master Plan include:

- Availability of sufficient resources to implement the proposed strategies both at national and regional level;
- Member States need to give high priority in their national plans to implementing the set goals of the Master Plan;
- As governments will be required to continue financing their respective NMSs, Member States should set aside sufficient funds in their budgets to support the implementation of some of the activities of the Master Plan;
- Development Partners need to be supportive of both regional and national activities that support implementation of the Master Plan goals;
- NMSs need to fulfil their respective national goals, while collaborating with other regional NMSs on matters of regional significance; and
- Institutions such as the WMO will need to play a coordination and supportive role to SADC regional centres and NMSs.

SADC should establish a mechanism that will ensure its continued supportive and guiding role throughout the whole process.

5. Annexures

Annexure 1: Implementation Strategy of Prioritised Projects

SADC METEOROLOGY SECTOR DEVELOPMENT MASTER PLAN 2012-2027

No	IMPLEMENTATION STRATEGY OF PRIORITISED PROJECTS				
1.	**PROJECT STRATEGIC GOAL 1:** Strengthening of the Meteorological Observation Network in the SADC region				
	Strategic Interventions	**Project Activities**	**Budget US$ ('000)**	**Funding/ Action Party**	**Timeline**
	1.1 Establish new/revive silent rainfall and climate stations at national level to increase the network available for monitoring climate	1.1.1 Establish new and revive silent rainfall stations	24	SADC, Member States, Development Partners	2012-2026
		1.1.2 Establish new climate stations	1275		
	1.2. Expand surface observation network in SADC including over the Indian Ocean and inland lakes	1.2.1 Establish new Synoptic Stations	5200	SADC, Member States, Development Partners	2012-2027
	1.3. Increase the number of the AMDAR aircraft reports	1.3.1 Recruiting and equipping airlines with the necessary equipment for AMDAR data transmission.	2000	SADC, Member States Development Partners	2012-2027
	1.4 Establish//Rehabilitate Automatic Weather Observation Stations (AWOSs) and Automatic Weather Stations (AWSs) in data sparse areas, within the manned stations, along the coast, and over large lakes, and upgrade the existing ones	1.4.1 Acquire and install AWOSs at identified locations	3500	SADC, Member States, Development Partners	2012-2027
		1.4.2 Support in acquisition and implementation of automatic weather stations (AWSs)	5,750		
	1.5 Deploy drifting and fixed buoys in SWIO eastern Atlantic Oceans	1.5.1 Support acquisition and installation of drifting and fixed buoys at identified locations	4,050 (50 K@ drifting buoy+ 60 K@ fixed buoy)	SADC, Member States, Development Partners	2012-2027
	1.6 Revive silent stations and upgrade outdated upper air stations at various locations in SADC	1.6.1 Purchase new equipment and spares	6,900	SADC, Member States, Development Partners	2012-2027

	1.7	Acquire and network weather radars in the SADC Partner States for monitoring real-time weather for public safety and for the safety and efficiency of air transport, and marine navigation among other weather dependent activities	1.7.1	Purchase and install radars at identified locations ***These can be installed in three phases of 5 years each***	52,500	SADC, Member States, Development Partners	2012-2017 2018-2022 2023-2027
	1.8	Establish a lightning detector network for early warning of severe weather events in SADC	1.8.1	Acquire and install lightning detectors at identified locations in SADC	3,790	SADC, Member States Development Partners	2012-2017
	1.9.	Train staff at RIC and NMSs in management, operation and maintenance and calibration of observation instruments	1.9.1	Support training of staff on specialised instrument calibration courses	300	SADC, Member States	2012-2027
	1.10.	Allocate adequate staff to the RIC and make necessary calibration instruments available	1.10.1	Recruit staff at RIC	240	SADC, Member States	2012-2017
			1.10.2	Acquire calibration instruments and tools	100		2012-2017
	1.11.	Develop an MoU to facilitate smooth export and re-importation of instruments to be calibrated between NMSs and RIC	1.11.1	Facilitate development of MoU between RIC, host country and NMSs or other SADC Member States	NIL	SADC, host country and other Member States	2012-2013
PROJECT SUB-TOTAL					**85,629**		

NO	IMPLEMENTATION STRATEGY OF PRIORITISED PROJECTS				
2	**PROJECT STRATEGIC GOAL 2:** Improvement of Meteorological Telecommunications and Communication Systems for rapid data collection, exchange and dissemination of data and information				
	Strategic Interventions	**Project Activities**	**Budget US$ ('000)**	**Funding/ Action Party**	**Timeline**
	2.1 Acquire new and replace aging Automatic Message Switching Systems at NMCs	2.1.1 Installation of AMSSs at RTH and all NMCs of Member States	1,680	SADC Member States Dev. Partners	2012-2017
	2.2 SADC and Member States develop a policy to support the establishment of V-sat Networking for exchange of meteorological data and products in the region	2.2.1 Developing a policy for networking V-sat systems for meteorological data exchange	150	SADC Member States Dev. Partners	2012-2017
	2.3 Partner States support NMSs to rehabilitate/modernise National Meteorological Telecommunications Networks for data collection and transmission facilities at NMCs along WMO WIS/GTS guidelines	2.3.1 Introduction of satellite based communications such as VSAT networks nationally and at sub-regional level 2.3.2 Installation of radio-telecommunication systems (HF, VHF), use of SMS, and internet	300	SADC Member States Dev. Partners	2012-2017
	2.4 SADC support NMSs to implement broadband high-speed Internet access at all 15 NMCs and at the CSC in support of NWP and Climate Modelling and prediction services	2.4.1 Implementation of broadband internet connectivity at CSC and at NMCs	600	SADC Member States Dev. Partners	2012-2017
	2.5 Upgrade/modernise NMS's media systems for information dissemination	2.5.1 Acquisition of necessary Media infrastructure and software for timely production and dissemination of forecasts	1500	SADC Member States, SADC, Dev. Partners	2012-2022
PROJECT 2 SUB-TOTAL			**4,230**		

NO	IMPLEMENTATION STRATEGY OF PRIORITISED PROJECTS				
3	**PROJECT STRATEGIC GOAL 3:** Improvement of technical capacity (resources, expertise to generate appropriate policy-relevant climate information and operational warning services				
	Strategic Interventions	**Project Activities**	**Budget US$ ('000)**	**Funding/ Action Party**	**Timeline**
	3.1 NMSs and CSC develop new innovative products, starting as a pilot project at CSC and some NMS, replicating to others later	3.1.1 Support CSC and NMSs to conduct research on generation of application products tailored to specific user needs for: energy generation, disaster management, agriculture, water resources management, health and building and construction industry	600 (15 Centres*40)	SADC Member States Dev. Partners	2012-2017
		3.1.2 Implement sector specific pilot application projects (energy generation, disaster management, agriculture, water resources management, health and building and construction industry) in Member States	500 (5 PAPs*5*20)		
	3.2 SADC and Member States support training on new product development and packaging techniques involving CSC in collaboration with NMSs and Development Partners	3.2.1 CSC in collaboration with NMSs and Partners conduct training workshops on new product development and packaging techniques	420 (70 pp*$150*10 days*2 workshops)	SADC Member States Dev. Partners	2012-2017
	3.3 SADC, MASA and Member States support acquisition of relevant hardware and software for data analysis and generation of tailored products at CSC and at NMSs	3.3.1 Purchase computers and software for data analysis and generation of tailored products at CSC and NMSs	450 (30*15 Centres)	SADC Member States Dev. Partners	2012-2017
	3.4 SADC and Member States support upgrading of Database management systems including Data Rescue in NMSs	3.4.1 Upgrade Database management Systems of NMSs	1,020 (14 NMSs*80)	SADC Member States Dev. Partners	2012-2017

		3.4.2 Enhancing and modernising data storage facilities; and carrying out data rescue activities	770 (11 NMSs*70)		
		3.4.3 Train human resources on efficient data management	700 (14 NMSs*40)		
	3.5 SADC and Member States support upgrading and modernisation of real-time data processing and forecasting, post-processing and service production systems at NMSs and CSC	3.5.1 Procurement of real-time computerised data processing and forecasting systems and software for timely production forecasts	1400 (14 NMSs*100)	SADC Member States, SADC, Dev. Partners	2012-2022
	3.6 SADC, in collaboration with MASA, strengthen the capacity of NMSs and CSC for Numerical Weather Prediction (NWP) and climate modelling including assessment to high resolution climate scenarios	3.6.1 Procurement of hardware (workstations) and software for NWP at NMCs	1600 (14 NMCs*100 +200 CSC)	SADC Member States, SADC, Dev. Partners	2012-2027 5 Centres per 5 years
		3.6.2 Procurement of hardware and software for climate modelling			
	3.7 Member States support NMSs to improve Aviation Weather Services including introduction of QMS framework for aeronautical meteorological services and ISO certification	3.7.1 Support NMSs in Member States to implement QMS Framework for Meteorological services for air navigation and ISO certification	980 (70*14 States)	SADC Member States, SADC, Dev. Partners	
PROJECT 3 SUB-TOTAL			**8,440**		

NO	IMPLEMENTATION STRATEGY OF PRIORITISED PROJECTS				
4	**PROJECT STRATEGIC GOAL 4:** Improving the understanding of economic benefits and effective use of climate information and products through collaboration with stakeholders				
	Strategic Interventions	**Project Activities**	**Budget US$ ('000)**	**Funding/ Action Party**	**Timeline**
	4.1 Implement pilot application projects at CSC and NMS level to demonstrate economic benefits of meteorological services	4.1.1 Organise workshops at CSC and NMSs involving producers and users of climate information and products on the economic benefits of meteorological services	937.5 (70 pp*$150* 5 days*15 work shops+150)	SADC Member States, Dev. Partners	2012-2017
		4.1.2 Undertake pilot projects at national level to demonstrate the economic benefits of meteorological services	280 (20*14 Members)		
	4.2 Conduct capacity building workshops involving CSC, NMSs, RMTCs, stakeholders and users of climate information on best practices for effective use of climate information and products	4.2.1 Organisation of training workshops for stakeholders on effective use of weather and climate services at national and regional level	937.5 (70 pp*$150 *5 days*15 workshops+150)	SADC Member States, Dev. Partners	2012-2017
PROJECT 4 SUB-TOTAL			**2,155**		

NO	IMPLEMENTATION STRATEGY OF PRIORITISED PROJECTS					
5	**PROJECT STRATEGIC GOAL 5:** Strengthening institutional capacity of the NMSs to provide relevant, reliable and timely climate and weather services					
	Strategic Interventions		**Project Activities**		**Budget US$ ('000)**	**Funding/ Action Party**	**Timeline**
	5.1	Develop policy for the Meteorology Sector at regional and national level and institutional framework for the transformation of the NMSs to Autonomous/Semi-Autonomous Institutions	5.1.1	Establish policy for the Meteorology Sector both at national and regional level	1300 (100*13 States)	Member States	2012-2017
			5.1.2	Establish Legal and Institutional framework for the transformation of the NMSs to Autonomous/Semi-Autonomous Institutions.	1200 (100*12 States)	Member States	
	5.2	Improve funding base of the NMSs through strengthened status of the organisations and financial management	5.2.1	Organise workshops to create awareness and sensitise Policy Makers on the economic benefits of Meteorological Services	1400 (50*3 workshops* 14 States)	SADC Member States	2012-2017
	5.3	Improve human resources capacity (training of Class1 meteorologists especially in NWP) in Member States NMSs to ensure improved services	5.3.1	Support training of Class 1 meteorologists	3150 (45*70 pp)		
			5.3.2	Support training of Class 1 meteorologists in NWP and climate modelling	1200 (20*60 pp)		
	5.4	Improve management, planning, operational and maintenance practices in the NMSs to ensure efficient use of resources and quality services to customers	5.4	Support training of staff in management, planning, and maintenance practices	2520 (20*9 pp* 14 States)		
PROJECT 5 SUB-TOTAL					**10,770**		

NO	IMPLEMENTATION STRATEGY OF PRIORITISED PROJECTS					
6	**PROJECT STRATEGIC GOAL 6:** 6.Strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RMTCs, RICC) to function as efficient regional coordination, development, services and dissemination centres					
	Strategic Interventions		**Project Activities**		**Budget US$ ('000)**	**Funding/ Action Party**	**Timeline**
	6.1	SADC, in collaboration with MASA, develop coordination and management mechanisms to ensure efficient regional coordination and cooperation between meteorological institutions and stakeholders	6.1.1	Financial support to MASA activities	500	SADC, Member States, Dev. Partners	2012-2017
	6.2	SADC support implementation of relevant regional events and networking	6.2.1	Support networking of climate scientists, media and users of weather and climate information and products (workshops, training events and exhibitions)	1000	SADC, Member States, Dev. Partners	2012-2017
	6.3	Improve funding base for the CSC and RICC to ensure efficient functioning of the institutions	6.3.2	Allocation of adequate budgetary commitments by SADC for CSC and RICC operations		SADC	2012-2027
	6.4	Upgrade human resources and infrastructure (office accommodation) of the CSC and RIC to ensure availability of requisite services	6.4.1	Recruit and maintain at least 10 personnel at CSC	5220	SADC, Dev. Partners	2012-2027
			6.4.2	Recruit and maintain at least 3 personnel at RICC	1,350	Botswana Govt, Dev Partners	2012-2027
	6.5	Upgrade meteorological and technical (hardware and software) infrastructure at SCS and RICC	6.5.1	Purchase hardware and software for operations at CSC	700	SADC, Dev. Partners	2012-2017
			6.5.2	Purchase equipment for instrument calibration at RICC	200	Botswana Govt, Dev. Partners	
PROJECT 6 SUB TOTAL					**8,970**		
TOTAL					**120,194**		

Annexure 2: Implementation Plan for Strengthening of Meteorological Observation Station Network

Country	SYNOP Stations			Climate Stations		Upper air stations proposal	AMDAR	Automatic Weather Stns				TEMP stations		Lightning			Radar stations		Total cost
								AWS proposal	AWOS	AWS				Lightning proposal	Detection				
	(Unit cost=25)	No (Unit cost=25)	Cost US$'000	No (Unit cost=25)	Cost US$'000				No (Unit cost=250)	No (Unit cost=250)	Cost US$'000	No (Unit cost 300)	Cost US$'000		No (Unit cost35)	Cost US$'000	No (Unit cost2500)	Cost US$'000	Cost US$'000
Angola	20	10	500	10	200	5		20	1	10	500	2	600	**20**	12	420	2	5,000	7,220
Botswana	20	5	250	5	100	5		20	1	5	375	2	600	**20**	5	175	1	2,500	4,000
DRC	40	10	500	10	200	10		40	1	10	500	3	900	**40**	25	875	3	7,500	10,475
Lesotho	10	-	50	1	20	2		10	1	1	275		300	**10**	1	35	1	2,500	3,180
Malawi	10	2	100	3	60	3		10	1	3	325	1	300	**10**	1	35	1	2,500	3,320
Mauritius	5		50	1	20	2		5	1	1	275	1	300	**5**	1	35	1	2,500	3,180
Mozambique	20	5	250	5	100	5		20	1	5	375	1	300	**20**	10	350	1	2,500	3,875
Namibia	20	4	200	4	80	5		20	1	4	350	2	600	**20**	10	350	2	5,000	6,580
RSA	30	-	50		20	10		30	1		250		300	**30**	25	875	1	2,500	3,995
Seychelles	5		50		20	2		5	1	2	300		300	**5**	1	35	1	2,500	3,205
Swaziland	10		50	1	20	2		10	1	1	275		300	**10**	1	35	1	2,500	3,180
Tanzania	30	5	250	5	100	10		30	1	5	375	2	600	**30**		35	2	5,000	6,360
Zambia	30	3	150	3	60	5		30	1	3	325	2	600	**30**	10	350	2	5,000	6,485
Zimbabwe	30	3	150	3	60	5		30	1	3	325	2	600	**30**	5	175	2	5,000	6,310
TOTAL	**280**	**47**	**2350**	**51**	**1020**	**71**		**280**	**14**	**53**	**4825**	**18**	**5400**	**280**	**107**	**3745**	**21**	**52,500**	**69,840**

Annexure 3: Profiles of Ongoing and Proposed Projects for the Meteorology Sector

<table>
<tr><td>Title of Project</td><td>AMESD (African Monitoring of the Environment for Sustainable Development)
Thematic Action on Agricultural and Environmental Resource Management</td></tr>
<tr><td>Project ID Number</td><td>FED /2009/244-432</td></tr>
<tr><td>Date of PD Preparation</td><td>February 2009 – November 2009</td></tr>
<tr><td>Project Contact – Person/ Entry</td><td>Mr Phetolo Phage (Director)
Botswana Department of Meteorological Services
Plot 54216, Corner Maaloso-Metsimotlhabe Road
P.O. Box 10100, Gaborone, BOTSWANA.
Tel: +267 361 22 71, Fax: +267 395 62 82
Email: pphage@gov.bw</td></tr>
<tr><td>Project Sponsors</td><td>European Union (9th European Development Fund)</td></tr>
<tr><td>Corridor</td><td>N/A</td></tr>
<tr><td>Participating Countries</td><td>Angola, Botswana, Namibia, Lesotho, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Zimbabwe, and Zambia.</td></tr>
<tr><td>Project Location</td><td>Department of Meteorological Services, Botswana</td></tr>
<tr><td>Sector (Road/Rail/Air/ Water)</td><td>Meteorology</td></tr>
<tr><td>Objectives</td><td>The overall objective of the AMESD programme in the SADC region is to enhance the management of agriculture and environmental resources in support of sustainable development</td></tr>
<tr><td>Project Description</td><td>Summary:
The project aims to put in place in the SADC region satellite data receiving systems (upgrade
of existing PUMA station in the National Meteorological Services and installation of new AMESD Stations in the Ministries of Agriculture and Environment) to facilitate access to environmental information derived from Earth Observation Technologies; Development and making operational Geo-information Services, strengthening the information management capacity of regional and national institutions in order to support decision and policy making processes; and build capacity at technical national institutes to ensure sustainability.

The African Union Commission (the Contracting Authority) is responsible for the overall management of the programme in the capacity of Delegated Regional Authorising Officer (DRAO).

The AMESD project has a programme Steering Committee on which the SADC Secretariat sits as a voting member in her capacity as the Regional Economic Community (project owner).

Technical /operational Features:
Botswana Department of Meteorological Services is the lead Partner in the implementation
of the AMESD Programme and is supported by the following partners:

<table>
<tr><th>Name of Partner</th><th>Main role</th></tr>
<tr><td>Agriculture Research Council (ARC)</td><td>Development of the Drought service</td></tr>
<tr><td>University of Zimbabwe (US)</td><td>Capacity building for Drought service</td></tr>
<tr><td>CSIR-Meraka</td><td>Development of the Fire Service</td></tr>
<tr><td>University of Botswana (UB)</td><td>Capacity building for Fire Service</td></tr>
<tr><td>BDMS</td><td>Development of the Agriculture Service</td></tr>
<tr><td>University of Botswana (UB)</td><td>Capacity building for the Agriculture Service</td></tr>
<tr><td>South African Weather Service (SAWS)</td><td>Provide support to development of the core services (Drought, Fire and Agriculture)</td></tr>
<tr><td>South African National Space Agency</td><td>Provision of data (country mosaic) towards support on data access</td></tr>
</table>
</td></tr>
</table>

Expected Results	**<u>Outputs:</u>** Four (4) Key Result Areas are defined for the project: **Result Area 1:** To improve Earth Observation Data Access in the Region/ Member States by: • Upgrading eleven (11) PUMA Station in National Meteorological Services • Installing ten (10) AMESD – Environment Station at the Ministry of Agriculture • Installing eleven (11) AMESD Fire stations in the Ministry of Environment • Providing each Member State (Ministries of Environment, Ministry of Agriculture and Universities) with three (3) 1Tb disk full of country mosaic of historical EO data for research purposes. **Result Area 2:** Three core service development, implementation and operational areas (Agriculture, Drought and Fire) are foreseen in the SADC THEMA. The Agricultural Service will monitor the state of the crops and rangeland. The Drought Service will monitor drought during the whole year and deliver a decadal "Drought map" and a "Drought Outlook" in support of both agriculture and environmental issues. The Fire Service will provide a daily fire risk indication (before the fire), continuous active fire maps (in real time during the fire season, refreshed every 15 minutes) and monthly burnt area assessments (after the fire). A common "Long Range forecast" service will complement the three (3) core services and provide them with a seasonal forecast outlook. **Result Area 3:** To strengthen policy development frameworks of participating Member States by sensitising decisions on the AMESD Programme and encouraging them to utilise the outputs of the programme in policy development framework. **Result Area 4:** To ensure that adequate technical expertise of the SADC THEMA is made permanent by implementing various capacity building activities (strategic objectives).
On-going related activities in SADC/ Tripartite Region	**<u>Activities:</u>** **Result Area 1:** Upgrading of PUMA stations (in NMS) completed Installation of AMESD E-station (in Ministry of Agriculture) completed Installation of AMESD Fire station (in Ministry of Environment) on-going **Result Area 2:** Development of Agriculture, Fire and Drought service on-going at BDMS and Partners **Result Area 3:** Three (3) Regional workshops (Kickoff, Mid-term and Final workshop) and twenty two (22) National workshops are planned during the implementation phase of the thematic action in each participating SADC Member State (Angola, Botswana, Namibia, South Africa, Swaziland, Lesotho, Zimbabwe, Zambia, Malawi, Tanzania and Mozambique) by May 2013. **Result Area 4:** Two regional and twenty two (22) national training sessions are planned during the implementation phase of the thematic action in each participating SADC Member State (Angola, Botswana, Namibia, South Africa, Swaziland, Lesotho, Zimbabwe, Zambia, Malawi, Tanzania and Mozambique) by May 2013. See attached implementation status Report (5-May 2010 – 31-October 2011) for achievements in the four result areas in the past 18 months. The project has a further 18 months of implementation remaining.
Description of national plan of the project	Not foreseen in AMESD. Follow up project (MESA: 2013- 2016) expected to make contribution.
Status	See attached implementation status Report (5-May 2010 – 31-October 2011).

Social and/or Environmental Impact Statements		Better informed decisions on environmental aspects.	
Next steps		Preparation of the follow up Project on-going. The project is called Monitoring of the Environment for Security in Africa. The project is sponsored by the European Union. The project is expected to consolidate AMESD outputs and introduce new services e.g. Flood Monitoring Service.	
Business Model		N/A	
Implementing Agency		BDMS (Botswana Department of Meteorological Services)	
Main Parties in Place		N/A	
Main parties to be procured		N/A	
Technical/Operational Notes		As above	
Project Documentation		See attached Grant Contract Document.	
Intervention for which Financing is required		None	
Revenues for Repayment of Financing		N/A	
Estimated Total Cost			
Estimated Total cost	**Finance secured**	**Finance unsecured**	**Remark/Financier/**
€1,956,000.00	**€1,956,000.00**	**None**	
Source:	**EU (EDF)**		

Title of Project	**ISACIP**		
Project Sponsors	AfDB		
Corridor			
Participating Countries	AFRICA-WIDE		
Objectives	Strengthen the capacities of African regional climate centres to generate and disseminate climate information to support economic development in the African continent.		
Project Description	Project has three components: production of climate related information, enhancement of capacity of scientists and institutional strengthening.		
Expected Results	Improved access to observation network, operationalisation of climate information system, downscaling global climate data and scenarios, climate impact assessment.		
On-going related activities in SADC/Tripartite Region			
Description of national plan to the project	N/A		
Status	At the starting point		
Next steps			
Business Model			
Main parties in place	AfDB-ACMAD		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	Yes		
Intervention for which financing is required	Counterpart funding for the next year		
Revenues for repayment of financing	Grant		
Estimated Total Cost	**Finance secured**	**Finance unsecured**	**Remark/Financier**
€4 million	**1st year**	**Counterpart fund**	**AfDB**

Title of Project	**ClimDev-Africa**		
Project Sponsors	AfDB		
Corridor			
Participating Countries	AFRICA-WIDE		
Objectives	Strengthen national and sub-regional institutional capacities to overcome the lack of necessary climate information, analysis and options required by policy and decision makers at all levels within the context of threats of climate change.		
Project Description	Climate for Development in Africa Project.		
Expected Results	Availability of weather and climate Information contributing to overall sustainable development and poverty reduction in Africa.		
On-going Related activities in SADC/ Tripartite Region			
Description of national plan to the project	N/A		
Status	Ongoing		
Next steps			
Business model			
Main parties in place	AUC, UNECA, AfDB		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	YES		
Intervention for which financing is required			
Revenues for Repayment of Financing			
Estimated Total Cost	**Finance secured**	**Finance unsecured**	**Remark /Financier**
US$68,700,000.00	**YES**		

Title of Project	**SADC REGIONAL INFRASTRUCTURE DEVELOPMENT MASTER PLAN**		
Project Sponsors	SADC/COMESA		
Corridor			
Participating Countries	SADC-WIDE		
Objectives 1	Strengthening of the Weather and Climate Observation Network in the SADC region		
Project Description	SADC Regional Infrastructure Development Master Plan-Meteorology Sector		
Expected Results	Availability of more reliable, timely weather and climate prediction forecasts and relevant information including climate variability and change for making informed decisions.		
On-going related activities in SADC/ Tripartite Region	SAMPRO Project EAC Meteorological Development Investment Strategy AMESD,GCOS, ClimDev Africa		
Description of national plan to the project	N/A		
Status	Being developed		
Next steps			
Business Model			
Main parties in place	SADC, COMESA, Member States of SADC		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	Under preparation		
Intervention for which financing is required	**Interventions are:** • Revival/establishment of more rainfall and climate stations at national level to increase the network available for monitoring climate and have more data for applications; • Revival/improvement of surface observation network in SADC including over the Indian and Atlantic Oceans and inland lakes; (SYNOP, DCPs); • Increase the number of the AMDAR aircraft reports; • Establishment of Automatic Weather Observation Stations (AWOSs) at airports and Automatic Weather Stations (AWSs) in data sparse areas, within the manned stations, along the coast, over large lakes, and upgrade the existing ones; • Revival of silent stations and upgrade outdated upper air stations at various NMSs; • Deploy drifting and fixed buoys over the SW Indian and eastern Atlantic Oceans; • Acquisition and networking of weather radars in the SADC Partner States for monitoring real-time weather; • Establish a Lightning Detection Network (LDN) over the entire SADC region; • Training of staff at RIC and NMSs in management, operation, maintenance and calibration of observation instruments; • Training of staff at RIC on instrument calibration; • Allocate adequate staff to the RIC and avail necessary calibration instruments; and • Develop a MoU to facilitate smooth export and re-importation of instruments to be calibrated between NMSs and RIC.		
Revenues for Repayment of Financing			
Estimated Total Cost	**Finance secured**	**Estimated Total Cost**	**Finance secured**
US$85,629,000		**US$85,629,000**	

Title of Project	**SADC REGIONAL INFRASTRUCTURE DEVELOPMENT MASTER PLAN**		
Project Sponsors	SADC/COMESA		
Corridor			
Participating Countries	SADC-WIDE		
Objectives 2	Improvement of Meteorological Telecommunications and Communication systems for rapid data exchange of data and dissemination of information		
Project Description	SADC Regional Infrastructure Development Master Plan-Meteorology Sector		
Expected Results	Improved availability of quantity and quality data and products. Efficient exchange of data and products. Availability of more reliable, and timely weather and climate prediction forecasts and relevant information including climate variability and change for informed decision making by policy makers and other users.		
On-going Related activities in SADC/ Tripartite Region	SAMPRO Project EAC Meteorological Development Investment Strategy AMESD		
Description of national plan to the project	NA		
Status	Being developed		
Next steps			
Business Model			
Main parties in place	SADC, COMESA,SDAC Member States		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	Under Preparation		
Intervention for which financing is required	**Interventions are:** • Replacement of the aging Automatic Message Switching Systems at NMCs; • Development of a policy to support the establishment of V-sat Networking for exchange of meteorological data and products in the region; • Rehabilitation/modernisation of National Meteorological Telecommunications Network for data collection and exchange facilities at NMCs along WMO WIS/GTS guidelines; • Implementation of broadband high-speed Internet access at all the NMCs and at the CSC in support of NWP and climate modelling and prediction services; • Improving of media systems for information dissemination within the NMSs; and • Implementation of Table Driven Code Formats (TDCF) by all NMSs.		
Revenues for repayment of financing			
Estimated Total Cost	**Finance secured**	**Estimated Total Cost**	**Finance secured**
US$4,230,000		**US$4,230,000**	

Title of Project	**SADC REGIONAL INFRASTRUCTURE DEVELOPMENT MASTER PLAN**		
Project Sponsors	SADC/COMESA		
Corridor			
Participating Countries	SADC-WIDE		
Objectives 3	Improvement of level of technical capacities (resources, expertise to generate appropriate policy-relevant climate information and operational warning services)		
Project Description	SADC Regional Infrastructure Development Master Plan-Meteorology Sector		
Expected Results	Improved data base for the SADC region. Improved medium-term to long-term forecasts. Improved human resource capacity and research products. Improved accuracy of forecasts and of early warning products. Availability of quality user-friendly sector-specific/tailored products. NMSs with QMS frameworks and ISO certification in place.		
On-going related activities in SADC/Tripartite Region	SAMPRO EAC		
Description of national plan to the project	NA		
Status	Being developed		
Next steps			
Business Model			
Main parties in place	SADC, COMESA		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	Under preparation		
Intervention for which financing is required	**Interventions are:** • Development of new innovative products, starting as a pilot project at CSC and some NMSs, replicating to others later on; • Regional/sub-regional training on new product development and packaging techniques conducted involving CSC in collaboration with NMSs and Development Partners; • Upgrading of Database management systems including Data Rescue at CSC and NMSs; • Acquisition of relevant hardware and software for data analysis and generation of products at CSC and at NMSs; • Modernisation of real-time data processing and forecasting, post-processing and service production systems; • Improving capacity for generation of tailor made sector specific products; • Improving regional and national capacity (hardware and software) for Numerical Weather Prediction (NWP) and dynamic climate modelling including assessment of high resolution climate scenarios; and • Improvement of Aviation Weather Services in NMSs including introduction of QMS framework for aeronautical meteorological services and ISO certification.		
Revenues for Repayment of financing			
Estimated Total Cost	**Finance secured**	**Estimated Total Cost**	**Finance secured**
US$8,440,000		**US$8,440,000**	

Title of Project	**SADC REGIONAL INFRASTRUCTURE DEVELOPMENT MASTER PLAN**		
Project Sponsors	SADC/COMESA		
Corridor			
Participating Countries	SADC-WIDE		
Objectives 4	Improving the understanding of economic benefits and effective use of climate information and products through collaboration with stakeholders		
Project Description	SADC Regional Infrastructure Development Master Plan-Meteorology Sector		
Expected Results	Availability of guidance on the generation of sector specific/tailored information and products. Improved capacity for generation. Improved understanding of weather and climate services by users. Enhanced and effective use of weather and climate services and products.		
On-going related activities in SADC/ Tripartite Region	SAMPRO EAC		
Description of national plan to the project	NA		
Status	Being developed		
Next steps			
Business Model			
Main parties in place	SADC, COMESA		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	Under preparation		
Intervention for which financing is required	**Interventions :** • Implementation of application pilot projects at CSC and NMS level to demonstrate economic benefits of meteorological services; and • Conduct capacity building workshops involving CSC, NMSs, stakeholders and users of climate information on best practices for generation and effective use of climate products and information.		
Revenues for Repayment of Financing			
Estimated Total Cost	**Finance secured**	**Estimated Total Cost**	**Finance secured**
US$2,155,000		**US$2,155,000**	

Title of Project	**SADC REGIONAL INFRASTRUCTURE DEVELOPMENT MASTER PLAN**		
Project Sponsors	SADC/COMESA		
Corridor			
Participating Countries	SADC-WIDE		
Objectives	5.1 Strengthening institutional capacity of the NMSs to provide relevant, reliable and timely climate and weather services; 5.2 Strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RIC) to function as efficient regional coordination, development and dissemination centres; 5.3 Coordination and management mechanisms developed to ensure efficient regional coordination and cooperation between meteorological institutions and stakeholders; 5.4 Support implementation of relevant regional events and networking; 5.5 Funding base for the (SCS, MASA, and RIC) strengthened for efficient functioning through improved institutional capacity both in terms of human resources and infrastructure.		
Project description	SADC Regional Infrastructure Development Master Plan-Meteorology Sector		
Expected results	Availability of harmonised Meteorology Policy for the region and at national level. Availability of guidance on the generation of sector specific/tailored information and products. Improved capacity for generation and effective use of products. Improved products and services from the regional centres.		
On-going related activities in SADC/Tripartite Region	SAMPRO EAC		
Description of National plan to the project	NA		
Status	Being developed		
Next steps			
Business Model			
Main parties in place	SADC, COMESA		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	Under preparation		
Intervention for which Financing is required	**Interventions are:** • Conduct capacity building in the management of NMSs to ensure improved capacity of the NMSs to provide relevant, reliable and timely climate and weather services; • Develop a harmonised Policy for the Meteorology Sector at regional and national level; • Strengthen the funding base of the NMSs through improved financial management and strengthened status of the organisations; • Strengthen human resources of the NMSs to ensure improved services; • Establish modalities for enhanced networking and cooperation between NMSs with SADC's relevant organisations and processes for active sharing of data and experiences; • Improve management, planning, operational and maintenance practices in the NMSs to ensure efficient use of resources and quality services for the key customers.		
Revenues for Repayment of Financing			
Estimated Total Cost	**Finance secured**	**Estimated Total Cost**	**Finance secured**
US$10,770,000		**US$10,770,000**	

Title of Project	**SADC REGIONAL INFRASTRUCTURE DEVELOPMENT MASTER PLAN**		
Project Sponsors	SADC/COMESA		
Corridor			
Participating Countries	SADC-WIDE		
Objectives 6	• Strengthening capacity of the regional climate and meteorological units of SADC (CSC, MASA, and RIC) to function as efficient regional coordination, development, services and dissemination centres; • Coordination and management mechanisms developed to ensure efficient regional coordination and cooperation between meteorological institutions and stakeholders; • Support Implementation of relevant regional events and networking; • Funding base for the (SCS, MASA, and RIC) strengthened for efficient functioning through improved institutional capacity both on human resources and infrastructure.		
Project Description	SADC Regional Infrastructure Development Master Plan-Meteorology Sector		
Expected Results	Availability of harmonised Meteorology Policy for the region and at national level. Availability of guidance on the generation of sector specific/tailored information and products. Improved capacity for generation and effective use of products. Improved products and services from the regional centres.		
On-going related activities in SADC/ Tripartite Region	SAMPRO EAC		
Description of national plan to the project	NA		
Status	Being developed		
Next steps			
Business Model			
Main parties in place	SADC, COMESA		
Main parties to be procured			
Technical/Operational Notes			
Project documentation available	Under preparation		
Intervention for which financing is required	**Interventions are:** • SADC in collaboration with MASA develop coordination and management mechanisms to ensure efficient regional coordination and cooperation between meteorological institutions and stakeholders; • SADC support implementation of relevant regional events and networking; • Improve funding base for the (CSC and RIC) to ensure efficient functioning of the institutions; • Upgrade human resources and infrastructure (office accommodation) of the CSC and RIC to ensure availability of requisite services; and • Upgrade meteorological and technical (hardware and software) infrastructure at SCS and RIC		
Revenues for Repayment of Financing			
Estimated Total Cost	**Finance secured**	**Estimated Total Cost**	**Finance secured**
US$8,970,000		**US$8,970,000**	

Annexure 4: Guidance for Prioritisation of Projects for the Meteorology Sector

Overarching Criteria

- The Project should foster economic development, poverty reduction and regional integration.
- All regional projects should be channelled through the SADC structure.
- The project should have the necessary enabling environment, for example policy, legal and regulatory instruments in place – or, at a minimum, have no major legal impediment.

Criteria for Regional Infrastructure Project Selection in all Sectors

- The Project should benefit all Member States.
- A cross-sectoral project will be given special consideration.
- The Project should fill a gap identified in the Diagnostic Sector Analysis.
- The Project should have the commitment of all the states involved in the form of a formal agreement to take the project forward.
- Projects can be identified as short-term, medium-term and long-term.

Additional Requirements for Short-term Projects (2013 – 2018)

- The Project should fill an immediate need to fill a gap in infrastructure development and service delivery. There should be some projects that can achieve quick win, rapid results and have adequate capacity to implement and for sustainability.
- There should be identified and demonstrated socio-economic demand for the Project.
- The Project should be in line with the SADC Protocol on Transport Communication and Meteorology.
- The technical design is appropriate and there are no significant environmental impediments. Preliminary economic and financial analysis is positive.
- Resource requirements should be spelt out.

Additional Requirements for Medium-term Projects (2018 – 2023)

- Projects should fill a medium-term requirement identified in the Diagnostic Report when prerequisite projects are completed.
- Projects should be ready for preparation around 2018, including market assessment, prefeasibility technical design, initial environmental and social evaluation and positive economic and financial assessment.
- Participating countries should address the availability of necessary policy, legal and regulatory instruments prior to 2018.
- Financing should be committed or available.
- Project preparation should start far enough in advance so that projects can be initiated by 2018 or 2019.

Additional Requirements for Long-term Projects (2024- 2030)

Project preparation for long-term projects should begin in the previous period, so that projects are ready for the 2024 – 2030 period. The same criteria would apply as for medium-term, however, the appropriate project sequencing falls in the later period.

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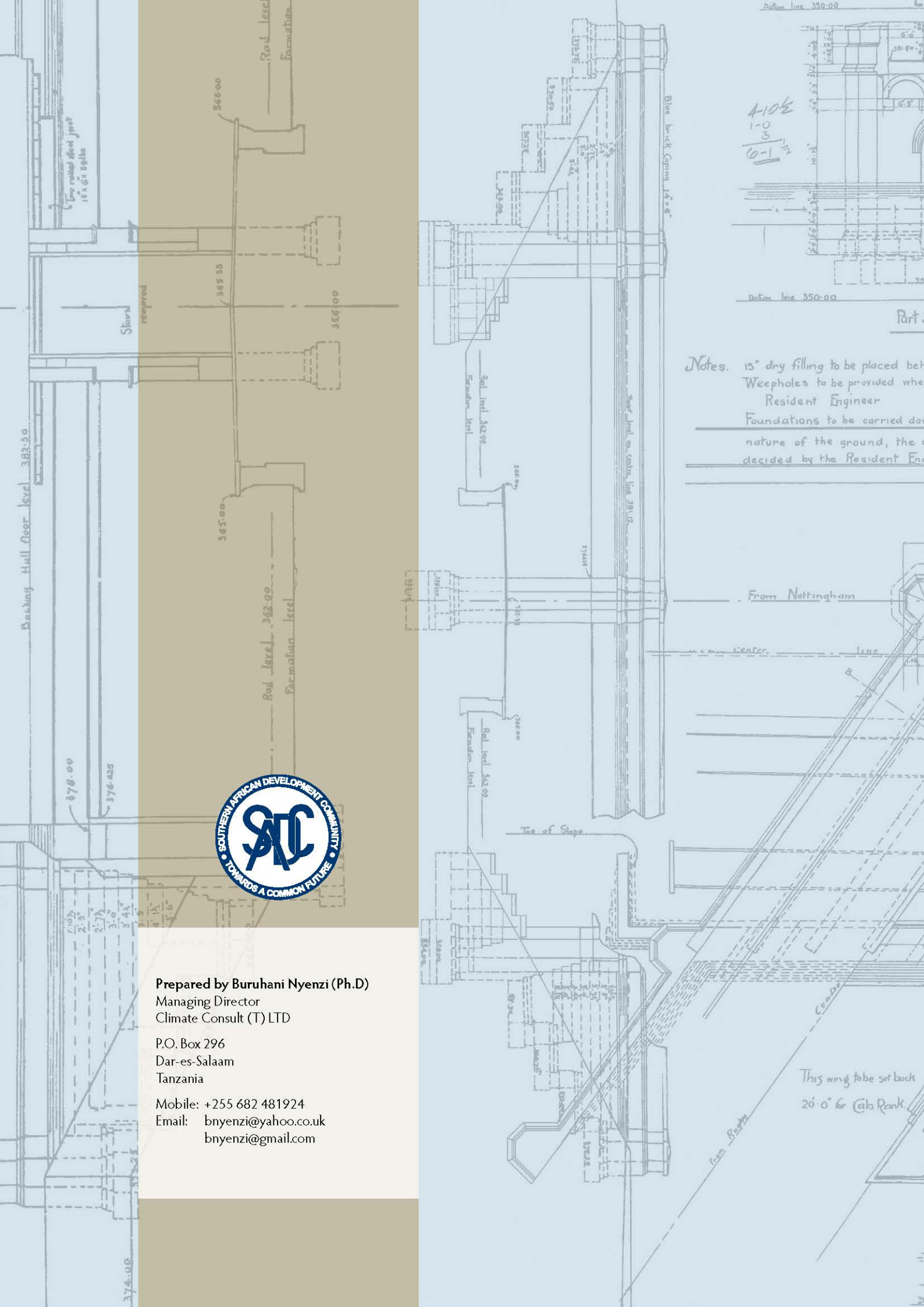

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